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1990

CANADIAN MINERALS YEARBOOK

REVIEW AND OUTLOOK

Energy, Mines and Resources Canada
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Foreword

Each year, Energy, Mines and Resources Canada completes a comprehensive review of developments in the minerals and metals sector and publishes the results as the Canadian Minerals Yearbook. The subject matter spans all aspects from geoscience and exploration, through mining and processing, to markets, consumption and recycling. Although domestic developments receive the greatest attention, international items are also reviewed because of the worldwide interrelationship that is characteristic of this sector. Some chapters of the Yearbook are intended to be general enough to be of interest to a broad readership, while others are more technical and will largely appeal to individuals who are directly or closely associated with the industry.

The Canadian Minerals Yearbook series forms a continuous record from year to year. Generally, the basic industry indicators are comparable from one year to the next, but format and focus may shift over time. An example is the prominence given to trade, markets, health and the environment in the current commodity chapters. In earlier times, commodity markets were mainly supply driven; they are now largely demand driven.

The ups and downs of the industry, which have been especially pronounced during the past decade, have been leading factors in determining content in the Yearbook. Many analysts began to view the minerals and metals sector as a sunset industry because of its difficult recovery from the 1981/82 recession. This prognostication appears to have been premature as the value of production for the sector has recently made strong gains to reach $41.3 billion in 1990, representing 6.1% of the economy and accounting for an impressive 26.6% of Canada's merchandise exports. Clearly, the industry will remain a cornerstone of the Canadian economy for some time to come.

Although the minerals and metals industry successfully managed to readjust to some very fundamental changes in the 1980s, there is evidence that more change will be needed in this decade. The environment, free trade and globalization, which have important implications for the sector's competitiveness, have already appeared as leading issues for the 1990s. Fortunately, the minerals and metals industry is as well prepared now to manage and take advantage of the challenges and opportunities arising from these and other issues as it has been at any other time in its history.

This edition of the Yearbook reports on the activity of the minerals and metals industry during 1990. The first chapter is a general review that identifies the predominant economic events of 1990 and indicates the major trends in the Canadian economy. It also covers general developments in the minerals industry during the year. This is followed by chapters on the regional and international scenes, labour and employment, mine reserves and promising deposits, and mineral exploration. The 45 commodity chapters–the work of the Mineral and Metal Commodities Branch of the Mineral Policy Sector and the Uranium and Nuclear Energy Branch of the Energy Sector–feature economic and policy developments and data specific to each commodity on markets, prices, trade, production and consumption. The outlook section under each commodity review provides a forecast of the industry's future position.

The basic statistics on Canadian production, trade and consumption, unless otherwise stated, were collected by the Mineral and Metal Statistics Division, Mineral Policy Sector, and by Statistics Canada. Market quotations were taken mainly from published marketing reports. Corporate data were obtained directly from company officials through surveys or correspondence, or were extracted from annual reports. Energy, Mines and Resources Canada is grateful to everyone who contributed information used in the preparation of the Yearbook.

Additional copies of the Yearbook can be purchased from the Canada Communication Group-Publishing (819) 956-4802 and associated bookstores. Previous editions of the Canadian Minerals Yearbook have been deposited in various libraries across Canada.

Reprints of individual chapters and Map 900A, Principal Mineral Areas of Canada, may be obtained free of charge from:

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CHAPTERS

Note: Commodities shown in bold face are covered in this issue. The other commodities listed have appeared in previous editions.

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General Review

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THE CANADIAN ECONOMY IN 1990

The beginning of 1990 marked the entrance of the Canadian economy into its eighth year of expansion since the 1981/82 recession. After achieving growth in the first quarter, however, the economy then began a period of declining activity, with total output declining in each of the last three quarters. Nevertheless, on the basis of the entire year, the economy did manage to achieve some measure of real economic growth vis-à-vis the previous year. Real Gross Domestic Product (GDP at constant prices) was estimated to be up some one percent in 1990, contrasting sharply with the 3.0% growth achieved in 1989 and the 4.4% growth attained in 1988.

In general, 1990 was characterized by high interest rates, rising unemployment rates, weaker consumer spending, declining corporate profits and declining investment spending. In addition, a high Canadian dollar relative to the U.S. dollar had a dampening effect on Canadian export trade. By the end of the year, consumer and business confidence had fallen to the rock-bottom levels of the last recession. This strongly suggested that the current recession (already three quarters of a year in duration) was not about to end abruptly, particularly since the downturn in the United States had only just begun in the last quarter of 1990. This was the first time in the postwar period that the Canadian economy had entered a downturn ahead of the American economy. (A downturn in the economy, consisting of at least two consecutive quarters of negative growth, is commonly referred to as a recession.)

Consumer spending, which accounts for about 60% of total GDP, has been one of the main factors of Canada's economic growth since the 1981/82 recession. In 1990, however, the real volume of consumer spending (after adjusting for inflation) was estimated to have increased by about only 1.5%. This was considerably lower than the 3.8% growth recorded in 1989 and the 4.3% average growth achieved during the seven-year period 1983-89. In reporting the results for the third quarter of the year, Statistics Canada noted that the recession showed signs of deepening late in the third quarter and early in the fourth. In fact, relative to the level of consumer spending in the fourth quarter of 1989, there had been no net growth in real terms since the start of 1990.

Moreover, Statistics Canada indicated that the decline in economic activity was focused most sharply on the business sector, and more specifically on business investment. Corporate profits had been sliding for almost two years, since the first quarter of 1989. Coupled with high interest rates, businesses were finding it increasingly difficult to finance their investment intentions. Consequently, business expenditures for plant and equipment in 1990 dropped by about 3.0% in real terms. This was in sharp contrast to the business investment boom of the previous three years: 5.0% growth in real terms in 1989; 15.2% in 1988; and 9.3% in 1987.

Statistics Canada also reported that business investment was continuing at a pace well below that which had been indicated by earlier investment intentions surveys, including the most recent survey at the time, the Large Company Capital Expenditures Survey of September 1990, which had indicated a 13.4% growth in nominal terms for 1990.

Businesses relying on export trade experienced difficulties during 1990. Although exports had grown in the first half of the year, they began to weaken as the U.S. economy began to show signs of slowing down. Furthermore, a strong Canadian dollar and rising wage settlements were adversely affecting competitiveness in manufacturing industries. Capacity utilization in the manufacturing industries continued its steady decline from the peak of 87.1% recorded in the first quarter of 1988. By the third quarter of 1990, capacity utilization had fallen to 78%, reflecting declining orders and faltering shipments.

The downward trend of the economy was also reflected in the number of bankruptcies reported, both business and personal. For the first 10 months of 1990, over 9000 businesses had gone bankrupt across Canada, an increase of more than 30% over the first 10 months of 1989. Including 34 000 personal bankruptcies, this represented an increase of about 40% in total bankruptcies in the first 10 months of the year. With this increase accelerating toward year-end, it was estimated that total bankruptcies for the year would be up about 43% over 1989.

High interest rates and the recession had a major impact on the housing industry. Construction of new homes in Canada fell to a near six-year low in November when housing starts fell to a seasonally adjusted annual rate of 133 000 units. This represented a 40% drop from the annual rate that had been achieved during the first quarter of the year. For the year 1990, housing starts were estimated at 182 000 units, a major reduction from the 215 000 starts achieved in 1989 and the lowest level since 1985. This was the first time in five years that housing starts failed to reach the 200 000 mark for the year in total.

The unemployment rate declined during the first quarter of the year, falling to 7.2% in March. However, the trend was reversed during the remainder of the year, adversely affecting consumer confidence. By December, the unemployment rate had risen to 9.3%, the highest in over three years. This meant that about one and a quarter million people were out of work. Indeed, by November, Statistics Canada's help-wanted index (an early indicator of the demand for labour) had fallen to its lowest level in almost six years, continuing its downward trend since early 1989. On average, the unemployment rate during 1990 was estimated to be about 8.1%, compared to 7.5% in 1989. Most of the job losses over the year had been borne by the goods-producing industries, in which employment fell by 3.0% during 1990.

The rate of inflation in 1990, as measured by the increase in the Consumer Price Index (CPI), was estimated at about 4.8%, down slightly from 5.0% in 1989. Control of inflation continued to be the key policy concern of the Bank of Canada. In response to persistent inflationary pressures, the central bank rate was kept at high levels. Changes in this rate influence changes in the prime lending rates charged by the banks. The prime rate, which is offered to blue-chip corporate borrowers, acts as a benchmark for the rates charged for other consumer, business and mortgage loans. During the earlier months of the year, the central bank rate was on an upward trend, peaking at 14.05% in May. However, as the economy began to slow down, the rate was allowed to decline. As the year progressed, there was continued concern about the inflationary effects of higher wage settlements and, later in the year, the effect of higher oil prices resulting from the Persian Gulf crisis. As well, there were fears regarding the effect that lower interest rates might have on the value of the Canadian dollar.

By year-end, the central bank rate had fallen to 11.72%, its lowest level in almost two years. Correspondingly, the chartered banks had lowered their prime lending rates by December to a near two-year low of 12.75%, responding to fears of the possibility of a more severe slowdown in the economy. Despite the faltering economy, however, the Bank of Canada did not want to allow interest rates to fall too rapidly, reflecting its continued concern about inflation. It still feared, for example, that workers trying to keep pace with higher oil prices and the expected increase in consumer prices caused by the proposed Goods and Services Tax (GST) would demand higher wage settlements, possibly setting off a wage-price spiral. For example, despite rising unemployment during the latter half of the year, wage settlements in the third quarter averaged 6.5% compared to 5.4% in the second quarter.

High interest rates in Canada increased the costs of servicing the public debt. That and a weaker economy put further adverse pressure on the federal government's deficit reduction targets. As a result, the federal budget deficit for fiscal year 1990/91 was projected to be in the order of $30 billion or more. This would bring the total public debt (the accumulated annual deficits) to over $380 billion.

Throughout 1990, short-term interest rates in Canada were four to five percentage points higher than corresponding rates in the United States. This wide spread between Canadian and U.S. interest rates had the effect of keeping the value of the Canadian dollar at high levels relative to the U.S. dollar. The Canadian dollar averaged about US85.7¢ in 1990 compared to an average of US84.5¢ in 1989. At its high point for the year, the Canadian dollar reached a near 12-year high of US88.11¢ in August. At the close of the year, the dollar was trading in the range of US86.2¢, somewhat above its average for the year.

A strong Canadian currency has an adverse impact on Canada's export-import trade because a high-valued dollar makes its exports more expensive to foreign buyers while it makes imported goods less expensive to Canadian buyers. Merchandise exports increased by only 2.5% in the first three quarters of the year, reflecting the effects of a high Canadian dollar and weakening export markets. For the same period in 1989, exports had increased by 3.4%. Imports during the first three quarters of 1990 increased by only 0.7%, reflecting the effects of a weakening Canadian economy. On balance, this resulted in a merchandise trade surplus of about $8.2 billion for the first three quarters of 1990. For the year in total, a trade surplus of about $11 billion was projected, compared to only $7.6 billion in 1989, which was the smallest trade surplus recorded since 1981.

Merchandise trade is typically a source of strength to the Canadian economy. However, in terms of total international transactions (including exports, imports, services, investment income and transfers), Canada has been recording a current account deficit in recent years. For the year 1990 in total, it was projected that the current account deficit would be in the order of $16 billion, compared to the $16.7 billion deficit recorded in 1989.

The strength of the Canadian economy relies to a considerable extent on the strength of its export trade. This fact can be realized by noting that exports of goods and services account for approximately one quarter of the total output of Canada's economy. Canada's major trading partner is the United States, with three quarters of Canada's merchandise exports going to that country. This illustrates the importance to the Canadian economy of the performance of the U.S. economy. Preliminary estimates indicated that economic growth in the United States was only about 0.9% in 1990, well below the 2.5% growth achieved in 1989. Economic indicators showed that the United States had entered a recessionary period in the last quarter of the year. This downturn in the American economy suggested that there would not be an early improvement in the Canadian export picture.

THE MINERAL INDUSTRY IN 1990

With demand remaining relatively strong during most of the year, and supply constrained by a number of factors, metal prices stayed at relatively high levels during 1990 as seen from a historical perspective. However, as demand showed signs of weakening during the latter part of the year, commodity prices also weakened. In general, metal prices averaged out at lower levels for 1990 than in the previous year. (It should be noted that metal prices, for the most part, had peaked in early 1989 as a result of a price boom that had begun in 1986.) The effect of lower average prices and/or lower volumes of production for some of the leading metals was such that the total value of metallic mineral production fell by more than 8% in 1990.

The mining industry in Canada operated at a capacity utilization level of about 85%-90%. Although mining capacity utilization had generally been trending downward since its most recent peak of 94% in the second quarter of 1988, this was still a positive position relative to its long-term average of about 82%. The capacity utilization rate in the primary metals industries was also trending downward. In 1990, the capacity utilization rate averaged about 85%.

Lower commodity prices in 1990, combined with higher interest rates and a strong Canadian dollar, resulted in poorer financial performance for most producers. The financial results for the first three quarters of the year gave indications that earnings for the full year could end up being as low as half the earnings of 1989.

General Review

Initial capital expenditure intentions reported for the mining industry as a whole (metal and nonmetal mining) for 1990 were down by over 15% in real terms from the 1989 level. Although mid-year revised intentions were up about 4% over the initial intentions, the deterioration of economic conditions since those plans were formulated may well have had an impact on realized expenditures for the year.

The levels of short- and long-term debt in the metal mining sector totalled $6.2 billion at the end of the second quarter of 1990, similar to the levels that prevailed in 1989. The debt to equity ratio, which was 0.30 in mid-1990, was considered to be at a satisfactory level, thus placing the industry in a much better position than it was prior to the last recession.

Return on assets for metal mines in mid-1990 was about 10%, down significantly from its peak level of 18% in the first quarter of 1989. In contrast, return on assets for other mining, which had been increasing since 1985, was about 18% in mid-1990. This was a level not seen since 1981.

Although Canadian exploration expenditures were down relative to the record spending years 1987 and 1988, they were not down by historical standards. Preliminary estimates for 1989 indicated that exploration spending totalled $927 million. It was expected that total spending in 1990 would be in the range of $750 million to $850 million. In constant dollar terms, the upper half of this range would represent the fourth or fifth highest exploration year ever.

The value of Canadian mineral production, including metallic minerals, nonmetallic minerals, structural materials and fuels, totalled $41.3 billion in 1990 compared with $39.3 billion in 1989. This represented an increase of 5.2% over the previous year and was achieved on the strength of mineral fuels. On the other hand, the nonfuel sector as a group (metals, nonmetals and structurals) saw the total value of production fall by 8.6% to $17.8 billion in 1990 from $19.5 billion in 1989. The value of production is summarized below, by commodity group:

THE CANADIAN MINERAL INDUSTRY VALUE OF PRODUCTION, 1989 AND 1990

	1989	1990	Change
	($ millions)		(%)
Metals	13 982.5	12 777.7	–8.6
Nonmetals	2 594.9	2 385.2	–8.1
Structurals	2 897.2	2 633.1	–9.1
Total Nonfuels	19 474.5	17 795.9	–8.6
Fuels	19 784.5	23 509.5	18.8
Total	39 259.1	41 305.4	5.2

Note: Totals may not add due to rounding.

The total value of metallic mineral production fell by 8.6% to $12.8 billion in 1990 from $14.0 billion in 1989. The value of output of the nonmetallics, which include minerals such as asbestos, potash and sulphur, declined by 8.1% to $2.4 billion in 1990 from $2.6 billion in the previous year. The value of production for the structural materials group, which includes sand and gravel, stone, cement and lime, fell to $2.6 billion from $2.9 billion, a decrease of 9.1%.

In the fuels sector, which includes crude petroleum, natural gas, natural gas by-products and coal, the value of production increased by 18.8% to $23.5 billion in 1990 from $19.8 billion in 1989. This overall increase of about $3.7 billion was accounted for almost entirely by petroleum. Petroleum prices had escalated in the latter half of the year as a result of the Persian Gulf crisis. Although the volume of petroleum production fell by 1.1% in 1990, the effect of higher prices was such that the overall value of petroleum production increased by 27.3%, or about $3.0 billion, over the 1989 level.

On a regional basis, Alberta's contribution to total Canadian mineral output (including fuels) represented the largest share, contributing $19.3 billion, or 46.8% of the total in 1990. Ontario was second with a value of $6.4 billion, or 15.6% of the total. British Columbia accounted for $4.1 billion (10.0%), Saskatchewan for $3.2 billion (7.8%), Quebec for $3.0 billion (7.2%), and Manitoba for $1.3 billion (3.2%). The remaining provinces and the territories accounted for the balance of $4.0 billion, roughly 10% of the total.

The top ten commodities in terms of value of output in 1990 were: crude petroleum ($13.8 billion), natural gas ($5.6 billion), copper ($2.5 billion), zinc ($2.5 billion), gold ($2.4 billion), natural gas by-products ($2.2 billion), nickel ($2.0 billion), coal ($1.9 billion), iron ore ($1.3 billion) and potash ($0.9 billion).

Total employment in the mineral industry (mining and mineral manufacturing) declined by about 2.8%, reflecting a weaker Canadian economy in 1990. Preliminary estimates for the year indicated that total employment in the mineral sector of the economy was 387 500, down from about 398 500 in 1989.

All stages of the industry experienced a decline in employment during 1990. The total number of employees in stage I (metal mining, nonmetal mining, quarrying and coal mining) was estimated at about 74 800, down from 77 400 in 1989. Employment in stage II (nonferrous smelting and refining and the primary steel industries) was estimated at 75 500, down from 78 100 in 1989. Employment in stages III and IV (semi-fabricating and fabricating mineral industries) declined to 237 200 in 1990 from 243 000 in 1989.

Exports of Canadian minerals, metals and their basic products were down somewhat from the previous year, but continued to make a significant contribution to Canada's merchandise trade surplus. For the first nine months of 1990, the total value of mineral exports (including coal, but excluding mineral fuels) was estimated at $19.3 billion. This included crude minerals, smelted and refined products, and semi-fabricated and fabricated forms. Imports of mineral products for the first nine months of 1990 were estimated to be about $10.2 billion. This resulted in a trade surplus for minerals (excluding fuels) of more than $9 billion for the first three quarters of 1990.

Including fuels, total mineral exports for the first nine months of the year were estimated at approximately $27.5 billion. Mineral exports (including fuels) account for about one quarter of the value of Canada's total exports. About two thirds of total mineral exports go to the United States, with roughly 10% going to the European Communities and 10% to Japan.

Canada ranks fourth in the world in mine production of copper. Copper production in Canada made a significant recovery in 1990 after falling sharply the year before, becoming the leading metal in terms of total value of output for the year. Mine production increased by 10.7% to about 780 000 t in 1990 from 704 000 t in 1989. The value of production, however, increased by only 4.4% to $2.5 billion, reflecting a lower average price of US$1.21/lb on the London Metal Exchange (LME) in 1990 compared to US$1.29/lb in 1989. Copper prices trended generally upward during the year until mid-September when they peaked at over US$1.50/lb. This was the result of unexpected strength in demand, along with production disruptions in several countries due to strikes and rebel activity, as well as technical problems. Toward the end of the year, there were signs of weakening copper demand in North America, although the demand in Europe and Japan was still strong. Prices eased somewhat in the last quarter of 1990 and this trend was expected to continue into the next year.

Canada is the world's second largest producer of nickel, topped only by the U.S.S.R. Canada's nickel production increased slightly by 0.5% to about 197 000 t in 1990 from 196 000 t in 1989. The value of production, however, was considerably reduced from the 1989 level of $3.0 billion to only $2.0 billion in 1990. This decrease was the result of a much lower average price, US$4.03/lb on the LME in 1990 compared to US$6.04/lb in 1989. Inventories were generally low during the year and this tended to keep prices firm relative to the average for the 1980s. As the year progressed, there were signs that inventories were starting to increase. The stainless steel sector, which accounts for more than 60% of nickel demand, was showing signs of slowing down in North America, putting a downward pressure on prices. However, stainless steel production in Europe and Japan continued to be reasonably strong. In spite of some weakness, nickel prices were expected to stay at levels that would be profitable for most producers.

Canada is the world's largest producer of zinc concentrates. Zinc production in Canada increased by 1.0% to almost 1.3 Mt in 1990. The value of production, however, fell by 9.6% to about $2.5 billion, reflecting a lower average price for the year. Nevertheless, the value of zinc production was only slightly lower than that of copper, which was the number one metal in terms of value of output. Despite some mine closures, zinc production was slightly ahead of the 1989 level as a result of new capacity in Nova Scotia, New Brunswick and Quebec. Production was expected to increase further in 1991 as a result of new mines in the Yukon and northern British Columbia. The price of zinc started the year at a little less than US60¢/lb, climbed to a maximum of US85¢/lb in May, then declined steadily to close the year at about US57¢/lb. For the year overall, the price of zinc averaged US69¢/lb compared to US78¢/lb in 1989. Although the price of zinc had dropped somewhat, it was still relatively strong due to a number of factors including tight supplies during much of the year, technical problems at a number of sites, as well as labour disputes. Prices were expected to drop somewhat in 1991 as additional mine and metal capacity in other parts of the world reached full production. Prices would also be affected by the economic downturn, especially in the United States.

Canada is the world's third largest producer of lead. Lead production in Canada fell by 16.7% to 224 000 t in 1990 from 269 000 t in 1989. This was the result of labour disputes and production or start-up difficulties. The total value of lead production, however, did not fall as drastically because of higher prices during most of the year. The value of output was $268 million in 1990 compared to $280 million in 1989. Higher prices had resulted from a continuation of strong demand coupled with supply disruptions. Prices eased somewhat during the last quarter, ending the year at about US27¢/lb on the LME. The average price for the year was US37¢/lb compared to US31¢/lb in 1989. Analysts were predicting that prices would hold for the first half of 1991, but then would decline in the latter half of the year as a result of new capacity coming on stream. If recessionary pressures on the world's economies continued to worsen, there would be further downward pressure on prices.

Canada is the world's fifth largest producer of gold. Gold production in Canada increased by 3.4% to 165 t in 1990 from about 159 t in 1989. The value of output increased by 2.7% to almost $2.4 billion. The price of gold averaged about US$384/oz in 1990, only slightly higher than the average price of about US$381/oz in 1989. (Because of exchange rate fluctuations, the average price in Canadian funds in 1990 was actually slightly lower than in 1989.) High interest rates, relatively low inflation rates and rising gold production have kept gold prices from rising dramatically. Analysts were predicting that world gold production would continue to grow, thereby keeping a downward pressure on prices. On the other hand, speculation and political factors, such as the Persian Gulf crisis, have the potential for causing major fluctuations in gold prices. Because of low prices, as well as reduced incentives, the rate of exploration for gold in Canada eased further in 1990.

Canada is the world's fifth largest producer of silver. Canada's silver production increased by 6.6% to 1400 t in 1990 from 1300 t in 1989. However, because of lower prices, the value of output fell by 7.0% to $256 million. The price of silver was on a downward trend throughout the year, falling to a 14-year low in December when it reached US$3.95/oz. The price declined over the years not only because of the lack of investment interest, but more importantly, because of the insensitivity of supply-to-market factors. Over 60% of world silver output is produced as a by-product of base-metal operations. Consequently, the price was expected to remain relatively low. Silver is now viewed more as an industrial metal as opposed to a precious metal.

Iron ore production fell by 7.6% to 36.4 Mt in 1990 from 39.4 Mt in 1989. The total value of output declined by 4.2% to $1.3 billion. Although the worldwide market for steel was soft in 1990, iron ore prices were up. Prices are set in annual contracts and lag the steel market by up to a year. Steel production and consumption had increased considerably in 1988 and levelled out in 1989. Two small mines in Ontario closed in March 1990, reducing the number of Canada's iron ore mines to four and the production capacity to 48 Mt/y. About 75% of Canada's iron ore production is exported, with about 54% of production going to Europe. A tight market for iron ore in Europe was expected to bring about another price increase for 1991 deliveries.

Asbestos production continued to decline in 1990. The volume of production fell by 5.1% to about 665 000 t in 1990 from 701 000 t in 1989. The value of output fell by 4.2% to $256 million. The regulatory framework associated with this commodity continued to have an adverse impact on some world markets for asbestos products.

Potash production was 7.0 Mt in 1990, unchanged from the previous year. However, the value of output fell by 10.8% to $907 million. Due to world overcapacity, the Canadian industry has been operating at only 65%-70% of capacity, compared to a world average of about 85%. Nevertheless, Canada remains the world's second largest producer of potash, exceeded only by the U.S.S.R. Canada is by far the largest exporter of potash, accounting for about 40% of world trade.

Coal production declined by 2.9% to 68.5 Mt in 1990 from 70.5 Mt in 1989. The value of production fell by 1.9% to slightly less than $1.9 billion. Not only was Canadian coal consumption down in the year, but coal exports were down as well because of decreased exports to Japan. Approximately 45% of Canada's coal production is exported, with about 80% of that being metallurgical coal. Coal prices were not expected to improve because most exporting nations have surplus coal.

The total value of structural materials fell by 9.1% to $2.6 billion in 1990 from $2.9 billion in 1989. Lower shipments of primary construction materials, such as cement, stone, sand and gravel, reflected the general slowdown in the construction industry. In light of the prospects for a depressed economy for at least the first half of 1991, no improvement is expected for the structural materials industry during the year.

OUTLOOK 1991

The Canadian economy entered 1991 on the downward trend that it had been following since the spring of 1990. Businesses and industry foresaw an economy that would continue to be hampered by a recession already three quarters in duration. Economic indicators at the onset of the year strongly suggested that the recession would continue until at least the second half of 1991. Many analysts were of the opinion that the economic downturn would drag on even longer. The downturn in the U.S. economy, which began in the last quarter of 1990, also served as notice that the Canadian economy would remain virtually flat for much of the year.

Within the framework of the Canadian economy during 1991, consumer spending was forecast to show little or no growth, or perhaps even to decline. The forecasts of spending growth were in the general range of -1.0% to 1.0% in real terms, reflecting such adverse factors as higher levels of unemployment, the negative impact of the new Goods and Services Tax (GST), and the effect of continued high interest rates. Even though interest rates were expected to drop somewhat during the year, analysts were predicting that the Bank of Canada would not allow them to fall too severely. This reflected the Bank's continued focus against such inflationary factors as the GST, higher oil prices and the effect of higher wage settlements in the past year that were now entering the cost base in 1991.

The already weak housing market was expected to remain depressed. National housing starts were projected to be in the range of about 150 000-160 000 units, compared to the already relatively low total of 182 000 starts in 1990. Business capital investment for plant and equipment was forecast to decline by about 3% or 4% in real terms, reflecting an outlook of weak profits and sluggish demand for goods and services.

The unemployment rate was expected to average about 10% in 1991, compared to the 8.1% average recorded in 1990. The Consumer Price Index (CPI) was projected to increase by about 6%, or more, over the course of the year. In relative terms, this would be a much larger rate of increase than the 4.8% rise in the CPI during 1990. It had been estimated that the impact of the GST alone would cause the CPI to grow by at least 1.25%-1.5%.

General Review

Overall, economists were predicting that the Canadian economy would achieve only a marginal gain, if any at all, for the year in total. Indeed, some forecasts of GDP indicated a slight decrease of about 1% or less in real terms, while others indicated only a slight increase at best. In general, these projections assumed that the economy would begin to recover from its recession during the second half of the year, although the initial recovery was expected to be rather sluggish.

The extent of the recovery and its timing would depend to a considerable degree on economic developments in the United States. Predictions at the beginning of the year generally indicated that the American economy would have to endure only a mild, brief recession and that the economy would begin to recover in the last half of the year. In general, economic growth in the United States was expected to be somewhat less than 1% in 1991, in the order of perhaps 0.5%. However, some economists were predicting even lower growth, particularly in light of economic uncertainties at the time.

Forecasts that had been prepared at the end of 1990 regarding the economic outlook for Canada and the United States in 1991 were also clouded by major uncertainties regarding the Persian Gulf crisis and the strong possibility of war early in the new year. These uncertainties were reflected in the wide range of opinions regarding the negative impact that war would have on the world's economies, and on future supplies of oil, world oil prices, inflation, interest rates, business and consumer confidence, etc. In general, however, analysts were predicting that the outbreak of war in the Middle East would serve to extend the current recession well into the third and fourth quarters of 1991. Although some industries might benefit from a war, such gains would be more than offset by damage to the overall economy. Any prolonged crisis in the Persian Gulf, even without a war, was seen to put upward pressure on oil prices. On the other hand, an early settlement of the Gulf crisis was viewed to be conducive to lowering oil prices, giving a boost to the already weak economies, and even perhaps triggering a turnaround in economic activity.

Taking into consideration the weaker economies predicted for 1991, the growth in Canada's external trade was expected to be modest. The growth in Canadian exports, however, was anticipated to exceed the growth in imports. The value of the Canadian dollar was predicted to decline gradually during 1991, to about US84¢ or US85¢ by the end of the year. This would be seen as providing some relief to Canadian exporters who had been suffering the effects of a high Canadian dollar (making exports more expensive). On the other hand, a high Canadian dollar (making imports less expensive) had also created problems for Canadian firms competing heavily against imports at home. On balance, Canada's merchandise trade surplus was predicted to increase to approximately $12 billion from $11 billion in 1990. Canada's current account deficit, which takes into consideration non-merchandise trade as well, was forecast to be about $16 billion, roughly the same as in 1990.

In light of prevailing economic conditions, what are the implications for the mineral industry? With some of the world's economies already in recession and others entering a period of slower economic growth, 1991 could be a challenging year for the industry. Demand had shown signs of weakening in the latter part of 1990, particularly in North America. A continued weakening of the world economy in 1991, further hampered by the Middle East situation, would translate into even weaker demand for base metals, putting downward pressure on prices. Declining volumes and prices, in turn, would result in lower earnings for producers. However, prices for most metals were expected to stabilize at levels at which the majority of Canadian producers would be able to cover costs.

One bright spot with regard to the world economic climate is the fact that some economies, particularly Germany's and Japan's, had been growing quite vigorously and were expected to continue to grow. Although analysts were predicting slower growth rates for these economies in 1991, it was still expected that they would record healthy growth. This would provide a welcome support to Canadian export trade.

Increasingly tough global competition continues to be a challenge to the Canadian mineral industry. The trend to further trade liberalization, however, could present some opportunities. For example, relatively little expansion worldwide is currently planned in smelting and refining. If Canada is able to get major tariff cuts on refined metals in future GATT negotiations, some opportunities for metal processing growth could follow.

The long-term adequacy of Canada's base-metal reserves continues to be a concern. In recent years, the emphasis had been on gold exploration and development, at the expense of base metals. However, because of lower gold prices and higher base-metal prices, there has recently been a shift in exploration focus from gold to base metals. Consequently, the inventory of base-metal properties approaching or already in the mine development stage is growing. This success must continue if Canada is to keep pace with growth in world demand and maintain its share of world markets.

The threat of declining intensity-of-use, as well as product substitution by metal-displacing substitutes such as plastics and ceramics, are also matters of great importance to the industry. There is a growing need for the continued development of advanced, metal-based materials and products to meet this challenge.

In addition to the supply/demand challenges facing the industry, there is increasing pressure for environmental protection measures. Environmental concerns have been, and will continue to be, a vital issue for both the mineral industry and government. In December 1990, the Government of Canada released its long-awaited Green Plan, the most ambitious environmental action plan ever produced in Canada. The Green Plan commits the federal government to $3 billion of new funding over a six-year period for over 100 initiatives. The Green Plan offers new policies, programs and standards to clean up, protect and enhance Canada's land, air and water. The wide range of initiatives covers matters such as the Canadian Arctic, parks and wildlife, the use of Canada's renewable resources, as well as measures to reduce waste generation and to improve energy efficiency. The Green Plan also includes measures to maintain global environmental security, to foster environmentally responsible decision-making and to improve emergency preparedness.

Mineral industry associations sponsored seminars on environmental topics and worked with government on issues raised by the Green Plan. Furthermore, the Mining Association of Canada followed its adoption of an Environmental Policy in 1989 with the adoption in 1990 of detailed guidelines for good environmental practices within the industry. The mineral industry will continue to be active in fostering environmental awareness among its members. While most of the Green Plan does not focus on minerals and metals production, many of the initiatives will have implications for the mineral industry.

Green Plan initiatives include: the release by 1994 of control option reports for major sources of emissions from metal mines and smelters; development of regulations to deal with the recycling and control of transboundary movements of hazardous wastes and their disposal consistent with the Basel Convention; capping of sulphur dioxide and greenhouse gas emissions, including carbon dioxide, by the year 2000; the creation of an extended national accounts-reporting system that would include environmental indicators; and the completion of the national parks system by the year 2000.

The Government of Canada has undertaken to consult with stakeholders as the initiatives under the Green Plan are developed. This will include in-depth consultations with industry and government departments. With respect to implications for the mineral industry, major initiatives involving the Mineral Policy Sector of Energy, Mines and Resources Canada will include such activities as: compiling information on the availability of land for exploration and development; determining the implications of regulations implementing the terms of the Basel Convention; developing statistical information and expertise; developing regulatory amendments under the Fisheries Act; and co-sponsoring a toxicology seminar in Brussels, Belgium. The success of these activities will depend to a large extent on the close co-operation and support of the mineral industry.

In spite of the many challenges facing the industry, whether environmental, economic or technological, the Canadian mineral industry is reasonably well positioned to manage a period of weaker demand and weaker prices. In the longer term, when the world economies begin to emerge from recession in late 1991 or in 1992, the Canadian mineral industry can look forward to financially healthier times. No doubt, Canada's mineral industry will successfully meet the challenges of the months to come. As in the past, it will continue to be a source of strength to the Canadian economy and will make a significant contribution to the country's economic growth.

Note: Information contained in this review was current as of early January 1991.

CANADA, PRODUCTION OF LEADING MINERALS, 1989 AND 1990

		1989	1990p	Percent Change 1990/1989	1989	1990p	Percent Change 1990/1989
		(000 tonnes except where noted)			($ millions)		
Metals							
Copper		704.4	779.6	10.7	2 388.7	2 494.6	4.4
Zinc		1 272.9	1 285.4	1.0	2 739.2	2 477.0	-9.6
Gold	kg	159 494.5	164 990.9	3.4	2 315.9	2 378.3	2.7
Nickel		195.6	196.6	0.5	3 042.3	2 024.0	-33.5
Iron ore		39 445.0	36 442.7	-7.6	1 369.2	1 312.2	-4.2
Uranium	tU	10 994.8	9 458.0	-14.0	912.7	868.0	-4.9
Lead		268.9	224.0	-16.7	279.6	268.1	-4.1
Silver	t	1 312.4	1 399.6	6.6	274.7	255.6	-7.0
Platinum group	kg	9 869.5	11 208.8	13.6	141.7	205.6	45.0
Molybdenum	t	13 543.0	13 480.7	-0.5	111.7	98.9	-11.5
Nonmetals							
Potash (K_2O)		7 014.1	7 014.5	0.0	1 017.5	907.2	-10.8
Sulphur, elemental		5 749.8	5 802.3	0.9	419.5	363.7	-13.3
Asbestos		701.2	665.3	-5.1	267.3	256.1	-4.2
Salt		11 057.4	11 096.6	0.4	228.5	239.9	5.0
Sulphur in smelter gas		808.8	929.3	14.9	86.9	93.4	7.5
Peat		812.2	748.8	-7.8	99.7	89.5	-10.2
Structurals							
Cement		12 590.6	11 252.0	-10.6	960.0	864.9	-9.9
Sand and gravel		274 847.9	250 069.8	-9.0	874.1	794.1	-9.1
Stone		118 015.7	112 005.0	-5.1	661.4	650.7	-1.6
Lime		2 551.9	2 403.7	-5.8	201.6	180.3	-10.6
Clay products		. .	. .	. .	200.1	143.1	-28.5
Fuels							
Petroleum	000 m^3	90 640.5	89 607.6	-1.1	10 862.9	13 831.8	27.3
Natural gas	million m^3	96 116.8	98 333.6	2.3	5 394.3	5 597.9	3.8
Natural gas by-products	000 m^3	23 055.2	23 316.7	1.1	1 620.3	2 208.7	36.3
Coal		70 527.0	68 450.0	-2.9	1 907.1	1 871.0	-1.9

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary; . . Not available.
Note: Figures have been rounded.

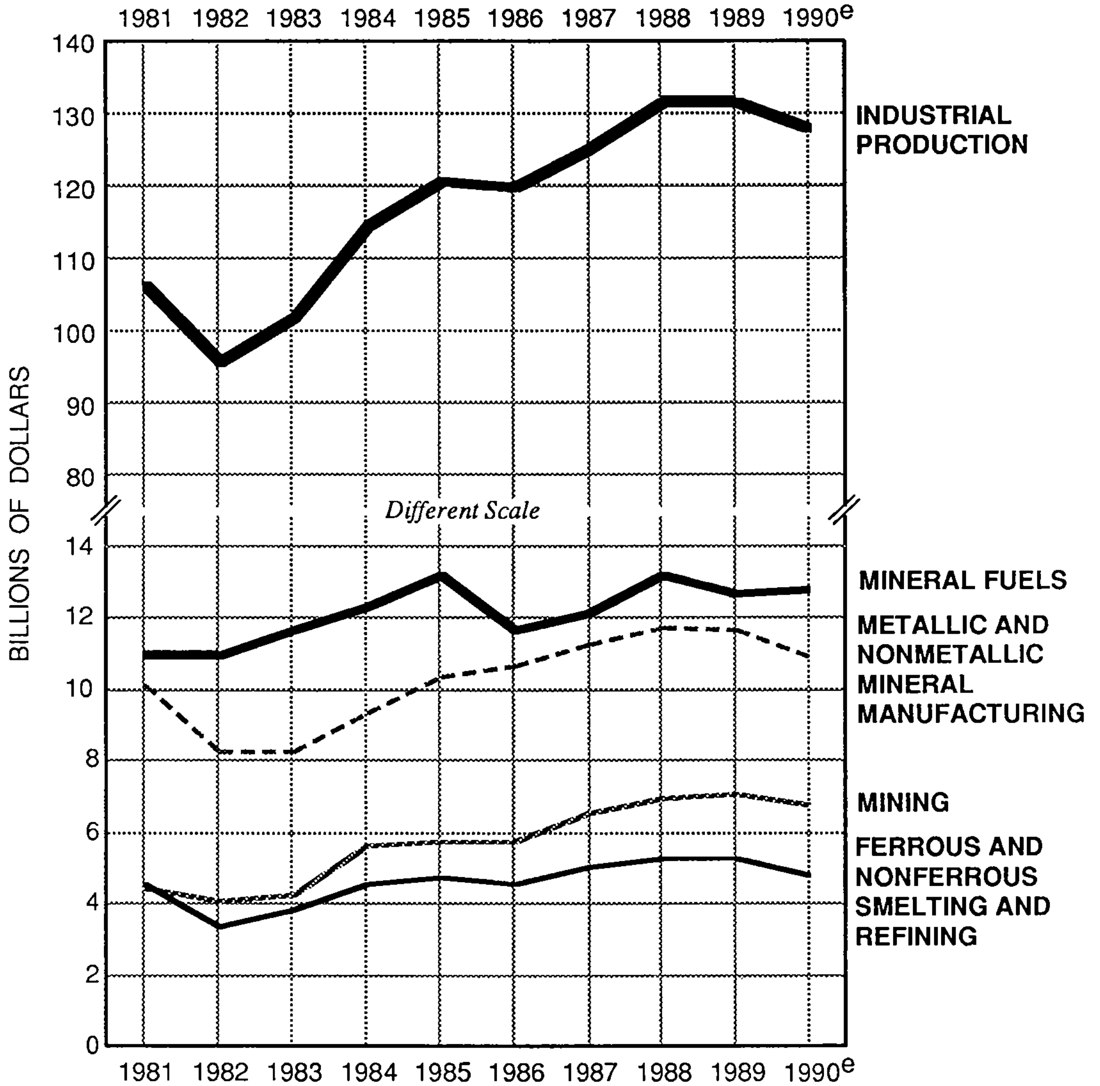
CANADA, VALUE OF EXPORTS OF MINERALS, METALS AND THEIR PRODUCTS FOR 1990 (9 MONTHS)

Chapter[1]	Description	United States	EEC	Japan	Other	Total
				($000)		
25	Salt; sulphur; earths and stone, plastering material, lime and cement	393 206	125 859	42 131	516 930	1 078 126
26	Ores, slag and ash	496 020	1 015 326	793 159	333 870	2 638 375
27	Mineral fuels, oils and products of their distillation; bituminous substances; mineral waxes[2]	8 350 672	134 259	1 143 563	466 537	10 095 031
28	Inorganic chemicals; compounds of precious metals, radioactive elements, etc.	993 104	95 092	20 186	74 556	1 182 938
31	Fertilizers	732 216	49 037	48 447	384 607	1 214 307
68	Articles of stone, plaster, cement, asbestos, mica or similar materials	237 737	9 542	1 557	8 343	257 179
69	Ceramic products	35 248	1 419	529	6 427	43 623
70	Glass and glassware	249 608	28 211	1 156	13 646	292 621
71	Natural/cultured pearls, precious stones and metals, coins, etc.	616 392	275 691	321 065	875 849	2 088 997
72	Iron and steel	1 237 065	213 275	10 284	278 549	1 739 173
73	Articles of iron or steel	1 159 708	27 827	4 849	78 450	1 270 834
74	Copper and articles thereof	674 638	299 634	3 846	73 406	1 051 524
75	Nickel and articles thereof	590 999	198 199	19 597	304 181	1 112 976
76	Aluminum and articles thereof	1 911 031	123 905	232 685	265 873	2 533 494
78	Lead and articles thereof	55 251	22 408	6 939	7 181	91 779
79	Zinc and articles thereof	567 907	20 848	30 282	61 615	680 652
80	Tin and articles thereof	5 019	111	94	806	6 030
81	Other base metals; cermets; and articles thereof	96 251	17 238	3 337	22 503	139 329
	Total	18 402 072	2 657 881	2 683 706	3 773 329	27 516 988

Source: Statistics Canada, Catalogue 65-003 (Quarterly).
[1] Chapter refers to a group of commodities covered in a specified chapter of the "Harmonized Commodity Description and Coding System," as of January 1, 1988. Canadian external trade statistics are classified according to the Harmonized System. [2] Total value of coal exports included in Chapter 27 is $1850 million.

Figure 1

GROSS DOMESTIC PRODUCT AT FACTOR COST AT 1986 PRICES

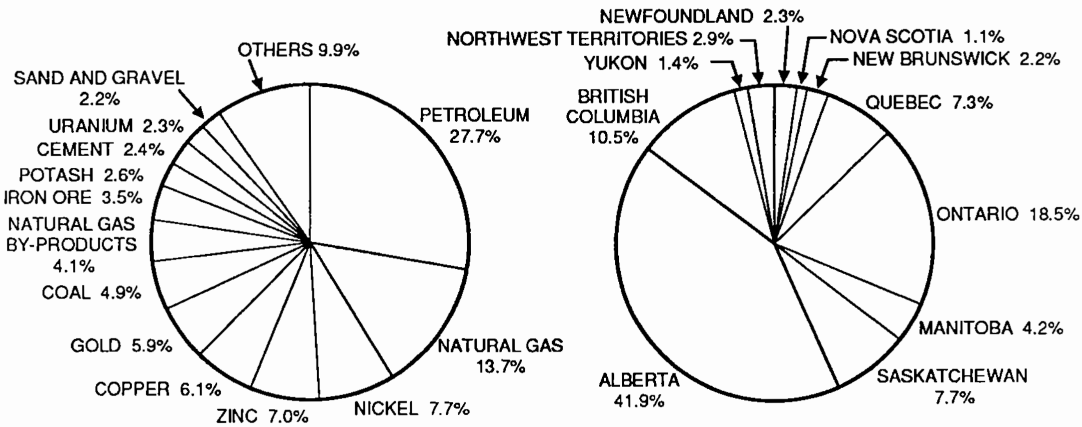


Source: Statistics Canada.

[e] Estimate.

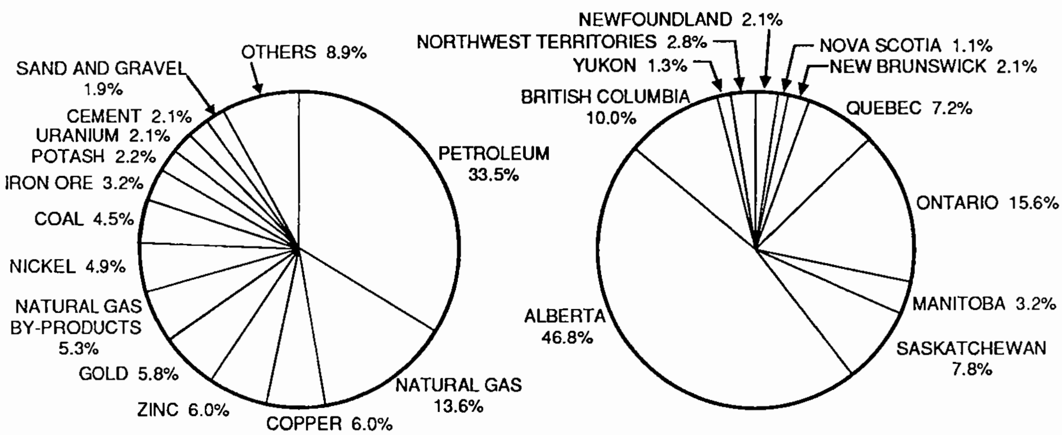
Figure 2

CANADA, VALUE OF MINERAL PRODUCTION, 1989



% OF TOTAL BY COMMODITY **% OF TOTAL BY PROVINCE**

CANADA, VALUE OF MINERAL PRODUCTION, 1990

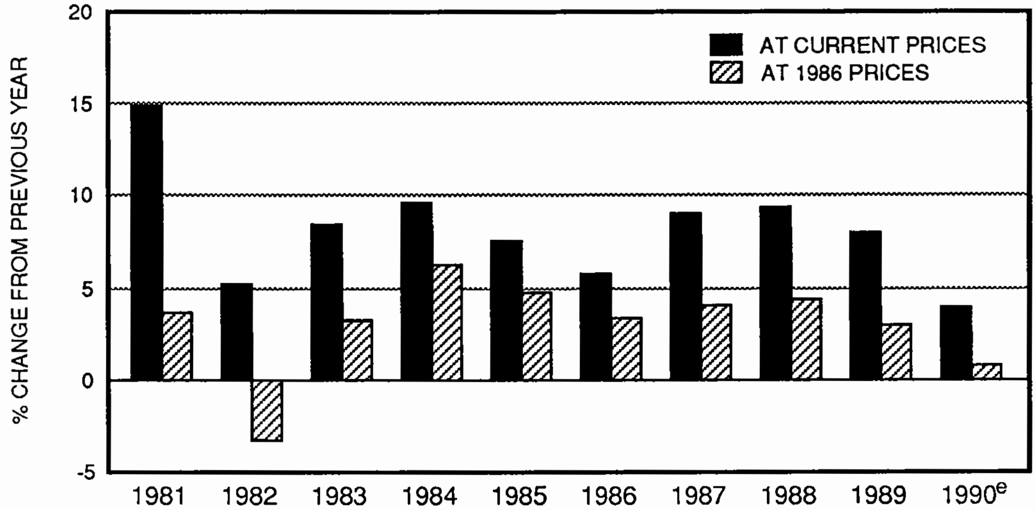


% OF TOTAL BY COMMODITY **% OF TOTAL BY PROVINCE**

Source: Energy, Mines and Resources Canada.

Figure 3

TRENDS IN CANADIAN ECONOMIC ACTIVITY
(% CHANGE IN GROSS DOMESTIC PRODUCT)

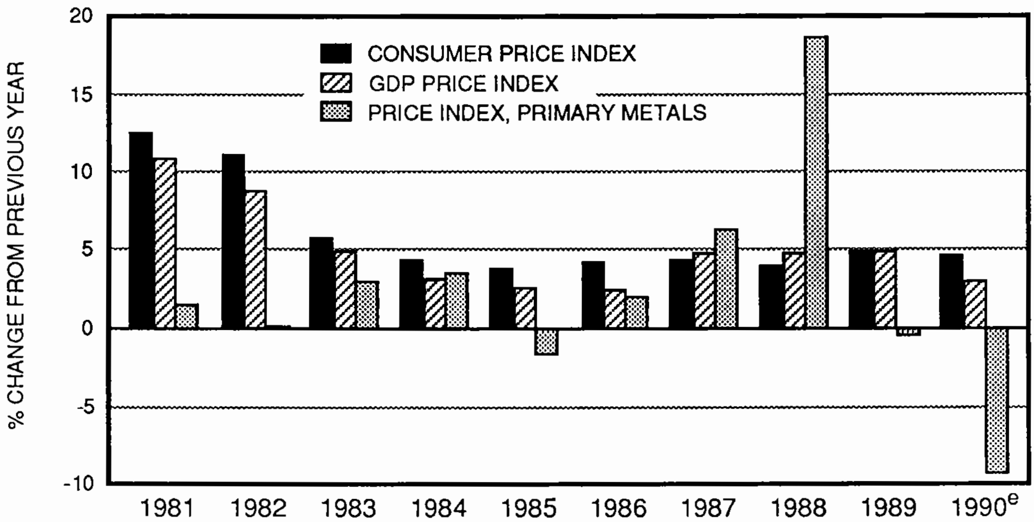


Source: Statistics Canada.

e Estimate.

Figure 4

CANADIAN PRICE TRENDS



Source: Statistics Canada. Based on 1986 Price Indexes = 100.

e Estimate.

International Scene 1990

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The beginning of 1990 heralded an era of potentially strong international growth opportunities for the Canadian mining industry. The development of market economies in Eastern Europe, strong growth of consumer markets in Asia, rise of the single European market, expansion of the North American trade bloc and revitalization of Latin America were promising areas of change for Canadian exporters.

These developments were important considering that Canada's prosperity depends on its ability to compete internationally. Indeed, one quarter of our Gross National Product (GNP) and one fifth of our employment is dependent on exports. As Canada must constantly seek to improve its competitive trade performance, or risk seeing its economic prosperity suffer, 1990 appeared as a year of new challenges and new opportunities for the Canadian mining industry.

However, although observers of the international minerals scene were relatively optimistic early in 1990, domestic economic realities in the following months tempered their views. High interest rates and a strong Canadian dollar offset some of the advantages provided by buoyant prices and continued brisk international demand for minerals.

MINERAL TRADE

Preliminary statistics indicate that Canada's mineral and metal exports, broadly defined and including $10.1 billion worth of petroleum and natural gas, were valued at $27.5 billion for the first nine months of 1990. Imports for the same period were $15.2 billion. The level of both exports and imports was up marginally from 1989. The United States accounted for two thirds of these exports and 54% of Canada's imports. Japan remained the second largest market, accounting for 10% of exports, and the European Communities (EC) accounted for 9.6%.

Apart from energy products, the main commodity exports were as follows: crude materials–iron ore to the United States; copper concentrates to Japan; iron ore and zinc concentrates to the EC; sulphur and potash to the United States and a host of other countries; smelted and refined metals–aluminum, copper, iron and steel, gold, nickel, silver and zinc to the United States; aluminum and gold to Japan; and copper and nickel to Europe. Canada's coal exports, valued at $1.9 billion for the first nine months of 1990, went mainly to Japan.

BILATERAL MATTERS

There is more trade between Canada and the United States than any other two countries in the world. Two-way trade in goods and services between Canada and the United States amounted to $204 billion in 1989, the year of the signing of the Canada-U.S. Free Trade Agreement (FTA). The goals of the FTA remain the same now as at the outset: a) to improve the trading environment with and to ensure more secure access to the United States, accounting for 75% of Canadian exports; and b) to stimulate Canadian competitiveness and industrial efficiency. The implementation of the FTA saw the Canada-U.S. Trade Commission meet twice in its second year. The dispute resolution mechanisms were actively utilized during 1990.

Copper and lead were identified under Section 409 b) of the U.S. FTA Implementation Act in 1989 at the request of the U.S. Nonferrous Metals Producers Committee (NFMPC). During the past year, the NFMPC pursued its allegations that it faces increased competition from alleged subsidized Canadian imports and a deterioration of the U.S. nonferrous industry's competitive position. In May 1990, the industry filed with the U.S. Trade

Representative (USTR), pursuant to Section 409 b), a request that the USTR compile and make available information under Section 308 of the 1974 Trade Act. A further, more detailed supplemental petition was filed in June. However, despite these developments, there was no sign of an impending trade action on the part of the United States against Canadian nonferrous producers at year's end.

Two other trade policy developments have occurred throughout 1990 which have implications for the FTA. First, the multilateral trade negotiations (MTN) were suspended in December after a ministerial meeting in Brussels failed to achieve a final agreement. A successful MTN outcome which liberalizes world trade multilaterally is a major Canadian trade priority. The FTA contributes to this process of world trade liberalization. However, the FTA is also an insurance policy for the large majority of Canadian trade should the multilateral liberalization process be slowed. Second, during 1990 Canada decided to enter into discussions with Mexico and the United States concerning North American free trade. This decision was primarily motivated by the desire to extend the benefits of freer trade embodied in the FTA to the rest of North America. There was also a strong interest to protect Canadian benefits already secured in the FTA with the United States.

Turning to Eastern Europe, the dust is not settling in the region except for the territory formerly known as the German Democratic Republic which in October 1990 was officially reunited with the Federal Republic of Germany. Eastern Europe has been surveyed by many mining and metallurgical companies and the overwhelming impression is of technological and environmental bleakness. It would appear that a number of mining and metallurgical operations are bound to disappear under a combination of economic and environmental imperatives, and with some modestly positive consequences for the supply-demand balance for the products of the Canadian mining industry. With a few minor exceptions, Canadian sales of technology or investment would not appear to be imminent.

The U.S.S.R. is larger, more remote and even less stable. It also has enormous current and potential production, and that has proven to be sufficient incentive for many Canadian companies to at least visit the country. These excursions have had varying degrees of formality. Energy, Mines and Resources Canada led a mission on behalf of the Canadian nickel industry to the Noril'skiinikel complex in June 1990, and several Canadian companies participated in a seminar in Moscow on mining investment late in the year. Other companies have gone to follow up on various leads suggested by individuals or organizations which have been promoting contacts or deposits in hitherto unreachable parts of the U.S.S.R.

It is a confusing situation in the U.S.S.R. Export discipline is breaking down. Some operations are being closed for environmental reasons. All manner of rules and regulations are unknown or untested. It is a struggle to learn where ownership or authority lies, and this is before the practical concerns of rouble convertibility, repatriation of profits, infrastructure, labour supply, etc., can be ranked against the attractiveness of the deposit in question. Canadian purchases of Soviet metals and intermediate products (mainly nickel-copper matte with high platinum group metals values) are significant and could grow if the supply is available. A two-way flow of technology is a distinct possibility, and sales of Canadian mining equipment are not out of the question. Actual investment will probably wait until the economic and political situation inspires some confidence, or until a deposit so attractive comes along that a company decides to test the system. That experiment will be closely watched.

MULTILATERAL MATTERS

The Uruguay Round of MTN grabbed centre stage in international news when world trade ministers met in Brussels during the first week of December 1990 in an effort to successfully conclude four years of world trade talks. They failed and the meeting was adjourned.

The MTN was launched in Punta del Este in September 1986, at a time when the world economy was quite buoyant. Contracting Parties to the General Agreement on Tariffs and Trade (GATT) signalled a need for a more open trade regime for goods, services and agricultural products. The next milestone in the talks came in December 1988 when world trade ministers met in Montreal. At that time, differences on agriculture proved too divergent to achieve a consensus on the form and depth of trade liberalization. However, negotiations continued with a more active participation of GATT Secretary-General, Arthur Dunkel.

Differences on agriculture continued to haunt ministers in December 1990, and Mr. Dunkel was again tasked with the chore of finding a basis to resume formal negotiations. By year-end, chief negotiators agreed to meet formally in mid-January with a view to reconvening the ministerial meeting in February, and to wind up the talks by mid-1991. A successful outcome is deemed important for long-term growth in world trade and for lending confidence to overcome short-term recessionary forces.

Although differences on agriculture dominated news headlines, negotiators did make good progress in other key areas such as services, subsidies and countervail, intellectual property, government procurement, the functioning of the GATT system, and on certain non-tariff measures. The outcome on tariffs seemed to be more closely linked to progress on agriculture. On the assumption that the Uruguay Round of talks can be concluded successfully, implementation can be expected to begin in January 1992.

Looking back from some vantage point in the future, 1990 might well be seen as the turning point for the fortunes of the Law of the Sea Convention. The fact that several more developing countries ratified the Convention is insignificant compared to the increased interest shown in the Convention by the United States. This country has neither signed the Convention nor participated in the ongoing negotiations in the Preparatory Commission for the International Seabed Authority. Attempts by other industrialized countries, Canada among them, to have the United States re-engage in the process may be on the verge of bearing fruit.

The year just past was marked by important speeches by the President of the Preparatory Commission, José Luis Jesus of Cap Verde, and the Under-Secretary General, Special Representative of the Secretary General for the Law of the Sea, Satya Nandan. These pointed to the problems faced by the Convention and ways that they might be remedied. The flexibility of attitude was just as important as the nature of the suggestions made. Similar progress has been made with representatives of developing countries over the past two years. This progress halted in December 1990 when, in spite of the moderation of the language in previous annual efforts, the United States registered its usual negative vote on the General Assembly Resolution on the Law of the Sea. It did, however, make positive comments in its explanation of its vote.

In other matters, China applied for the registration of its deep-seabed mining claim in August 1990, and a Group of Experts examined it in December of that year. Formal acceptance will follow in February 1991 at the next meeting of the Preparatory Commission. China will be joining India, Japan, France and the U.S.S.R. as registered deep seabed claimants. While of interest, this is not thought to signal the imminence of commercial deep-seabed mining.

The Preparatory Commission began the process of drafting the environmental rules and regulations which will govern deep-seabed mining. It is already clear that there are many questions about the impact that large-scale and prolonged activity on the deep seabed will have on the environment. In this context, Canada hosted the first international meeting on the deep seabed and the environment in 1990.

On the North American scene, in September 1990, Canada's Minister for International Trade advised that Canada would be seeking participation in trilateral free trade discussions with Mexico and the United States. A huge foreign debt (over US$100 billion) and an economy suffering from the adverse consequences of a policy of economic isolationism, forced Mexico to realize, during the 1980s, that it must try to become an effective member of the global economic system. To that end, Mexico effectively reduced its tariff barriers, joined the GATT, liberalized its foreign investment and foreign ownership laws, revised its tax system and changed its mining law. These measures have done much to improve the relative attractiveness of the investment climate in

Mexico. They may also have far-reaching financial and commercial consequences for segments of the Canadian mineral industry as they could impact directly through existing corporate linkages between Canadian and Mexican mining companies, or indirectly through international mineral markets.

By and large, the majority of the leading Canadian mining companies are favourably disposed toward a trilateral FTA. The reasons for this are twofold: the nature of production and market linkages between certain Canadian mining companies and the Mexican mineral industry; and Mexico's rich mineral resource endowment and the current economic and institutional transformation which Mexico is currently undergoing to make its mineral and other sectors highly competitive in international and domestic markets.

On the environmental front, the Basel Convention became an important issue in 1990. The Basel Convention is a United Nations Environment Programme (UNEP)-sponsored initiative that was designed as a means to control and ultimately minimize the international transportation of toxic and hazardous wastes destined for disposal. The objective is to prevent the dumping of wastes by some countries in other (especially developing) countries, and thus have countries take responsibility for the wastes that they generate. Disposal, however, was defined as including products for recycling, reuse and reclamation in addition to those for final disposal. Since several recyclable metals are considered as toxic or hazardous under a number of jurisdictions, the Basel Convention will directly impact on the metals-recycling industry.

The heavy administrative burden and other constraints the convention will add to the transportation of recyclables will negatively affect the economics of the industry. Research and investment in further metals recycling will have to take into account the increased international trade constraints on transporting feed for recycling operations. Inadvertently, the convention biases the economics of metal recyclables from global economic efficiency towards national self-sufficiency which, in some cases, could mean landfill disposal.

Several developing countries that lacked mineral resources have built a metals industry that greatly relies on imported metal recyclables. Implementation of Basel, as negotiated, could undermine the development base of these countries since developed countries could use Basel to prevent export of the metal recyclables they generate.

These unforeseen consequences of Basel are now gaining wider recognition and attempts are being made to address these implications. For example, the Organization for Economic Cooperation and Development (OECD) Waste Management Policy Group has recommended that the regulatory framework directed at recyclables destined for recycling differ from the one directed at wastes for final disposal.

The experience of Basel clearly indicates the need for environmental regulators to more systematically solicit input from trade and industry organizations when preparing environmental regulations in order to ensure that unforeseen consequences of implementing the regulations do not undermine the proposed objectives. Similarly, industry and trade organizations must recognize that increasing environmental regulations are inevitable, and that their organizations must adopt and implement policies and practices that will confirm their commitment to the environment.

Because of the requirement that those who ratify Basel can only trade in hazardous wastes, as defined by the Convention, with other countries that have ratified the convention, it would be risky for Canada not to follow the course of its trading partners, particularly its southern neighbour. Trade in recyclables between Canada and the United States is so integrated and specialized that an end to the trade in recyclables would be a major economic and environmental blow to our country.

To date, the Basel Convention has been signed by about 56 countries, including Canada. Only a handful of smaller countries have ratified the convention. Canada and its major trading partners (the United States, the European Communities and Japan) have not.

Turning to new initiatives, two important multilateral developments occurred in 1990. First, efforts by Canada over more than ten years culminated in the launching of the International Nickel Study Group in The Hague in June 1990. Initial membership comprises 12 countries that collectively account for 61% of world nickel trade. They are Australia, Canada, Cuba, France, Finland, Germany, Greece, Indonesia, Japan, the Netherlands, Norway and Sweden. The structure of the Study Group will initially comprise statistics, economics, and standing (administrative) committees, but the initial work will focus on statistics. Other activities will include an annual or semi-annual short-term forecast of nickel supply, demand and market balance, the preparation of industry directories, and the compilation of information on regulations affecting nickel production and use.

The second important new development which occurred in the past year is the creation, by the private sector, of an International Council on Metals and the Environment. Following an initiative by Canada's mining industry, a number of multinational companies met in London in the fall of 1990 to form a council to cooperate on matters related to health and the environment. The main objective of the new council will be to develop industry positions and to promote the safe production, use, recycling and disposal of metals.

A Perspective for 1991

The optimism that greeted the past year was short-lived. Developments through the second half of 1990 in the Persian Gulf and in the U.S.S.R., along with the threat of recession in North America and the suspension of the Uruguay Round of talks, make the prospects for 1991 appear bleaker. The development of a vibrant world economy in 1991 and beyond will require many new challenges including:

- a revitalization of the Canadian and U.S. economies;
- a further consolidation of gains for Canadian exporters under the FTA;
- a breakthrough in the currently stalled GATT negotiations;
- the successful negotiation of a U.S.-Canada-Mexico FTA;
- an end to the Persian Gulf conflict; and
- a more determined drive to improve the economic lot of Eastern Europe and the U.S.S.R.

Note: Information contained in this review was current as of mid-January 1991.

TABLE 1. CANADA, VALUE OF IMPORTS OF MINERALS, METALS AND THEIR PRODUCTS FOR 1990 (9 MONTHS)

Chapter[1]	Description	United States	EEC	Japan	Other	Total
				($000)		
25	Salt; sulphur; earths and stone, plastering material, lime and cement	257 832	6 744	2 488	64 305	331 369
26	Ores, slag and ash	319 826	33 802	0	216 903	570 531
27	Mineral fuels, oils and products of their distillation; bituminous substances; mineral waxes[2]	1 750 670	1 436 929	199	2 333 234	5 521 032
28	Inorganic chemicals; compounds of precious metals, radioactive elements, etc.	547 813	71 191	29 016	322 997	971 017
31	Fertilizers	124 858	18 284	692	7 802	151 636
68	Articles of stone, plaster, cement, asbestos, mica or similar materials	186 229	79 445	3 088	22 816	291 578
69	Ceramic products	153 519	157 971	39 857	80 556	431 903
70	Glass and glassware	577 604	70 060	31 715	70 930	750 309
71	Natural/cultured pearls, precious stones and metals, coins, etc.	644 280	115 742	4 867	234 840	999 729
72	Iron and steel	784 428	243 777	76 145	221 633	1 325 983
73	Articles of iron or steel	1 298 687	209 528	137 158	254 183	1 899 556
74	Copper and articles thereof	317 350	31 015	5 756	54 823	408 944
75	Nickel and articles thereof	51 940	25 299	804	61 927	139 970
76	Aluminum and articles thereof	1 025 048	97 931	4 812	60 151	1 187 942
78	Lead and articles thereof	18 286	330	10	2 710	21 336
79	Zinc and articles thereof	20 377	2 200	78	12 056	34 711
80	Tin and articles thereof	9 066	4 153	1	21 780	35 000
81	Other base metals; cermets; and articles thereof	109 349	15 819	4 087	19 625	148 880
	Total	8 197 162	2 620 220	340 773	4 063 271	15 221 426

Source: Statistics Canada, Catalogue 65-006 (Quarterly).
[1] Chapter refers to a group of commodities covered in a specified chapter of the "Harmonized Commodity Description and Coding System," as of January 1, 1988. Canadian external trade statistics are classified according to the Harmonized System. [2] Total value of coal imports included in Chapter 27 is $494 million.

TABLE 2. CANADA, VALUE OF EXPORTS OF MINERALS, METALS AND THEIR PRODUCTS FOR 1990 (9 MONTHS)

Chapter[1]	Description	United States	EEC	Japan	Other	Total
				($000)		
25	Salt; sulphur; earths and stone, plastering material, lime and cement	393 206	125 859	42 131	516 930	1 078 126
26	Ores, slag and ash	496 020	1 015 326	793 159	333 870	2 638 375
27	Mineral fuels, oils and products of their distillation; bituminous substances; mineral waxes[2]	8 350 672	134 259	1 143 563	466 537	10 095 031
28	Inorganic chemicals; compounds of precious metals, radioactive elements, etc.	993 104	95 092	20 186	74 556	1 182 938
31	Fertilizers	732 216	49 037	48 447	384 607	1 214 307
68	Articles of stone, plaster, cement, asbestos, mica or similar materials	237 737	9 542	1 557	8 343	257 179
69	Ceramic products	35 248	1 419	529	6 427	43 623
70	Glass and glassware	249 608	28 211	1 156	13 646	292 621
71	Natural/cultured pearls, precious stones and metals, coins, etc.	616 392	275 691	321 065	875 849	2 088 997
72	Iron and steel	1 237 065	213 275	10 284	278 549	1 739 173
73	Articles of iron or steel	1 159 708	27 827	4 849	78 450	1 270 834
74	Copper and articles thereof	674 638	299 634	3 846	73 406	1 051 524
75	Nickel and articles thereof	590 999	198 199	19 597	304 181	1 112 976
76	Aluminum and articles thereof	1 911 031	123 905	232 685	265 873	2 533 494
78	Lead and articles thereof	55 251	22 408	6 939	7 181	91 779
79	Zinc and articles thereof	567 907	20 848	30 282	61 615	680 652
80	Tin and articles thereof	5 019	111	94	806	6 030
81	Other base metals; cermets; and articles thereof	96 251	17 238	3 337	22 503	139 329
	Total	18 402 072	2 657 881	2 683 706	3 773 329	27 516 988

Source: Statistics Canada, Catalogue 65-003 (Quarterly).
[1] Chapter refers to a group of commodities covered in a specified chapter of the "Harmonized Commodity Description and Coding System," as of January 1, 1988. Canadian external trade statistics are classified according to the Harmonized System. [2] Total value of coal exports included in Chapter 27 is $1850 million.

Regional Outlook 1990

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The preliminary estimate of the value of production of metals, nonmetals, structural materials and coal in 1990 is $19.6 billion, a decrease of $1.7 billion from 1989. The metals sector showed a decrease of 8.6%, nonmetals decreased in value by 7.6%, structural metals were down by 8.9% and coal decreased in value by 2.0%. However, when natural gas, natural gas by-products and crude petroleum were included, the total value of production was $41.2 billion in 1990, an increase of 5.1% from last year's total production value of $39.2 billion.

The mineral industry has long been a major contributor to the regional economies of Canada. This is recognized in the Minerals and Metals Policy of the Government of Canada where it is stated that "The Government of Canada is committed to fostering the development of the minerals and metals sector as a foundation for regional economic development."

One acknowledgement of this commitment was the decision of the federal government to fund joint federal-provincial agreements called Mineral Development Agreements (MDAs), aimed at strengthening and diversifying the minerals sector of the provincial economies. Through the agreements, both levels of government coordinate their activities to focus on the specific needs of the individual regions.

MDAs which commenced in 1984 will have expired by the end of fiscal year 1990/91. The federal budget of April 1989 established funding levels for regional development for the next five years and new MDAs have received some of these funds. In Atlantic Canada, federal contributions of more than $23 million have been committed with last year's signing of agreements in Nova Scotia, Newfoundland and New Brunswick. Negotiations are well advanced in Ontario, Manitoba, Saskatchewan and Alberta, with signing expected in the near future. In the Territories, Indian and Northern Affairs Canada (INAC) is assuming the lead in negotiating new MDAs.

MDAs assist the mining industry at all levels of operations, from exploration assistance to increasing productivity. Over the years, the federal government has contributed more than $260 million to MDAs in the areas of geoscience, research and development, marketing and public information. Evaluations from the first round of MDAs indicate a high level of industry support for all types of programs conducted under the agreements.

NEWFOUNDLAND AND LABRADOR

In 1990, the estimated value of mineral production from Newfoundland and Labrador was $862 million, a 4% decrease from 1989.

Recent discoveries in Newfoundland, such as Corona Corporation's Pine Cove property and the Hammerdown property, have resulted in an active exploration scene in spite of unsteady commodity prices and a slowdown in flow-through share funding. Total exploration expenditures for 1990 are estimated at $23 million, a drop of some 20%-25% from last year. However, total metres of diamond drilling completed actually increased from 95 000 to 125 000 in 1990.

The mining industry in Newfoundland has suffered several setbacks in 1990. Newfoundland Zinc Mines Limited closed in August after depleting known ore reserves. St. Lawrence Fluorspar Limited closed due to the low price for its product on the world market. Baie Verte Mines Inc.'s open-pit mining operation is expected to close in the first half of 1991.

Although these closures have resulted in a net loss of jobs in 1990, the long-term outlook for the industry should improve due to a number of developments.

Baie Verte Mines Reprocessing Inc. will continue to operate the new wet process mill to recover asbestos from tailings. The Iron Ore Company of Canada has committed the first $100 million to upgrade its facilities. This company will be developing a new dolomite deposit in western Labrador in 1991. The Hope Brook Gold Inc. mine produced 110 000 oz of gold in 1990 with a production forecast of 150 000 oz for 1991. The Cape Ray gold deposit is still at the feasibility study stage.

There is more good news in the industrial minerals sector. A major expansion to the slate mining operation on Fandom Island was announced in December. The Newfoundland Resources & Mining Company Limited has constructed a new limestone mining facility on the Port-au-Port Peninsula. The plant has targetted sales of 2 Mt for its first year of operation. Exploration work is being aimed at some 40 mineable deposits of manganese in the Schefferville area.

As more companies take advantage of Newfoundland's potential for growth and diversification into new markets both at home and abroad, and as the Hibernia project comes on stream, the industrial minerals sector should continue to grow.

A new $17.5 million, four-year Cooperation Agreement on Mineral Development, aimed at assisting the development of the Newfoundland mineral industry, was signed in 1990.

NEW BRUNSWICK

In 1990, the value of mineral production in New Brunswick, including coal, was $886 million, an increase of 2.5% over 1989.

Last fall, the Caribou lead-zinc mine announced a closure due to a significant decrease in the price of zinc, the current economic recession and the Persian Gulf crisis. However, in January 1991, it reopened, announcing proven reserves of almost 2 Mt.

Workers at Brunswick Mining and Smelting Corporation Limited went on strike in July 1990 and were still on strike at year-end. Meanwhile, operations at Heath Steele Mines Ltd., a subsidiary of Brunswick Mining and Smelting Corporation Limited, continue. Marshall Minerals Corp. has received approval of its Environmental Impact Assessment screening and plans to continue development of its Restigouche base-metal and silver property.

NovaGold Resources Inc.'s Murray Brook gold and silver operation opened in October 1989 and is still in steady production. NovaGold Resources Inc. is studying the possibility of expanding this operation to include the underlying massive sulphide body which may contain in excess of 300 000 t grading better than 4.5% copper.

Stratabound Minerals Corp. is currently obtaining required government approvals and is discussing a milling contract with Heath Steele Mines Ltd. for its Captain North Extension lead-zinc deposit.

With several new producers and solid prospects on the scene to offset the effects of this year's mine closures, the value of the industry's overall metals production should remain steady through the coming year. The industrial minerals segment of the industry also remains strong in this province, with promising developments in gypsum, potash and stone quarries.

With New Brunswick's proven resource potential, long-term prospects for the industry are positive. With reasonable commodity prices, and exploration efforts, the mining industry will continue to be a cornerstone of the provincial economy.

The five-year, $10 million Canada - New Brunswick Cooperation Agreement on Mineral Development was signed in 1990. It is expected to contribute to exploration and development efforts in the mining industry.

NOVA SCOTIA

In 1990, the value of mineral production, including coal, in Nova Scotia increased by 2.4% from 1989 to $452 million.

Gold production levels fell dramatically, although these were offset by substantial increases in production of some base metals. Westminer Canada Limited's production of zinc and lead from the Gay's River mine and renewed efforts by Falconbridge Limited at the Jubilee deposit have contributed to the comeback in this sector. Metals production from Gay's River is expected to increase the value of this commodity in the marketplace.

Although 1990 was not a particularly good year for gold, there is still a great deal of interest in gold exploration in Nova Scotia, particularly in the Cape Breton Highlands. Minnova Inc. has signed a letter of intent to spend $5 million on exploration over the next three years at Orex Exploration Incorporated's Goldboro deposit at Upper Seal Harbour.

Industrial minerals production accounted for $195 million in 1990. The 2% drop from the 1989 figure is largely due to the slump in construction and the subsequent drop in cement and aggregate sales, which were down by about 20%. These sectors will have to wait out the current slowdown in the economy which is linked to the downturn in the construction industry.

With the exception of the cement and aggregates sector, the outlook for the minerals industry in Nova Scotia in 1991 is quite positive. A number of new developments on line for next year should provide a boost to the provincial economy.

The Louisiana-Pacific Corporation's fibre-gypsum plant is in the final pre-production testing stage and is expected to begin full production and product delivery by early 1991.

The Westray Coal Inc. mine is expected to come on stream by mid-1991, producing 250 000-300 000 t of coal in 1991. The production rate should reach the planned 700 000 t/y by 1992.

A new minerals agreement, the Canada - Nova Scotia Cooperation Agreement on Mineral Development, was signed this year. The term of this agreement is from April 1, 1990 to March 31, 1992 with a total funding of $9 million. It is aimed at assisting the mineral industry in Nova Scotia to explore and develop its resources.

QUEBEC

On the basis of 1990 preliminary statistics, the value of mineral production in Quebec reached $2.94 billion, up by 4% from the 1989 level. The production quantities of copper increased by 44%, which is mainly attributable to the resuming production at the Mines Gaspé Division of Noranda Minerals Inc., as well as the growing activities at the Ansil and Mobrun mines. The dollar value of the silver and zinc production has increased by 9% and 16% respectively.

It is estimated that companies spent $175 million on exploration in 1990. This reflects a substantial decrease from 1989 and is even more significant when compared to the record high levels of 1987 and 1988. This situation stems from an overall diminished interest of the investors in mining activities and, to a certain degree, from the elimination of the federal Canadian Exploration Incentive Program (CEIP).

Despite the decline noted in the exploration expenditures, reasonable levels of activities continued to take place in the industry. The Golden Pond West, Bousquet 2 and Silidor mines entered into production during the course of the year, creating 415 jobs and yielding an additional yearly production of about 190 000 oz of gold. The Estrades base-metal mine in Joutel and Ruth Lake manganese mine in Schefferville were also brought into production. Aur Resources Inc. and Louvem Mines Inc. settled their legal dispute over the Louvicourt base-metal property and proceeded to develop a $4.6 million exploration program. The metallurgical test work completed to date revealed excellent quality concentrates with possible recoveries in the range of 95% copper.

In other respects, the mining camp of Chapais-Chibougamau faces difficult times. The exhaustion of ore reserves brought Campbell Resources Inc. to close the S-3 and Cedar Bay mining operations. These closures are additional to the previous ones of the Cooke and Henderson II mines (both of Camchib Mines Inc.). In addition, 250 jobs will be lost in the summer of 1991 as Minnova Inc. plans to close its Perry and Springer operations. The region is threatened by a nearly 50% loss in its employment.

The funding allocated to the Canada - Quebec Subsidiary Agreement on Mineral Development was increased by $5 million, for a total of $112 million. The expiration date of the Agreement is delayed by an additional year for all of the programs except for one related to assisting the asbestos industry. The latter program will expire in 1993. More than $20 million was spent in 1990 on geoscience projects, infrastructure, feasibility and market studies, and exploration projects, as well as on research and development projects.

The Financial Assistance Program for Prospecting in the Lower St. Lawrence and Gaspé regions is in its last year. The program has proven to be successful and consideration is being given to its renewal.

ONTARIO

For 1990, the total value of mineral production, that is metals, nonmetals and structural materials, is estimated to be $6.32 billion, down 13.5% from 1989. Of this total, metals contributed $4.91 billion, down 14% from 1989; structural materials contributed $1.19 billion, also down 14% from 1989; and nonmetals $0.22 billion, down 9% from 1989 production levels.

In the metals group, the biggest drops in production value were for nickel (decline in world price) and iron ore (mine closings and strike), whereas the value of uranium production rose. For structural materials, the drop was due to a decline in the value of all products.

In 1990, the Ontario mining industry saw a net loss in direct mine employment. Northeastern Ontario was particularly affected, with losses of more than 2000 employees in total at Elliot Lake, Temagami, Kirkland Lake and Wawa. Several of these areas have no mining activity at present. Strikes in these and other areas added to production and employee difficulties. However, while a number of mines closed in 1990, an almost equal number opened, thereby somewhat offsetting overall production levels province-wide.

Exploration activity continued to fall in 1990. Reasons include: a decline in the price of gold, a lack of new discoveries, the removal of fiscal incentives for exploration, and investor disenchantment with junior stocks. Junior exploration companies have been hard hit; however, senior companies are still active.

Despite the reduction in exploration activity, there are several promising exploration plays which stand a good chance of becoming operating mines. If they do, several hundred jobs will be created in Wawa, Matheson-Kirkland Lake and Thunder Bay.

The notable exploration plays in 1990 were the Hemlo Gold Mines Inc./Central Crude Ltd.'s Eagle River gold deposit at Mishubishu, the Noranda Inc./Freewest Resources Inc. gold deposit near Matheson, and the large low-grade gold deposit near Thunder Bay belonging to the Moss Lake joint venture (Central Crude Ltd./Hemlo Gold Mines Inc./Tandem Resources Ltd./Storimin Exploration Limited).

The provincial government continues to encourage mineral exploration through its Ontario Prospectors' Assistance Program (OPAP) and Ontario Mineral Incentives Program (OMIP). Recent changes in OMIP regulations have made the program more attractive. The $8 million set aside has been fully subscribed. Over 400 applications have been approved for the $4 million available under OPAP.

Two areas hard hit by mine closures, Elliot Lake and Cobalt-Kirkland Lake, were targetted for additional incentives under OMIP. The Temagami-Cobalt-Kirkland Lake area also stands to benefit from the lifting of part of the Bear Island Caution. Agreement reached with the Indian band cleared the way for renewed mineral exploration over some 1000 km^2 of land where activities have been frozen since the land claim was declared in 1963.

Activities under the Canada - Ontario Mineral Development Agreement (COMDA) ended on March 31, 1990, although publication of results continue during this, the wrap-up year. Negotiations are proceeding towards signing a new five-year Mineral Development Agreement.

MANITOBA

In 1990, the value of nonfuel mineral production is estimated at $1.21 billion, a decrease of 23% from 1989. There are several promising developments on the horizon which should improve the overall production figures in the coming year.

Although Inco Limited had planned early in the year to cut its nickel production by 10%, the price stabilized through the course of the year. Hence, the company announced new mine developments in the Thompson area. It earmarked $287 million to expand production of its Manitoba nickel mines and another $7 million to find more ore in the Thompson nickel belt. The company's commitment demonstrates its stated objective of becoming a low-cost producer of nickel for the next 20 years.

Talks continued through the year between federal and provincial governments and Hudson Bay Mining and Smelting Co., Limited (HBMS) for modernization at the company's Flin Flon smelter to meet federal and provincial standards on sulphur dioxide emissions.

The town of Lynn Lake continues to feel the effects of the closing of LynnGold Resource Inc.'s MacLellan gold mine. The mine had ceased operations in late 1989 due to plummeting gold prices. An attempt in April 1990 by Royal Oak Resources Ltd. to buy up the assets of LynnGold Resources Inc. and put the mine back in production, failed.

Grassroots exploration activity has decreased substantially in the province; for example, only one claim was staked in September.

The Manitoba government is preparing a new Mines Act, which will be a priority item when the legislature convenes in early 1991. As a part of this exercise a joint industry-government task force will work towards revision of the mining tax.

The Manitoba Department of Energy and Mines will be releasing a paper on mineral strategy which will outline the mineral policy for the province and government direction in achieving sustainable mine development. The Department is also looking at ways of encouraging more prospecting through a prospector's assistance program and prospector training.

The Canada - Manitoba Mineral Development Agreement expired in March 1989. Work towards a new federal-provincial mineral development agreement is under way.

SASKATCHEWAN

In 1990, the value of nonfuel mineral production is estimated at $1.11 billion, a decrease of 21% from 1989. The decline was due principally to low prices and soft market conditions for uranium and potash, the two main commodities of the Saskatchewan mineral industry. These conditions are expected to persist in 1991.

The Cameco Corporation-Uranerz Exploration and Mining Limited's Rabbit Lake uranium mine, which closed on a temporary basis in 1989, remained closed throughout 1990. However, this has enabled their Key Lake mine to operate at high levels of capacity. The Cameco Corporation-Amok Ltd.'s Cluff Lake operation was suspended in 1989 and, although grades are low by Saskatchewan standards, it resumed production early in 1990. The development of the high-grade Cigar Lake deposit of Cigar Lake Mining Corporation (CLMC) continued during 1990. Feasibility and environmental studies are to be completed by 1993. Although there is unused capacity and promising orebodies for development, poor marketing conditions in the near term may hinder any significant expansion over current levels.

An environmental impact statement has been filed for the Denison Mines Limited project, and one is expected very soon for the Wolly Joint Venture at McClean Lake.

The potash industry operated at about 60% of capacity with the largest firm, the Potash Corporation of Saskatchewan Inc. (PCS Inc.), operating at about 50%. Although no mining operations were suspended during the year, most mines operated with reduced shifts. Later in the year, International Minerals and Chemical Corporation (Canada) Limited (IMCC) announced ongoing activities to consider a new potash mine in the Esterhazy area for possible production in the mid-to-late 1990s. Although marketing conditions are not expected to change significantly in the near term, recent potash sales to China bodes well for the industry.

Exploration expenditures are estimated at $65 million, down some 15% from 1989 due principally to a continuing decline in gold activity resulting from lower gold prices. However, uranium and base-metal exploration activity remained relatively steady even though uranium markets remained soft. Base-metal activity continued to be centred in the Flin Flon area. Gold exploration activity was focussed in the La Ronge area. Interest in diamond exploration remained high, particularly east of Prince Albert where Uranerz Exploration and Mining Limited announced finding macro-diamonds on its Fort à la Corne property.

At year-end, negotiations were well advanced on a new federal-provincial five-year, $10 million Mineral Development Agreement.

ALBERTA

In 1990, the value of mineral production was up 17.5% to $19.3 billion. Included in this amount is $18.7 billion for mineral fuels, of which coal accounted for about $486 million. Total tonnage of coal produced in 1990 was estimated to be 30.3 Mt, a decrease of 2% from 1989.

Production of elemental sulphur, a by-product of sour natural gas and oil sands petroleum production, was estimated at 5.3 Mt, about a 10% increase over 1989. Value of the sulphur was $315 million.

The Shell Canada Limited Caroline project was approved by the provincial Energy Resources Conservation Board after a series of environmental hearings held last spring. The industry calls the project a major economic boost for all of Alberta, with safety features to prevent environmental damage. Shell Canada Limited, which owns 62% of Caroline's reserves, estimates that the development would produce 4000 t/d in addition to natural gas and gas liquids.

Minerals have been incorporated into the Alberta government's agenda on the environment. Alberta proposes legislation to achieve national objectives of clean economic development; projects with industry; and the creation of a new watchdog, the Natural Resources Conservation Board. The legislation would apply to coal development, oil sands and small operations such as gravel quarries.

A magnesium plant was opened near High River by Magnesium Company of Canada Ltd. (MAGCAN). Raw material comes from the Baymag high-grade magnesite deposit near Radium Hot Springs, British Columbia. By year-end, the plant had reached about 35% production. Plans to expand the facility from the original 12 500 t/y will depend on market conditions.

Negotiations are presently under way for the first federal-provincial Mineral Development Agreement with Alberta.

BRITISH COLUMBIA

In 1990, the value of mineral production was down 0.4% to $4.11 billion. Included in this amount is $1.97 billion for mineral fuels, of which coal accounted for $1.05 billion. Total production of coal in 1990 was estimated at 24.8 Mt, approximately the same figure as for 1989. As well, a total of 430 000 t of sulphur was produced in 1990, about a 5% increase over 1989.

Overall exploration activity in British Columbia is expected to slow down in 1991 as junior companies find it increasingly difficult to raise risk capital and the seniors tighten up on their exploration budgets.

A recent report from the B.C. Coal Producers shows that 1990 was the worst year in terms of return for the industry, with a 1%-2% return on investment. This low return is due to the high Canadian dollar, high taxes and the low price of coal.

The legal future of the Quintette Coal Limited mine is uncertain, as it continues to seek court protection. The price received by the company is below its cost of producing and transporting the coal, and has forced Quintette Coal Limited to seek a reorganization of its business.

The year-end saw base-metal prices moving lower, and with the recession pointing to further softening in demand, prices are likely to continue to decrease. Some companies have written down the carrying values of mining investments that have not done as well as expected in 1990. Golden Bear (North American Metals Corp.), for example, has taken a $24 million write-down due to low gold prices, a reduction in reserve estimates and an increase in operating costs. Also, a number of mine shutdowns, planned shutdowns and cutbacks in production were announced through the year.

New projects under development include the Placer Dome Inc. Mt. Milligan mine which may be in production by 1993, the Cirque, and Windy Craggy.

The "Golden Triangle" north of Stewart, which contains the Eskay Creek discovery, continues to be an active exploration area. Production will begin early in 1991 at the Snip gold mine in the Iskut River area. Construction of a toll road from the Cassiar Highway will vastly improve access to the Snip, Eskay Creek and other properties in the "Golden Triangle." Work on the road is expected to begin in the spring of 1991.

Probably the most controversial development is the Windy Craggy copper-gold property in the northwestern corner of British Columbia. The project is opposed by some American and Canadian government departments and environmental groups. A first-stage study by Geddes Resources Limited was deemed inadequate by the provincial mine development steering committee. The major concern is acid drainage into the Alsek River system which supports small fisheries in Alaska and the Yukon.

The year 1990 saw proposals for new environment legislation being tabled. The new B.C. Development Assessment Act, which will review proposals for new mines, will subject both mine-site facilities and off-site infrastructure submissions to impact assessment and an acceptable environmental protection plan. New projects subject to review will include coal and nonfuel mineral mines producing more than 10 000 t/y of ore, and may also include placer and quarrying operations.

The Mines Act, which was updated in 1989, provides for the regulation of mines from inception to abandonment. Environmental regulation is an integral part of the Act, which now requires mining firms to post bonds with the province until they leave the mine site. In this regard, Equity Silver Mines Limited has posted a bond to cover the projected costs of treating run-off waters entering nearby rivers.

The British Columbia government has reversed a long-standing 119-year-old policy and has recognized the validity of Indian land claims. This decision has raised some uncertainty in the province's mining and mineral exploration business. The mineral resource industry will need clarification on the future business environment before committing itself to long-term investments in exploration.

NORTHWEST TERRITORIES

In 1990, the value of mineral production was up 1.6% to $1.17 billion. Included in this amount is $261 million for mineral fuels. The value of nonfuel mineral production is estimated at $906 million, a decrease of 6% from 1989.

Shipments of concentrates from Pine Point Mines Limited, which was closed in 1988, are near complete and zinc and lead production is expected to drop next year as a result.

Exploration expenditures were concentrated mainly on gold projects in the western portion of the territory, with only a slight increase on exploration for base metals. Advanced exploration was carried out on a number of promising properties in the Yellowknife belt including the Nicolas Lake, George Lake and Hood River areas, and north of Baker Lake, but claim staking was down by about one third.

Regional Outlook

Seven mines were in production in the Northwest Territories in 1990. The Neptune Resources Corp. Colomac mine opened in 1990. However, lower-than-anticipated recoveries have created financing difficulties and this mine may have to close if grades do not rise.

Work under the Canada - Northwest Territories Mineral Development Agreement continued in 1990, and has started to wind down. Several projects obtained interesting results and companies are expected to follow up on results.

The Dene/Metis comprehensive land claim negotiations fell through and work is continuing towards settling this claim in smaller areas. Progress has been made towards settlement of the Tungavik Federation of Nunavut (TFN) land claims in the eastern Arctic. Selection of land is continuing and this claim should be completed by the federal government and the TFN in 1991.

An Environmental Rights Act was passed by the Northwest Territories Legislative Assembly in November. Under the bill, any person may obtain information from any minister regarding the release of contaminants into the environment and gain access to examine licences, permits, approvals, orders or notices. Any two residents of the Northwest Territories may apply for an investigation of a contaminant release, and where a resident believes that an offence has been committed, the person may commence an action in the Supreme Court against the responsible party. The Act is of interest to the mining industry and will be considered seriously in the development of operational plans.

YUKON TERRITORY

In 1990, the value of mineral production was $541 million, up marginally from 1989 by 0.2%. The increase was limited as a result of high production costs coupled with declining ore reserves. Although gold production was slightly down from last year, lead-zinc-silver production was up, thereby maintaining overall mineral production value at about the same level as last year.

Placer gold operations were down to 194 from 226 in 1989. High production costs and a decreased quantity of gold primarily accounted for the decrease in the number of operations from last year. Production dropped from 160 000 oz of gold reported in 1989 to 133 000 oz in 1990. This represents approximately a 20% production decrease and an $11 million decrease in value from last year.

The Faro lead-zinc-silver mine operated throughout the year and the Vangorda operation was recently brought into production. Currently, production from the two mines is 13 000 t/d, making it the world's largest lead-zinc operation. Near Watson Lake, Curragh Resources Inc. began developing its Mt. Hundere lead-zinc deposit; production is expected to begin in mid-to-late 1991. The gold contained in the Vangorda and Grum deposits will also make Curragh Resources Inc. a very large gold producer. These developments will have the most substantial impact on the Territory, offsetting the closure of the Canamax Resources Inc. gold mine at Ketza River in August 1990.

Preliminary estimates from Indian and Northern Affairs Canada (INAC) indicate that exploration spending was down again in 1990 to about $11 million, reaching the lowest level in many years. Reasons for the downturn include: high interest rates, declining overseas investment, discontinuation of government incentive programs and uncertainty over future environmental legislation and native Indian land claim settlements. However, at least 40 exploration projects were carried out, evenly split between gold and base metals. The exploration highlight of the year was undoubtedly Noranda Inc.'s Brewery Creek gold project near Dawson City.

An umbrella final agreement for the Council of Yukon Indians (CYI) land claim was concluded in March 1990. It established the common elements of the comprehensive land claim and the final agreements to be negotiated with individual bands. Ratification of the agreement is scheduled for March 1991, thereby ending a period of uncertainty for the mining industry in the Yukon.

INAC is proceeding with negotiations with the Yukon Territorial Government to develop a new Mineral Development Agreement (MDA) for the Yukon. The last MDA expired in March 1989 and was replaced by a one-year Canada - Yukon Economic Development Program.

Note: Information contained in this review was current as of mid-January 1991.

TABLE 1. VALUE OF LEADING MINERALS IN THE PROVINCES, TERRITORIES AND CANADA, 1989 AND 1990

	Value of Production			
	1989f	1990p	Change 1990/1989	1990p Proportion of Provincial Total
	($ million)		(percent)	
Newfoundland				
Iron ore	722.5	695.8	–3.7	80.8
Gold	x	52.4	x	6.1
Zinc	58.9	41.4	–29.6	4.8
Asbestos	24.9	26.3	5.9	3.1
Sand and gravel	18.0	17.4	–3.3	2.0
Total	896.4	861.6		
Prince Edward Island				
Sand and gravel	2.2	3.3	49.6	100.0
Total	2.2	3.3		
Nova Scotia				
Coal	199.5	199.2	–0.1	44.0
Gypsum	53.8	54.2	0.6	12.0
Salt	x	x	x	x
Cement	x	x	x	x
Tin	x	32.2	–10.0	7.1
Stone	33.7	28.7	–14.9	6.3
Total	441.5	452.3		
New Brunswick				
Zinc	433.7	481.0	10.9	54.3
Potash (K_2O)	x	x	x	x
Lead	67.8	61.4	–9.5	6.9
Coal	33.7	37.4	10.8	4.2
Peat	24.9	28.3	13.5	3.2
Total	864.1	886.1		
Quebec				
Gold	536.7	567.8	5.8	19.1
Iron ore	x	566.3	x	19.1
Copper	220.9	301.5	36.5	10.2
Stone	230.5	248.1	7.7	8.4
Titanium dioxide	x	x	x	x
Zinc	216.6	199.3	–8.0	6.7
Total	2 855.8	2 967.8		

TABLE 1 (cont'd)

	Value of Production			
	1989f	1990p	Change 1990/1989	1990p Proportion of Provincial Total
	($ million)		(percent)	
Ontario				
Nickel	2 010.1	1 316.6	–34.5	20.5
Gold	1 142.4	1 148.1	0.5	17.9
Copper	922.1	886.6	–3.8	13.8
Uranium (U)	500.3	635.4	27.0	9.9
Zinc	572.8	541.7	–5.4	8.4
Cement	444.4	401.8	–9.6	6.3
Total	7 257.2	6 419.7		
Manitoba				
Nickel	1 032.2	707.3	–31.5	53.2
Copper	171.2	178.1	4.0	13.4
Zinc	155.1	142.0	–8.5	10.7
Petroleum, crude	90.1	116.7	29.6	8.8
Total	1 668.2	1 329.9		
Saskatchewan				
Petroleum, crude	1 237.3	1 688.0	36.4	52.3
Potash (K_2O)	x	x	–13.7	23.0
Natural gas	238.9	314.0	31.4	9.7
Uranium (U)	412.3	232.6	–43.6	7.2
Total	3 011.3	3 229.8		
Alberta				
Petroleum, crude	9 055.3	11 394.4	25.8	58.9
Natural gas	4 624.7	4 716.5	2.0	24.4
Natural gas by-products	1 570.2	2 120.2	35.0	11.0
Coal	500.3	485.8	–2.9	2.5
Sulphur, elemental	374.8	315.2	–15.9	1.6
Total	16 455.8	19 338.7		
British Columbia				
Copper	1 045.6	1 106.2	5.8	26.9
Coal	1 059.0	1 048.5	–1.0	25.5
Natural gas	472.3	509.1	7.8	12.4
Petroleum, crude	268.9	338.1	25.7	8.2
Gold	227.0	232.2	2.3	5.7
Sand and gravel	156.6	158.7	1.4	3.9
Zinc	256.9	113.9	–55.7	2.8
Total	4 123.3	4 107.6		
Yukon				
Zinc	332.9	327.8	–1.5	60.6
Lead	98.3	127.5	29.7	23.6
Gold	82.1	66.3	–19.2	12.3
Silver	14.9	15.4	3.9	2.9
Total	533.9	541.1		

TABLE 1 (cont'd)

	Value of Production			
	1989f	1990p	Change 1990/1989	1990p Proportion of Provincial Total
	($ million)		(percent)	
Northwest Territories				
Zinc	708.0	611.4	–13.6	52.4
Petroleum, crude	178.1	250.4	40.6	21.4
Gold	177.3	217.1	22.5	18.6
Lead	41.3	45.6	10.3	3.9
Total	1 149.3	1 167.5		
Canada				
Petroleum, crude	10 862.9	13 831.8	27.3	33.5
Natural gas	5 394.3	5 597.9	3.8	13.6
Copper	2 388.7	2 494.6	4.4	6.0
Zinc	2 739.2	2 477.0	–9.6	6.0
Gold	2 315.9	2 378.3	2.7	5.8
Natural gas by-products	1 620.3	2 208.7	36.3	5.3
Nickel	3 042.3	2 024.0	–33.5	4.9
Coal	1 907.1	1 871.0	–1.9	4.5
Iron ore	1 369.2	1 312.2	–4.2	3.2
Potash (K_2O)	1 017.5	907.2	–10.8	2.2
Grand Total	39 259.1	41 305.4		

f Final; p Preliminary; x Confidential.

Labour and Employment

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OVERVIEW

Along with falling commodity prices for most major minerals, results for 1990 in the mining industry show significant weakening from 1989. After some employment stability in recent years, employment levels fell once again. Average wage settlements continue to exceed the rate of inflation. Meanwhile, longer term concerns about the availability of skilled workers for the industry have given new impetus to industry/labour/government efforts to ensure labour market stability.

This chapter offers a closer look at labour market developments in the minerals and metals industry, including an overview of the industrial relations scene and compensation trends, plus selected safety and health highlights. Major legislative developments at the federal level are also noted.

LABOUR MARKET DEVELOPMENTS

Department of Energy, Mines and Resources (EMR) forecasts indicate that employment in minerals and metals declined significantly in 1990, after three relatively stable years.

Forecasted direct employment in mining and primary metals for 1990 was 150 255 jobs, down 3% from 1989. This follows two years of slight increases in total mining and primary metals employment.

This was a year of workforce reductions in each metal mining commodity group. Overall employment in metal mines dropped to 45 461 in 1990, a 7% decline from 1989. Major contributors to this decline were gold and nickel-copper-zinc mines, which decreased by 13% to 10 937, and by 5% to 18 672, respectively.

Similarly, nonmetal mining commodities employed fewer workers. The exception was gypsum, which climbed 5% to 1018. The 1990 forecast of 10 984 employees in nonmetal mines represents a 5% reduction from the previous year. In contrast, employment in structural materials was 6266, an increase of 6%. Coal mine employment increased by 12% to 12 068 workers in 1990, the largest coal workforce since 1985.

At 44 267, iron and steel mill employment in 1990 was the lowest in twenty years. Nonferrous smelting and refining employed 31 209 workers, a small decrease from 1989.

Nonfuel semi-fabrication employed 94 425, a 5% decrease from 1989, metallic mineral manufacturing declined 1% to 142 773, and mining diamond drilling was forecast to remain at 1903.

Total 1990 employment in all four stages of mining and mineral products manufacturing (excluding petroleum and natural gas) was 387 453. This was 3% lower than the previous year.

The number of mine closures during 1990 was nearly double that of openings. Most of the year's closures were mines employing large numbers of workers, and one third were in Northern Ontario. The greatest job losses were 2150 at Denison Mines Limited and Rio Algom Limited uranium mining operations at Elliot Lake, and 689 at the Dofasco Inc. Adams and Sherman iron mines in Ontario. Also significant was the loss of 400 jobs at the Brenda Mines Ltd. British Columbia copper mine.

Operations starting up, on the other hand, tended to employ fewer people. Half of the new mines are in Quebec, and most are gold producers. The major new employers of the year were: NorthWest Gold Corp.'s Colomac gold mine at Indin Lake, Northwest Territories (300 employees); Inco Limited's Birchtree nickel mine in Thompson, Manitoba (160); and Noranda Minerals Inc.'s Silidor gold project in Rouyn, Quebec (120).

Technology, workforce demographics and required skill levels have been changing, as well as the size and nature of mining and metals operations. Concern has been growing in industry, labour and government over declining enrolments in mining-related courses at Canadian universities and colleges, and over possible future difficulties in attracting and maintaining a properly trained workforce in the mining industry. This concern led the Government of Canada to start a process in 1990, along with the mining industry, organized labour, provincial government departments and educational institutions, to develop an education, training and human resource development strategy for the Canadian mining industry. As a first step, a sector study will be undertaken to establish the present employment and skills situation, and future employment and skills requirements. This study should be completed by the end of 1991.

COMPENSATION

Average earnings in mining are among the highest of all industrial classifications. For 1989, average weekly earnings for hourly paid employees (including overtime) were $793.06 for metal mines and $653.47 for the nonmetals, in contrast to $572.93 in manufacturing and $598.55 in construction.

At the time of writing, data for 1990 were available to the end of September. Over the one-year period ending in September 1990, average weekly earnings in metal mines were up 5.8%, by 5.4% in nonmetals and by 2.7% in the coal industry.

The data indicate that real wages (based on the CPI: 1986=100) showed marginal increases in metal and nonmetal mines and a decrease in the coal industry for the period up to the end of September 1990. For the period September 30, 1989 to September 30, 1990, real wages in metal mining increased by 1.6%, and in nonmetals by 1.2%, while real wages in the coal industry decreased by 1.5%. Over the same period, real wages in all industries increased by 0.9%.

In 1989, the last year for which data are available, average annual labour income in current dollars (wages and salaries plus employer contributions to benefit plans) in mines, quarries and oil wells was $51 900, well above the average labour income of $32 152 for all industries. It should be noted that average annual labour income for 1988 was revised to $47 903 for mines, quarries and oil wells and $30 161 for all industries. The 1989 figures represent increases of 8.3% and 6.6% respectively, over 1988 revised dollar income.

INDUSTRIAL RELATIONS

The 1990 minerals and metals collective bargaining calendar was among the busiest in years. Some twenty-nine agreements were signed during the first nine months, covering over 23 000 employees in mining, smelting and refining. Of these, four were in the Atlantic region, four in Quebec, eleven in Ontario, four in the Prairies and six in British Columbia. The majority of contracts were for 36 months, although uranium agreements were of 12 months' duration.

Major minerals and metals bargaining units of 500 or more employees negotiated average annual wage increases of 5.9%, exceeding the average settlement in manufacturing and surpassing inflation.

Major metal mining increases averaged 6% for each year of the contract, and those in smelting and refining averaged 7.2%. Average settlements in nonmetal and coal mines were 2.8% and 3.4%, respectively.

Non-wage developments during 1990 included: pension plan improvements, in particular increased benefits, shorter vesting periods and indexed pensions; early retirement incentives; and new or improved provisions for contracting-out protection, seniority, severance pay, wage incentive plans such as productivity and market value bonuses, and paid vacation leave. Wage and non-wage patterns among smaller bargaining units were similar to those of major units.

In 1989 there were 17 work stoppages in mining; 7 in metals, 5 in nonmetals, 4 in coal and 1 in quarries. There were 7129 workers involved and 189 600 person-days were lost. The primary metals sub-sector lost 93 880 person-days, fewer than any year since 1985.

While aggregate data are not yet available for 1990, this appears to have been a considerably more disruptive year for minerals and metals, particularly in terms of days lost (Table 1). Strikes and lockouts occurred at lead-zinc mining, smelting and refining operations in New Brunswick and British Columbia, aluminum smelting and refining in British Columbia, and steel mills in Ontario, Quebec and Alberta.

SAFETY AND HEALTH

Once again in 1990, the issue of health and safety in the workplace was a priority for the mining industry and for government authorities responsible for legislation and regulations in this area. A number of efforts were made by the mining companies, in co-operation with workers in the mining sector and the union organizations representing them, to ensure that the number of accidents was as low as possible and to reduce the number of deaths caused by occupational diseases. In addition, several governments revised their legislation and regulations applying to occupational health and safety. For example, Ontario and British Columbia passed new laws and regulations in 1990 emphasizing the preventive aspect of their role in the work environment.

In 1989 (the latest year for which complete data are available), the statistics for mines, quarries and oil wells on industrial accidents and occupational diseases, involving lost time, suggest that the number of serious employment injuries (including fatal injuries) fell by about 8% (Table 2). This is below the average for the three previous years (1986-88), a period during which the number of injuries remained relatively stable. However, there were 5263 employment injuries with loss of time in the metal and nonmetal mines in 1989, up 8% from the 4888 injuries recorded in 1988. This increase occurred after an apparent general trend downward since 1982. There were 6% fewer injuries with loss of time in 1989 compared to 1982.

Preliminary statistics published by Labour Canada for 1989 indicate that 58 workers died as a result of industrial accidents or occupational diseases in the mining industry (including quarries and oil wells). Of this number, 35 fatal injuries resulted from industrial accidents which occurred in 1989 or earlier, while 23 were attributable to occupational diseases.

The frequency of fatal employment injuries was 0.35 per 1000 workers in 1989, a reduction from the figure of 0.46 in 1988 and, more significantly, the lowest rate ever recorded. Historically, this rate reflects a substantial improvement in the situation and represents a reduction of 40% from the average annual rate calculated for the five preceding years from 1984 to 1988. The frequency of fatal injuries for the forestry sector is still higher than that for the mining sector.

EMR's survey of chief inspectors of mines in the provinces and territories showed that there were 29 fatal mining accidents in 1990. This survey allows us to refine the published data somewhat, since it covers only fatal accidents directly related to the mining industry and excludes accidents in the oil and gas sectors. The number of fatal accidents was down in 1990 from the 36 reported in 1989 and compares favourably with the annual average of 38.6 fatal accidents recorded in the ten preceding years from 1980 to 1989. Additional information on fatal accidents in 1990 is given in Table 3, which also includes a breakdown by government responsible and type of mine.

In co-operation with the chief inspectors, EMR is continuing its efforts to complete development of the National Mine Accident Data Base. Currently, the three most important mining provinces, Quebec, Ontario and British Columbia, are taking an active part in this project. Moreover, starting in the spring of 1991, the data base will include a fourth participant, the Northwest Territories. Steps are also being taken to ensure the participation of other provincial and territorial authorities.

An example of an analysis performed with this pilot system is shown in Figure 3, in which fatal accidents from 1986 to 1989 in the occupations most affected are compared to accidents with loss of time in 1989 (analyses of fatal accidents must cover more than one year because of the small number of observations). This analysis shows that the occupations most affected by fatal accidents are those related to the category of underground production drilling (for instance, long-hole drillers, mechanized miners and blasters), which represent 29% of fatal accidents entered into the data base for the period 1986 to 1989. The next most affected are the occupations associated with the category of underground exploration and development (for example, shaft sinkers, drift miners and diamond drillers), which account for 13% of these accidents. In accidents with loss of time entered for 1989, we find that the occupations associated with the general services category (such as mechanics, welders and electricians) are the most affected, representing 29% of the total of such accidents, followed by occupations in the categories of underground production drilling, as well as underground exploration and development, referred to above, each representing 13% of these accidents.

LEGISLATIVE HIGHLIGHTS

The federal jurisdiction for labour matters affecting the mining industry is narrowly defined. Responsibility for most labour legislation, including safety and health, industrial relations and conditions of work, rests with the provinces and territories. A broad range of labour laws and regulations apply to employers and workers across Canada, and specific provisions vary widely across the jurisdictions.

Each year, a wide range of amendments to labour legislation may affect the mining industry. This section does not attempt to review all such legislation, but outlines developments at the federal level in 1990, with very brief reference to selected provincial initiatives.

Unemployment Insurance

Bill C-21, An Act to amend the Unemployment Insurance Act, became effective November 18, 1990. The amendments include: the withdrawal of federal government contributions to Unemployment Insurance funds; an increase in the number of weeks of work required to qualify for benefits according to regional unemployment rates, a reduction of the maximum benefit period, the increase and restructuring of maternity/parental/sickness benefits, the provision of benefits to employees who continue to work after age 65, and increased penalties for those who quit work without just cause. Funds made available through these amendments have been allocated to developmental assistance such as training programs, relocation assistance, self- and re-employment incentives.

A new Canadian Labour Force Development Board was subsequently created and assigned the task of identifying labour market needs and designing programs to train Canadians to meet those needs. The Board will be run by business and labour representatives.

Taxation of Northern Benefits

A revised system of tax benefits for residents of Canada's northern and isolated regions was announced in December 1990. Residents of a redefined Northern Zone remain eligible for full income tax deductions of up to $450 a month plus deductions for unlimited medical travel and two employer-provided vacation trips per year. The new system introduced an Intermediate Zone, where residents qualify for 50% of the full deductions. Benefits to newly eligible residents are retroactive to 1989, and deductions to those no longer eligible will be phased out annually until 1995. Some mining areas south of 60° will experience reductions in eligible tax benefits.

Employment Equity

The third annual report under Canada's Employment Equity Act was submitted to Parliament in December 1990. Minerals and metals employers covered by the Act include the uranium firms, Cape Breton Development Corporation, Hudson Bay Mining and Smelting Co., Limited, Alcan Smelters and Chemicals Limited and the Royal Canadian Mint.

The report assigned high, medium and low ranks to employers, according to the status of each designated group compared to the group's representation in the Canadian labour force at the end of the reporting year, 1989. Similar ranks were assigned according to progress achieved during the reporting year. All seven minerals and metals sector employers subject to the Act received the lowest rank for numbers of women employees, although three ranked high for progress. Rankings for aboriginal employees scored better with three high, three low and one medium rating. Over half of reporting minerals and metals employers rated high for employment of workers with disabilities and members of visible minorities.

As prescribed by the legislation, a Parliamentary Committee will undertake a review of the provisions and operation of this Act during 1991. A discussion paper and an invitation to submit views have been distributed to employers, unions and designated groups.

Health and Safety in Coal Mines

The federal government has established new Coal Mining Occupational Safety and Health Regulations (CBDC) under the Canada Labour Code. These regulations replace the Coal Mines Safety Regulations (CBDC) and apply to coal mines under the authority of the Cape Breton Development Corporation. These Regulations, passed on February 14, 1990, provide for the establishment of the Coal Mining Safety Commission and have withdrawn the right of safety officers to exercise their discretionary powers. The Commission has the authority to allow variations or exemptions in applying the regulations and to approve mining equipment, methods and standards.

Provincial/Territorial Developments

A number of changes to labour and employment standards legislation took place in 1990. Several jurisdictions legislated increases in minimum wages and introduced new pension standards legislation. Extensive amendments to Ontario's Workers' Compensation Act became effective in 1990. They include new rehabilitation obligations, the right of injured workers to re-employment, and a new pension system which compensates for economic and non-economic loss in case of permanent disability or impairment.

There are several changes to legislation on occupational health and safety. In Ontario, Bill 208, the Occupational Health and Safety Statute Law Amendment Act, 1990, which includes amendments to the Occupational Health and Safety Act and the Workers' Compensation Act, was passed on June 19, 1990. The amended Act provides for, among other things, the creation of a new occupational health and safety agency with a broadened role. In Manitoba, the Workplace Health Hazard Regulations, which apply the Workplace Safety and Health Act, have been amended, particularly with regard to the regular updating of controlled products. In British Columbia, the Mines Act (SBC 1989, c 56), passed in 1989, came into effect on July 15, 1990. This is a thorough revision of the previous legislation. In particular, it strengthens the provisions for applying health and safety standards in mines.

OUTLOOK

More uncertainty than usual accompanies economic forecasts for 1991. However, modest growth of real output for the mining industry is projected as North America emerges from the recession in the latter part of the year. As a result of productivity improvements achieved since the last downturn, mining output growth is no longer necessarily accompanied by employment growth but, rather, by a slowing or flattening of the employment decline.

A continued drop in minerals and metals employment is expected in 1991, reflecting the closure and workforce reduction announcements in late 1990. Employment in iron and steel mills, in particular, is expected to fall. Meanwhile, given changing demographics and disturbing enrolment patterns at Canadian colleges and universities, skill development at the professional and technical levels in the industry should continue to be a priority.

Closures announced for 1991 will affect 200 employees at the Minnova Inc. Opemiska gold operations in Chapais Quebec, 56 at the Corona Corporation Jolu gold mill at La Ronge, Saskatchewan, and 36 at the Teck Corporation Beaverdell silver mine in Kelowna, British Columbia. These job losses will be more than offset when production begins at new, rehabilitated and expanded operations.

Labour and Employment

Westray Coal Inc. in Pictou County, Nova Scotia expects to provide 210 permanent jobs; Claude Resources Inc.'s Seabee gold mine in La Ronge, Saskatchewan plans to employ 80; Cominco Ltd.'s Snip gold and silver project in Stewart, British Columbia, 154; and Curragh Resources Inc.'s Mount Hundere zinc mine in Watson Lake, Yukon, 110.

The collective bargaining calendar will be significantly quieter than that of 1990. Nonetheless, some important bargaining units will be at the table. Notables include the two nickel giants in Northern Ontario, Inco Limited and Falconbridge Limited, several Alcan Aluminium Limited operations in Quebec, major copper mines in Quebec and British Columbia, a number of potash mines in Saskatchewan and the Ontario uranium mines.

Note: Information contained in this review was current as of mid-January 1991.

TABLE 1. LABOUR DISPUTES, 1990

Employer	Location	Products	Union[1]	Period of Work Stoppage	Employees Involved
NEW BRUNSWICK					
Brunswick Mining and Smelting Corporation Limited	Bathurst	Lead, zinc	USWA	July 1-	1 092
Brunswick Mining and Smelting Corporation Limited	Belledune	Refined lead, zinc	USWA	June 24-July 4 July 22-	450
Denison-Potacan Potash Company (DPPC)	Sussex	Potash	USWA	Jan. 15-Feb. 5	353
NOVA SCOTIA					
Cape Breton Development Corporation (CBDC)	Lingan, New Waterford	Coal	UMW	Aug. 16-Sept. 20	2 300
QUEBEC					
Cambior Inc. Beauchemin mine	Rouyn-Noranda	Gold	USWA	Jan. 26-Mar. 19	140
LAC Minerals Ltd. Doyon mine	Rouyn-Noranda	Gold	USWA	Feb. 5-Mar. 5	380
Stelco Inc.	Lachine, Contrecoeur	Steel	USWA	Aug. 1-Nov. 14	625
Wabush Mines	Sept-Îles	Iron pellets	USWA	Apr. 4-May 15	300
ONTARIO					
Algoma Steel Corporation, Limited, The	Sault Ste. Marie	Steel	USWA	Aug. 1-Nov. 20	5 000
Algoma Steel Corporation, Limited, The	Wawa	Iron	USWA	Aug. 1-Nov. 20	300
Canadian Salt Company Limited, The	Windsor	Salt	CAW	Feb. 19-Aug. 14	320
Placer Dome Inc. Dome mine	South Porcupine	Gold	USWA	May 7-Oct. 31	580
Stelco Inc.	Hamilton, Burlington	Steel	USWA	Aug. 1-Oct. 29	6 760
ALBERTA					
Stelco Inc.	Edmonton	Steel	USWA	Aug. 11-Nov. 16	475
BRITISH COLUMBIA					
Alcan Smelters and Chemicals Limited	Kitimat	Aluminum	CASAW	July 24-26	1 500
Cominco Ltd.	Kimberley	Lead, zinc	USWA	July 9-20	500
Cominco Ltd.	Trail	Refined lead, zinc	USWA	July 9-23	2 460
Highland Valley Copper	Kamloops	Copper	USWA	Mar. 28-30	600
Similco Mines Ltd.	Princeton	Copper, gold, silver	CAIMAW	Jan. 5-11	235

Sources: Labour Canada; Canadian Labour Views Reports.
[1] Acronyms:

CAIMAW	Canadian Association of Industrial, Mechanical and Allied Workers
CASAW	Canadian Association of Smelter and Allied Workers.
CAW	National Automobile, Aerospace and Agricultural Implement Workers Union of Canada
UMW	United Mine Workers of America
USWA	United Steelworkers of America

TABLE 2. NUMBER OF TIME-LOSS INJURIES AND ILLNESSES ACCEPTED BY WORKERS' COMPENSATION BOARDS, MINING, 1982-89[1]

	Mines, Quarries and Oil Wells	Metal and Nonmetal Mines	Mineral Fuels	Services Incidental to Mining
	(SIC 051-099)	(051-059, 071-079)	(061-064)	(096-099)
1982	12 425	5 603	3 541	2 724
1983	11 717	5 114	3 153	2 815
1984	12 322	5 595	2 286	3 764
1985	13 471	5 411	3 175	3 956
1986	11 105	5 024	2 191	3 111
1987	11 103	4 766	1 931	3 526
1988	11 258[r]	4 888[r]	1 857	3 592
1989	10 282	5 263	1 485	2 537

Source: Statistics Canada.
[1] Includes fatalities.
[r] Revised.

TABLE 3. FATALITIES IN THE MINING SECTOR,[1] 1990

Jurisdiction	Employer: Company	Employer: Contractor and Misc.	Location: Underground	Location: Open Pit	Location: Other	Total
Newfoundland	2	0	2	0	0	2
Nova Scotia	0	0	0	0	0	0
Cape Breton Development Corporation	0	0	0	0	0	0
New Brunswick	0	0	0	0	0	0
Quebec	9[a]	0	4	2	3	9
Ontario	7	2	7	0	2	9
Manitoba	1	0	1	0	0	1
Saskatchewan	0	1	0	0	1	1
Alberta	0	0	0	0	0	0
British Columbia	4	1	3	1	1	5
Northwest Territories	1	0	1	0	0	1
Yukon	0	1	0	0	1	1
Canada Total	24	5	18	3	8	29

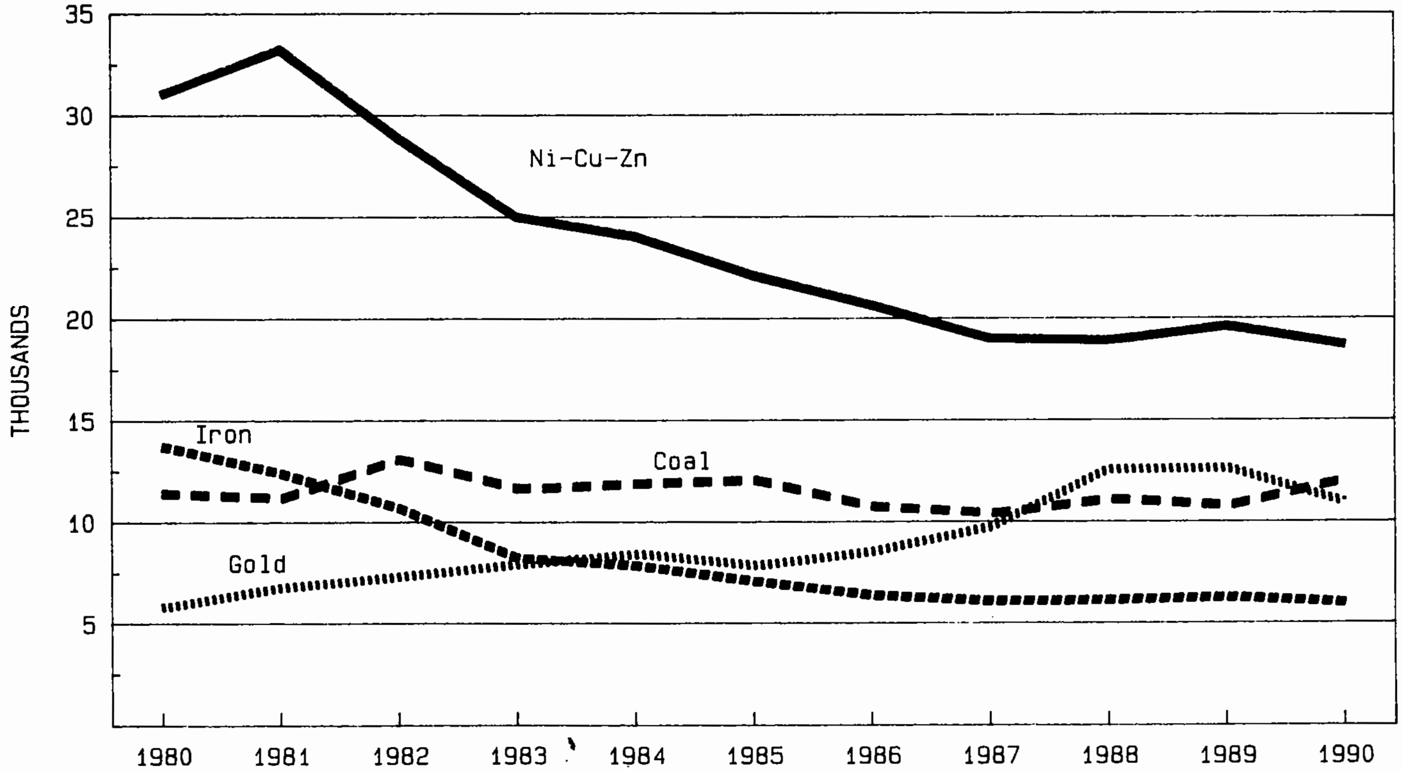
Source: Mine fatalities as reported by Chief Inspectors or corresponding authority of every mining jurisdiction in Canada. Compiled by EMR Canada, January 1991.

[1] For the purpose of this table, the mining sector is understood to include quarries and sand pits with the exception of Newfoundland, New Brunswick and Northwest Territories which have not reported under that category.

[a] Of these fatalities, three were workers employed in quarries.

Note: The table provides the number of work-related fatalities in 1990 caused by a traumatic accident. It does **not** include deaths resulting from occupational illnesses. Also, off-property and commuting transportation accidents such as highway traffic accidents are not included.

Figure 1
EMPLOYMENT BY COMMODITY
STAGE 1: MINING

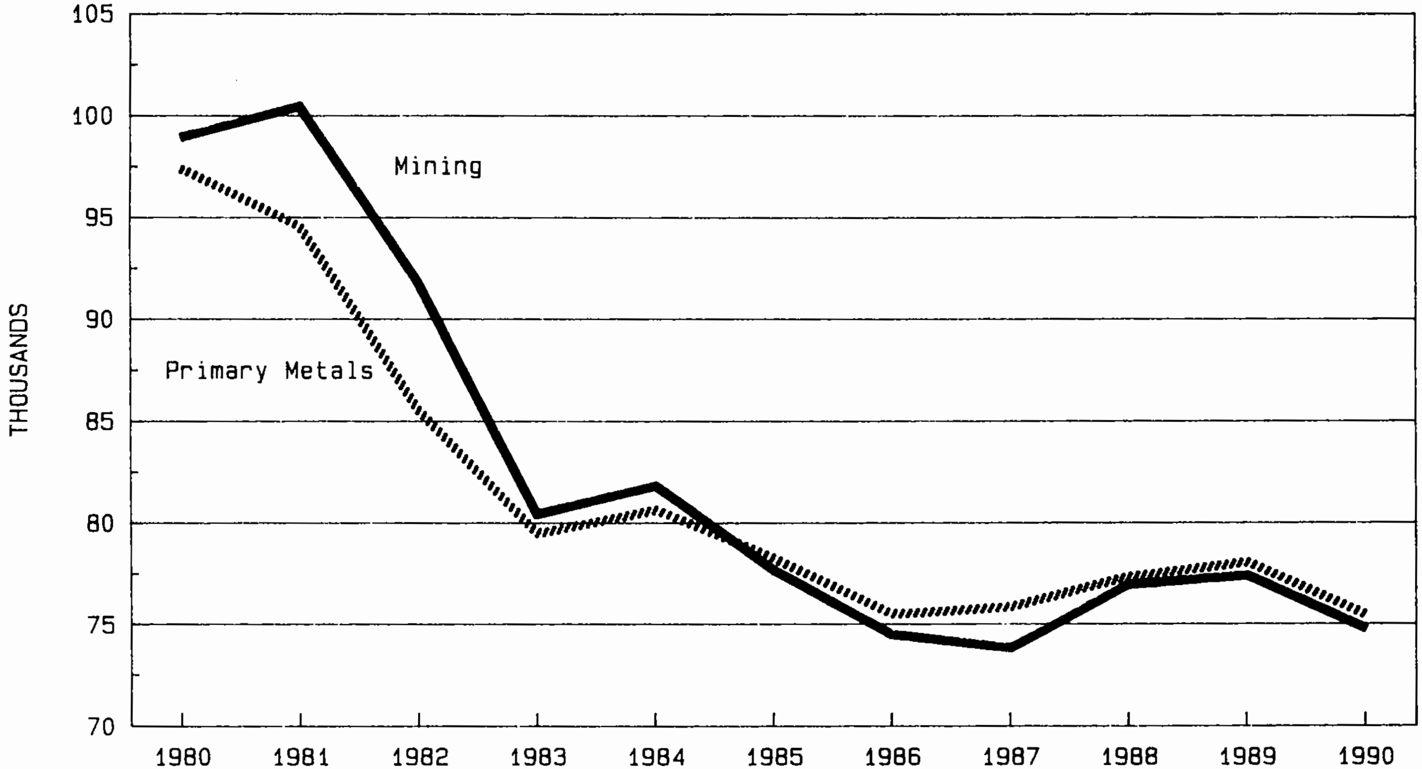


Sources: Annual Census of Mines for 1980-89 data; Energy, Mines and Resources Canada for 1990 forecast.

Figure 2

EMPLOYMENT

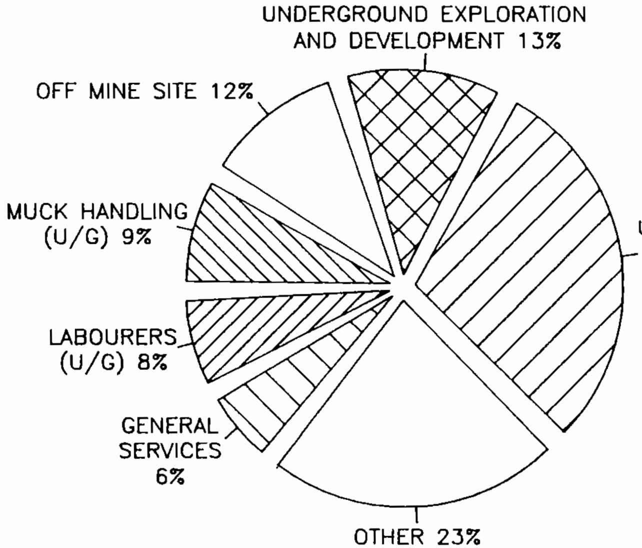
MINING AND PRIMARY METALS



Sources: Annual Census of Mines for 1980-89 data; Annual Census of Manufactures for 1980-86 data and Annual Survey of Manufactures for 1987-89 data; Energy, Mines and Resources Canada for 1990 forecast.

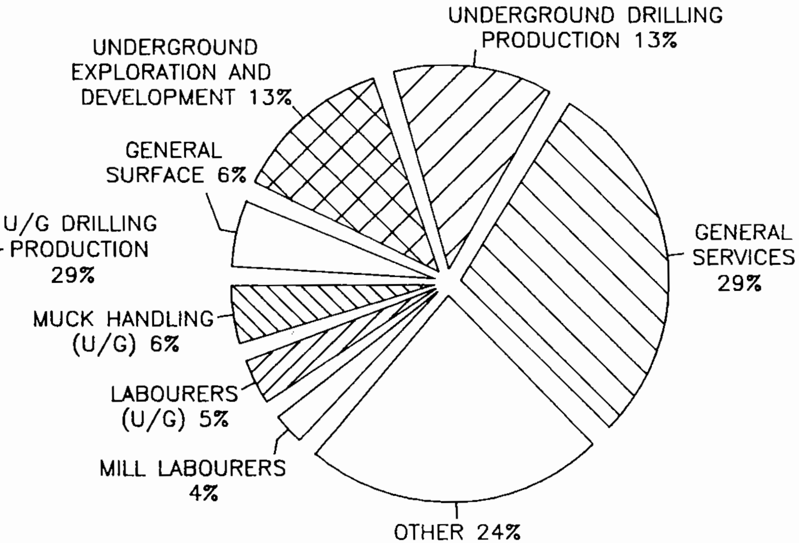
Figure 3
ACCIDENTS BY OCCUPATION

FATAL ACCIDENTS 1986–89



78 RECORDS

LOST TIME ACCIDENTS 1989



1771 RECORDS

Source: National Mine Accident Data Base.

Canadian Reserves, Mine Investment, New Projects and Promising Deposits

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RESERVES

Canadian reserves of metals contained in mineable ore were compiled from information provided by mining companies on returns to the Federal-Provincial Survey of Mines and Concentrators, and from information contained in annual and other corporate reports. These reserves are confined to those in producing mines and in deposits that were committed for production as at January 1, 1990. They include only those ore tonnages that, as far as could be determined, are known at a level of confidence equivalent to proven and/or probable. Tonnages reported as possible are not included in Canadian reserves totals.

The reserves reported here cannot, by themselves, give any indication of whether or not Canada might be running out of economically mineable minerals. Future production will draw not only on the 1990 reserves, but also on additional reserves yet to be developed–from new discoveries, from extensions to known orebodies and from known but currently marginal or uneconomic material. Energy, Mines and Resources Canada's annual mineral bulletin[1] on Canadian mines deals with Canadian capability for metal production, both from operating mines and from known deposits for which future production can be considered likely.

Reserves in most mines change slightly from year to year but, on balance, these changes cancel out in national totals. It is the relatively few mines with large changes that affect the overall direction of national trends.[2] This was again the case during 1989.

Reserves by Commodity

Gold

Canadian reserves of gold contained in proven and probable mineable ore stood at 1748 t in January 1990 (Figure 1), down by some 70 t compared with revised estimates for 1989. Although the decrease is less than 4%, it is the first significant reversal in the strong growth in gold reserves that took place during the 1980s. Overall, mine-site exploration and development did not replace all of the gold mined in Canada during 1989, and an amount of gold-in-ore equal to about half of what was mined in that year is also no longer counted in company reserves.

New mines committed to production during 1989 (Table 1) and counted for the first time in Canadian totals contributed over 60 t of gross additions to Canadian reserves. These are the Silidor mine, located near Rouyn-Noranda and owned by Noranda Inc. and Cambior inc. (about 30 t); the Casa Berardi Ouest mine, located north of La Sarre, and owned by TVX Gold Inc. and Golden Knight Resources Inc. (some 16 t); and Lac Minerals Ltd.'s Bousquet No. 2 mine, near Malartic (another 12 t).

The mines with the largest decreases in proven and probable reserves of gold during 1989 were Golden Giant, owned by Hemlo Gold Mines Inc. (about 17 t), and Williams, owned by Teck Corporation and Corona Corporation (about 16 t). However, the Hemlo deposits are open at depth, and the proven and probable reserves at the Williams mine, for example, are reported sufficient for at least 15 years of production.

Zinc

Canadian reserves of zinc rose for the second year in a row. They stood at 21 688 000 t in January 1990, some 600 000 t (almost 3%) more than in the previous year.

The largest single gross addition to zinc reserves, some 1 400 000 t, and by far the largest change at any single mine in Canada during 1989, resulted from the inclusion in Canadian totals of the reserves at the Heath Steele-Stratmat operation in New Brunswick. This operation, owned by Noranda Inc. and Brunswick Mining and Smelting Corporation Limited, was committed to production during 1989. The Heath Steele portion had been closed since 1983, and the Stratmat deposit is in production for the first time. Also counted for the first time were the reserves of the 1100 lens, found in 1988, at the Mobrun mine near Rouyn-Noranda, and operated by Audrey Resources Inc. This contributed the second largest gross addition to Canadian zinc reserves.

By contrast, the largest gross decrease in Canadian zinc reserves, some 570 000 t, occurred at Curragh Resources Inc.'s Faro mine in the Yukon, mainly because the company now reports mineable reserves for the Grum open pit rather than geological reserves. Another significant decrease in zinc reserves occurred at the Brunswick No. 12 mine, mainly because exploration during 1989 did not prove up additional ore.

Lead

Canadian reserves of lead stood at 6 941 000 t in January 1990, a decrease of less than 1% from the previous year. Counting the reserves at the Heath Steele-Stratmat operation in Canadian totals added more than 450 000 t of lead. Counting the reserves of the Gays River mine in Nova Scotia, owned by Westminer Canada Limited, contributed another 70 t. This mine, which was committed to production in late 1989, had been closed since the early 1980s.

The largest single gross reduction in Canadian reserves of lead, about 350 000 t, occurred largely because of the change in the method of reporting the reserves of the Grum open pit at Faro. Another significant decrease took place at the Brunswick No. 12 mine, mainly because production was not replaced by new reserves.

Copper

In January 1990, Canadian reserves of copper amounted to 12 258 000 t. There were two outstanding gross additions to copper reserves during 1989. About 172 000 t came from the inclusion in Canadian totals of the reserves from the Heath Steele-Stratmat operation. A further 141 000 t resulted from changes in the designs of the Valley and Lornex open pits at the Highland Valley mine in British Columbia, jointly owned by Cominco Ltd., Rio Algom Limited, Teck Corporation and Highmont Mining Company.

There were, however, significant reductions in reserves at a number of operations that produce copper, and overall, Canadian reserves of copper decreased by more than 2% during 1989, over 290 000 t, compared with the previous year.

Molybdenum

Canadian reserves of molybdenum increased by almost 2% during 1989, rising to some 234 000 t in January 1990. This was due to an increase in tonnage and grade at Placer Dome Inc.'s Endako mine, Canada's only primary molybdenum producer, and to the changes that were made to the designs of two open pits at the Highland Valley mine.

Nickel

Canadian reserves of nickel amounted to some 6 132 000 t in January 1990. Only about half of the metal mined during 1989 was replaced with metal in new-found ore. Inco Limited's total Canadian reserves of nickel decreased by some 100 000 t overall, down by about 1.6% compared with the previous year.

The largest single gross addition to Canadian nickel reserves resulted from the first-time inclusion in Canadian totals of the reserves of the Redstone mine, southeast of Timmins. This mine, owned by Timmins Nickel, Inc. and BHP-Utah Mines Ltd., added about 10 000 t of new metal to Canadian reserves.

Overall, Canadian reserves of nickel were down by more than 2% from 1989 to 1990. However, in Canada, the ratio of reserves to production continues to be substantially higher for nickel than for the other major metals.

Silver

Canadian reserves of silver stood at 26 790 t in 1990, down about 2% from 1989. More silver was either mined or is now no longer counted in company reserves than was replaced or added as a result of 1989 production decisions. The most noteworthy gross addition to silver reserves resulted from the inclusion in Canadian totals of the reserves of the Heath Steele-Stratmat operation.

Canadian Reserves by Province and Territory

At the beginning of 1990, three provinces held dominant positions in terms of Canada's proven and probable reserves of major metals (Table 2). New Brunswick had 55% of the lead, 45% of the zinc and 40% of the silver; Ontario had 73% of the nickel, 54% of the gold and 45% of the copper; and British Columbia had 93% of the molybdenum and 40% of the copper.

In 1990, compared with 1989 revised provincial totals, reserves of gold increased in Newfoundland; reserves of copper, lead, zinc and silver increased in New Brunswick; reserves of lead and zinc increased in Nova Scotia; reserves of copper, lead, zinc, silver and gold increased in Quebec; reserves of molybdenum increased in British Columbia; and reserves of silver increased in the Northwest Territories. Otherwise, proven and probable reserves either decreased or remained at about 1989 levels.

Reserve Trends

Reserves of metals were generally on the rise until the early 1980s. Except for reserves of gold which kept on rising, reserves of the other metals have generally declined each year over much of the 1980s (Figure 1). Compared with 1981, reserves in 1990 were down by 20% for silver, 26% for nickel and zinc, 27% for copper, 31% for lead, and 57% for molybdenum. For gold, reserves in 1990 were more than double those of 1981.

MINE INVESTMENT

Expenditures on exploration have attracted much attention over the past six or seven years. Nonetheless, investment made at operating mines and deposits committed for production accounts for the largest portion, by far, of all investment made by the mineral industry in Canada each year.

In 1989, mine investment (including repairs) amounted to some $4.4 billion, about 82% of the $5.3 billion (Figure 2) spent in total at all mines and on all exploration projects during that year. Compared with revised estimates for 1988, mine investment in 1989 (in constant dollars) was down about 9%. If expenditures aimed at finding new mines on producing properties were added to mine-site investment, investment would increase by only another $160 million, since about 83% of all mineral exploration in 1989 was conducted on properties that were neither in production nor committed for production. Typical examples of investment made at Canadian mine sites during 1989 are given in Table 3.

Investment by Commodity

Gold producers invested about $1 billion at mine sites in Canada in 1989, about 25% less (in constant dollars) than in 1988. This investment by gold producers nonetheless represent almost one quarter of all mine-site investment made in Canada during 1989. It is substantially more than was invested by any other single mineral commodity producer group (Figure 3). Producers of base metals invested some $1.4 billion in 1989, about 3% more (in constant dollars) than in 1988. Together, producers of all metallic mineral commodities invested about $3 billion in 1989, almost 70% of the total mine-site investment made in Canada during that year. Of the producers of nonmetals, coal producers invested the most during 1989.

Investment by Province and Territory

During 1989, some $2.9 billion in mine-site investment, about two thirds of the Canadian total, was made in Ontario, British Columbia, and Quebec (Figure 4). These provinces are the country's leading producers (in that order) of non-petroleum mineral commodities. They accounted for 26%, 23%, and 17% respectively of total mine-site investment in Canada in 1989.

Investment by Category

Four categories are used to record mine-site investment in Canada: i) surface and underground structures, ii) machinery and equipment, iii) ore development, and iv) repairs to existing structures, machinery and equipment.

Repairs to structures, machinery and equipment have consistently been the largest of the four mine-site investment categories during the 1980s (Figure 5). In 1989, repairs accounted for about $1.9 billion, some 44% of total mine-site investments in Canada. Development of deposits for production ($1.1 billion) held second place at 25%, installation of machinery and equipment ($928 million) accounted for 21%, and new structures ($429 million) made up the remaining 10%.

The value of Canada's non-petroleum mineral production in 1989 was some $21.6 billion. For each dollar's worth of non-petroleum mineral production during that year, the industry invested about 20 cents at mine sites: 9 cents in repairs, 5 cents in development, 4 cents in machinery and equipment, and 2 cents in structures.

Investment Trends

Total mine-site investment in Canada (in constant dollars) has generally declined during the 1980s. In 1989, mine-site investment was about 30% lower than in 1981, its highest level of the 1980s.

Annual expenditures (in constant dollars) on repairs to plants and equipment fell after 1981. They have remained at about $1.8 billion-$1.9 billion each year for the past five or six years. Development has been steady at over $1 billion annually throughout the 1980s, although there was a slight rise to some $1.3 billion in 1987 and 1988.

Annual investment in structures fell in 1984, and investment in machinery and equipment fell in 1985. Since then, investment of these types has generally declined each year, except towards the end of the decade: investment in structures rose in 1988 above the trend of the mid- to late 1980s, and investment in machinery and equipment showed a similar pattern in 1988 and 1989. In 1989, investment in machinery and equipment was about two thirds of what it was in 1981, and investment in structures was about one quarter of the 1981 level.

Investment by producers of nonmetals (in constant dollars) rose between 1980 and 1982 to some $2.5 billion, fell each year thereafter until 1987, and subsequently remained at about $1.4 billion. Investment by metal producers, other than gold, followed roughly the same pattern as that of nonmetal producers, although it flattened out earlier, in 1983. However, investment by gold producers, which had been fairly constant between 1980 and 1986, rose significantly during the rest of the decade. In 1989, investment by gold producers was almost one-and-a-half times what it was in 1981. In 1988 investment was about double what it had been in 1981.

Mine Investment in 1990

Overall, mine-site investment (including repairs) is likely to have decreased by 6%-7% (in constant dollars) between 1989 and 1990.

Investment by gold producers is expected to have fallen by about 30% from 1989 to 1990, so that investment levels (in constant dollars) are now back to those of the early to mid-1980s. Investment by base-metal producers, and by all nonmetal producers, is likely to have increased by 4%-5%.

The levels of investment in repairs, machinery and equipment as well as in development were probably maintained from 1989 to 1990. The trend to declining investment in structures likely continued into 1990.

NEW PROJECTS ANNOUNCED DURING 1990

At least 17 precious-metal (mainly gold) and base-metal (mainly polymetallic) mining projects were announced in the press during 1990. The yearly average since 1980 has been about 24, but a record 43 projects were announced in 1987. The number of projects announced during 1990 is considerably below average, despite the enormous sums expended on mineral exploration in recent years.

Eight of the seventeen projects announced during 1990 involved gold deposits. Since 1980, gold deposits constituted, on average, almost 65% of new projects announced. However, in 1986 and 1987, precious-metal deposits constituted roughly 80% of such announcements.

The projects announced during 1990 to bring on stream additional capacity for ore and concentrate production in Canada will require investment of more than $489 million (Table 4) over the next few years. For the second year in a row, the total value (in constant dollars) of projects announced has declined. Although the value (in constant dollars) of projects announced each year since 1980 has fluctuated, it has generally been declining.

The value of gold projects announced during 1990 is at least $91 million, about 19% of the total value of projects announced; the average during the 1980s was 50%, but it reached almost 75% in 1987.

The largest gold project announced during 1990 is the Snip mine in British Columbia, which is being prepared for production in 1991 by Cominco Ltd. and Prime Resources Group Inc., at a cost of $65 million. The largest single base-metal project announced during 1990 is Inco Limited's new 1D mine at Thompson, Manitoba, which is being developed for production in 1992 at a cost of some $209 million.

PROMISING DEPOSITS

The number of precious-metal (mainly gold) and base-metal (largely polymetallic) deposits in Canada judged promising for possible development into mines in the foreseeable future grew each year from 98 in 1981 to 268 at the end of 1989. The number fell to about 210 in February 1991 (Table 5). These deposits were selected based on public information on the results of recent exploration programs, tonnage and grade and other factors that affect economic viability. This selection process is inhererently subjective. Apart from the 210 deposits selected here, there are hundreds of other deposits and showings in Canada at various stages of exploration.

In early 1991, of the 210 deposits judged promising for future production, 152 are gold deposits and 58 are base-metal deposits. Quebec accounts for 60 (29%) of these promising deposits, Ontario for 47 (22%) and British Columbia for 46 (22%). Although the total number of promising deposits is down in 1991 compared with 1990, the percentage distribution by province of these deposits has remained roughly the same. However, as a percentage of all promising deposits in Canada, the number of base-metal deposits has increased to 28% in 1991, up from 22% in 1990 and up significantly from 13% in 1988. From 1990 to 1991, base-metal deposits increased as a percentage of all promising deposits in the Atlantic Provinces, in British Columbia, and in the Territories.

Based on metal prices prevailing at the beginning of 1991, gold accounts for roughly 30% of the gross in-situ value of the estimated mineral inventory reported by companies for these deposits. Copper accounts for roughly 30%, and zinc for 20%.

Based on gross in-situ values of estimated mineral inventories, the largest promising Canadian mineral deposits, include in **British Columbia**: Windy Craggy (copper, gold, silver, cobalt, zinc), Cirque (zinc, lead, silver), Mt. Milligan (copper, gold), Kerr (copper, gold, silver), Eskay Creek (gold, silver), Hushamu (copper, gold, molybdenum), Tulsequah Chief (zinc, copper, gold, silver, lead) and Mt. Polley (copper, gold); in **Quebec**: Louvicourt (copper, zinc, gold, silver) and Grevet M (zinc, copper, silver); in **Ontario**: Lindsley (nickel, copper, gold, silver, cobalt, platinum, palladium) and Moss Lake (gold); in the **Yukon**: Wellgreen (nickel, copper, platinum, palladium) and Dy (zinc, lead, silver, gold); in **Saskatchewan**: McIlvenna Bay (zinc, copper, gold, silver); in **Manitoba**: Minago (nickel); in **Newfoundland**: Duck pond (zinc, copper, lead, silver, gold); and in **New Brunswick** : Half-Mile Lake (zinc, lead, silver, copper).

OUTLOOK

There is still considerable effort in Canada aimed at proving up reserves of gold deposits. Gold reserves have more than doubled since 1983, and there are over 150 gold deposits currently being explored that appear particularly promising for possible future development into mines. In addition, exploration is continuing on many other gold deposits and gold showings. Therefore, there appears to be substantial opportunity to add to reserves of gold in the foreseeable future.

Compared with the beginning of the 1980s, reserves of base metals are down by some 25% to almost 60%, depending on the metal. However, the 58 promising base-metal deposits in early 1991 represent three times as many as there were in early 1986, 1987 or 1988. More than a dozen of these base-metal deposits each have potential mineral inventories valued at more than $1 billion at January 1991 metal prices. Many of these deposits have exploration programs backed by at least one major producing company, and others backed by several such companies. Some of these deposits will eventually be developed into large mines and contribute to the new reserves needed to maintain Canadian base-metal production in the coming years.

REFERENCES

[1] A. Lemieux, L.-S. Jen, D.A. Cranstone and G. Bouchard, "Canadian Mines: Perspective from 1989 - Production, Reserves, Development, Exploration," Mineral Bulletin MR 225, 1990, Energy, Mines and Resources Canada, Ottawa, 46 p.

[2] For the distribution of mine-by-mine net changes in gold reserves during 1988, see: A. Lemieux, "Canadian Reserves, Mine Investment, New Projects and Promising Deposits" in the 1989 **Canadian Minerals Yearbook**, Energy, Mines and Resources Canada, pp. 5.1-5.28.

Note: Information contained in this review was current as at February 28, 1991.

TABLE 1. NEW MINING OPERATIONS AND COMMITMENTS TO PRODUCTION ADDED TO CANADIAN RESERVE TOTALS AS AT JANUARY 1990

Operation	Operators and Major Partners	Major Metals	Province/ Territory
Heath Steele-Stratmat	Brunswick Mining and Smelting Corporation Limited and Noranda Inc.	zinc, copper, lead, silver	N.B.
Gays River	Westminer Canada Limited	zinc, lead	N.S.
Bousquet No. 2	LAC Minerals Ltd.	gold, copper, silver	Que.
Casa Berardi Ouest	TVX Gold Inc. and Golden Knight Resources Inc.	gold, silver	Que.
Montauban (tailings)	Aurtec Mining Development Inc.	gold, silver	Que.
Silidor	Noranda Inc. and Cambior inc.	gold, silver	Que.
Hoyle	Giant Yellowknife Mines Limited	gold, silver	Que.
Kidd Creek No. 3	Falconbridge Limited	zinc, copper, lead, silver	Ont.
Redstone	Timmins Nickel, Inc. and BHP-Utah Mines Ltd.	nickel	Ont.
Shasta (JM Zone)	International Shasta Resources Ltd.	gold, silver	B.C.

Source: Energy, Mines and Resources Canada.

TABLE 2. CANADIAN RESERVES BY PROVINCE AND TERRITORY, JANUARY 1, 1990

(Metal Contained in Proven and Probable Mineable Ore[1] in Operating Mines and Deposits Committed for Production[2])

Metal	Units[3]	Nfld.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	B.C.	Y.T.	N.W.T.	Canada[5]
Copper	000 t	–	21	471	844	5 514	519	2	4 889	–	–	12 258
Nickel	000 t	–	–	–	–	4 461	1 672	–	–	–	–	6 132
Lead	000 t	–	68	3 839	9	100	17	–	999	1 404	506	6 941
Zinc	000 t	16	160	9 704	1 414	2 999	1 084	1	1 934	2 250	2 126	21 688
Molybdenum	000 t	–	–	–	–	17	–	–	217	–	–	234
Silver	t	4	–	10 761	1 620	5 504	787	1	5 624	2 349	141	26 790
Gold[4]	t	41	1	69	352	951	40	4	124	29	136	1 748

Source: Energy, Mines and Resources Canada.

1 No allowance is made for losses in milling, smelting and refining. Material classified as possible is not included. 2 Includes metal in mines where production has been suspended temporarily. 3 One tonne (t) = 1.1023113 short tons. One kilogram (kg) = 32.150746 troy ounces. 4 Excludes metal in placer deposits. 5 May not balance due to rounding at the provincial level.

– Nil.

TABLE 3. SELECTED EXAMPLES OF MINE-SITE INVESTMENT MADE IN CANADA DURING 1989

Operation	Operators and Major Partners	Investment	Value	Province/ Territory
			($ million)	
Heath Steele - Stratmat	Brunswick Mining and Smelting Corporation Limited and Noranda Inc.	Reopening of Heath Steele mine.	8.1	N.B.
Bousquet No. 2	LAC Minerals Ltd.	Shaft sinking, mine development and completion of administration and service buildings.	27.4	Que.
Doyon	LAC Minerals Ltd. and Cambior Inc.	Start of construction of a high-density sludge plant to reduce the cost of treating acidic mine drainage.	3.3	Que.
Casa Berardi Ouest	TVX Gold Inc. and Golden Knight Resources Inc.	Start of mine construction.	17.8	Que.
Kiena	Placer Dome Inc.	Definition and development of orebody at depth.	2.3	Que.
Lac Shortt	Minnova Inc.	Deepening of mine to access ore reserves between 500 and 800 levels.	11.9	Que.
Ansil	Minnova Inc.	Mine completion.	8.0	Que.
Arthur White	Dickenson Mines Limited	Acquisiton of electric and diesel scooptrams, upgrading of backfill plant, design of gravity circuit and centralized blasting system for No. 2 shaft.	2.3	Ont.
Campbell	Placer Dome Inc.	Construction of new carbon-in-pulp circuit and new maintenance building, expansion of tailings gold recovery plant, replacement of siding on surface buildings and construction of new maintenance building.	8.9	Ont.
Detour Lake	Placer Dome Inc.	Equipment replacements, environmental improvements, and initial stages of an overland ore conveyor system.	3.1	Ont.
Dome	Placer Dome Inc.	New underground production equipment, installation of a surface jaw crusher and replacement of surface maintenance equipment.	4.7	Ont.
Afton	Teck Corporation	Development of Ajax open pit and modification of Afton concentrator to treat Ajax ore.	7.	B.C.
Endako	Placer Dome Inc.	Replacement of two pit dozers and service vehicles, and acquisition of computer equipment, mill process instrumentation and automated packaging equipment.	1.2	B.C.
Golden Bear	North American Metals Corp.	Company's share of new mine project completion costs.	27.	B.C.
Samatosum	Minnova Inc.	Completion of new mine.	16.	B.C.
Con	Nerco, Inc.	Completion of new headframe and renovations to shaft.	20.2	N.W.T.

Source: Energy, Mines and Resources Canada. Based on company annual reports.

TABLE 4. PRECIOUS-METAL AND BASE-METAL MINING PROJECTS ANNOUNCED IN CANADA DURING 1990

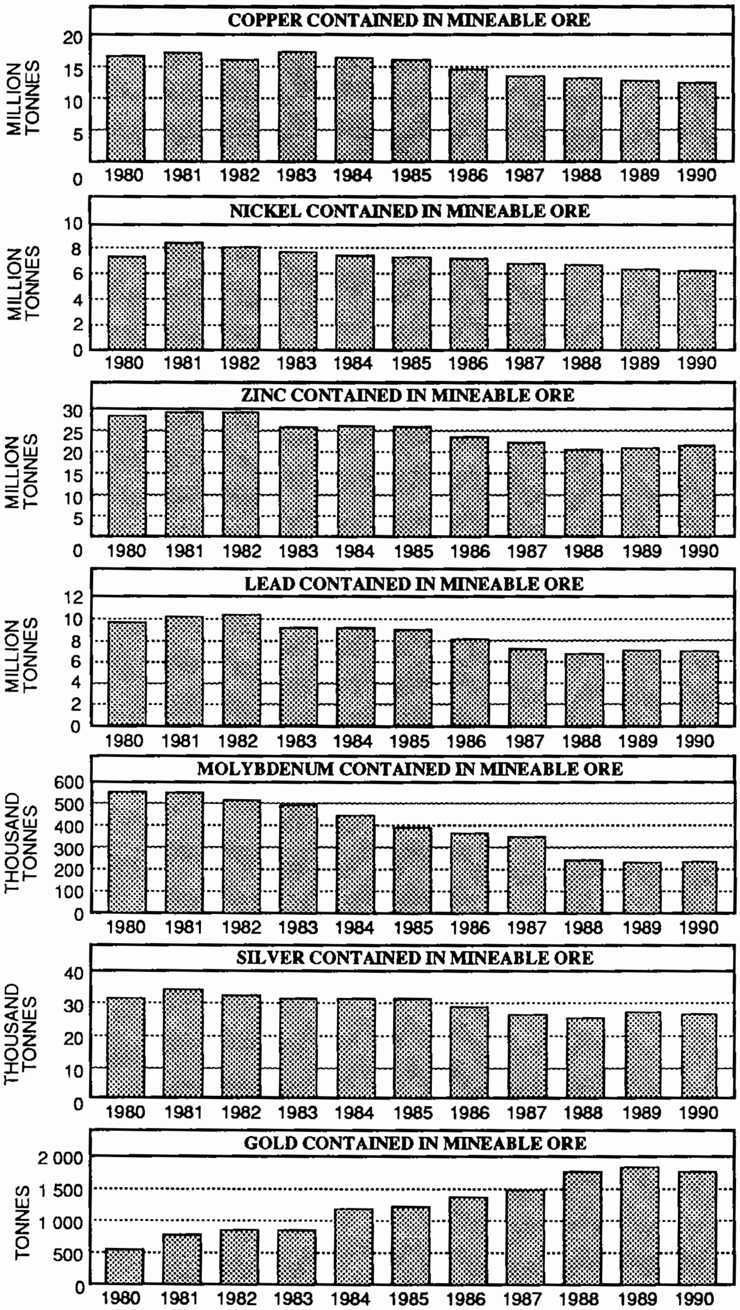
Companies	Projects	Metals	Start-Up Year	Incremental Project Budget
				($ milllion)
PRECIOUS METALS				
Cominco Ltd., Prime Resources Group Inc.	New 300 t/d **Snip** underground mine and concentrator, Stewart area, British Columbia	Gold, copper, silver	1991	65.
Claude Resources Inc., Mantle Investments Limited	New 400 t/d **Seabee** underground mine and concentrator, Laonil Lake (La Ronge) area, Saskatchewan	Gold	1991	22.
Ronrico Explorations Ltd., Louvicourt Gold Mines Inc.	Reactivation of **Simkar** (Louvicourt) mine at 300 t/d, Val-d'Or area, Quebec	Gold	1991	2.5
Timmins Nickel, Inc., Teeshin Resources Ltd.	New 320 t/d **Dome Mountain** underground mine, Smithers area, British Columbia	Gold, silver	1991	2.
GSR Mining Corporation	Reactivation of **Kerr Addison** underground mine (910 t/d), Virginiatown, Ontario	Gold	1990	. .
GSR Mining Corporation, Tyranex Gold Inc., Brown Mining Group	Reactivation of **Tyranite** mine (open pit), at 9 070 t/month, Gowganda area, Ontario	Gold	1990	. .
Northfield Minerals Inc., Rockford Minerals Inc.	New 225 t/d **Cheminis** underground mine, Virginiatown, Ontario	Gold	1990	. .
Cameco Corporation, Shore Gold Fund Inc.	New 225 t/d **Jasper** underground mine, Star Lake area, Saskatchewan	Gold	1990	. .
			Subtotal	91.5
BASE METALS AND BY-PRODUCTS				
Inco Limited	New **ID** mine (37 million pounds of nickel annually), Thompson, Manitoba	Nickel, copper, precious metals	1992	209.
Inco Limited	Doubling of production capacity of **Birchtree** mine (to 34 million pounds of nickel annually), Thompson, Manitoba	Nickel, copper, precious metals	1997	78.
Curragh Resources Inc., Hillsborough Resources Limited	New 450 000 t/y open-pit/underground **Mount Hundere** mine and concentrator, Watson Lake area, Yukon	Zinc, lead, silver	1991	70.
Breakwater Resources Ltd., Golden Group Explorations Inc., Golden Hope Resources Inc.	New 174 000 t/y **Estrades** underground mine, Joutel area, Quebec	Zinc, gold silver, copper, lead	1990	15.•
Noranda Inc.	Development of **E-29** underground deposit, Murdochville, Quebec	Copper, silver	1992	9.1
Timmins Nickel, Inc.	New 450 t/d **Langmuir No.1** underground mine, Timmins area, Ontario	Nickel	1990	7.5
Bethlehem Resources Corporation, Goldnev Resources Inc.	Reactivation of **Goldstream** underground mine at 1100 t/d, Revelstoke area, British Columbia	Copper, zinc, silver	1991	7.0
Exploration Minière Normétal Inc.	New 200 t/d **Normetmar** mine, La Sarre area, Quebec	Zinc, silver	1990	2.4
Deak Resources Corporation	Reactivation of **West MacDonald** mine at 41 000 t/m (open pit), Rouyn-Noranda area, Quebec	Zinc, silver, gold	1990	. .
			Subtotal	398.
			All Metals Total	489.5

Source: Energy, Mines and Resources Canada. Based on press reports.
. . Not available; • Estimated.

Figure 1

CANADIAN RESERVES, 1980-90

Metal contained in proven and probable mineable ore in operating mines and deposits committed for production, as at January 1 of each year

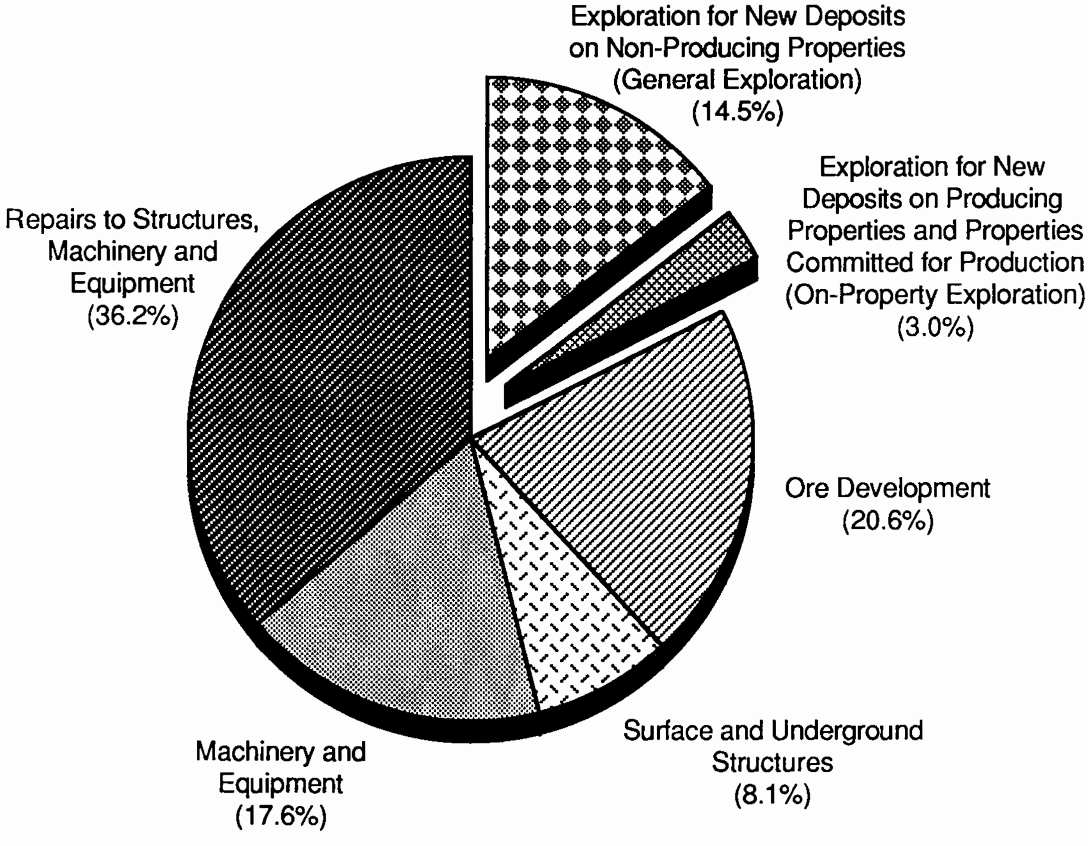


SOURCE: ENERGY, MINES AND RESOURCES CANADA.

Figure 2

MINE AND EXPLORATION INVESTMENT IN CANADA, 1989

$5.3 BILLION

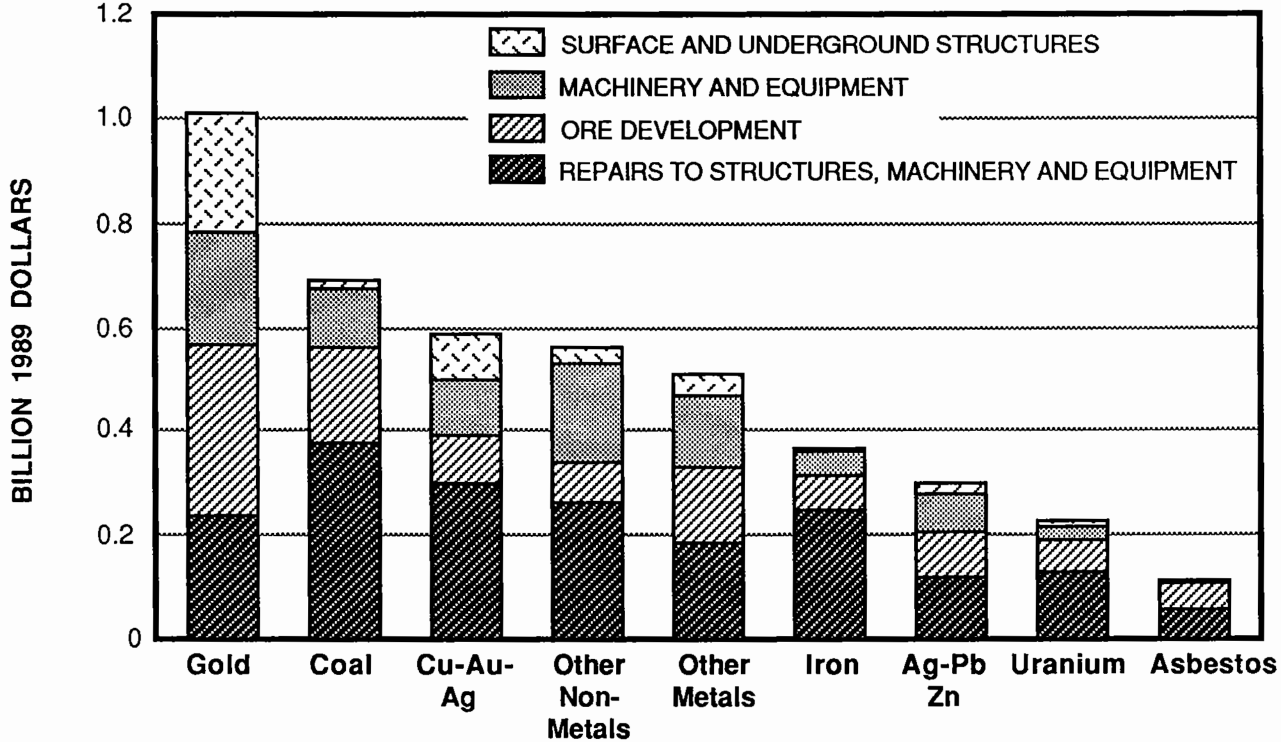


Sources: Statistics Canada Survey of Exploration, Development and Capital Expenditures for Mining, 1989 Preliminary Statistics and EMR Canada.

Figure 3

MINE INVESTMENT IN CANADA, 1989

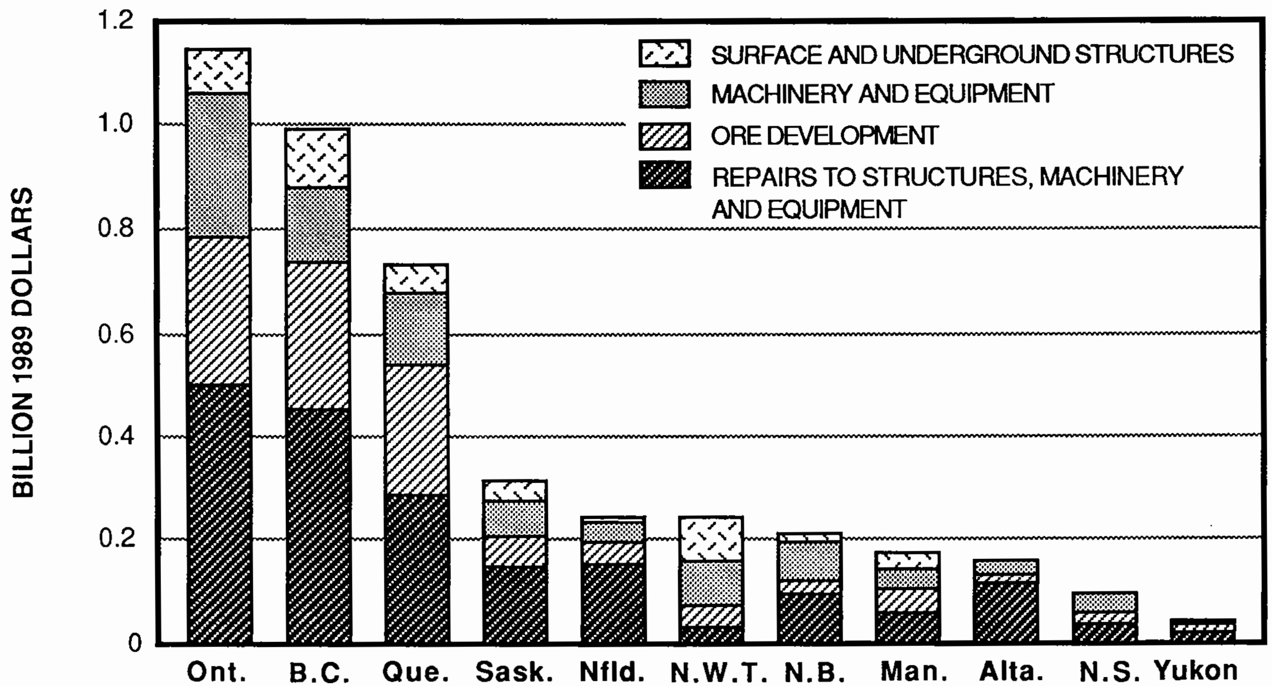
BY INDUSTRY GROUPS
$4. 4 BILLION



Source: EMR Canada. Based on Statistics Canada Survey of Exploration, Development and Capital Expenditures for Mining, 1989 Preliminary Statistics.

Figure 4

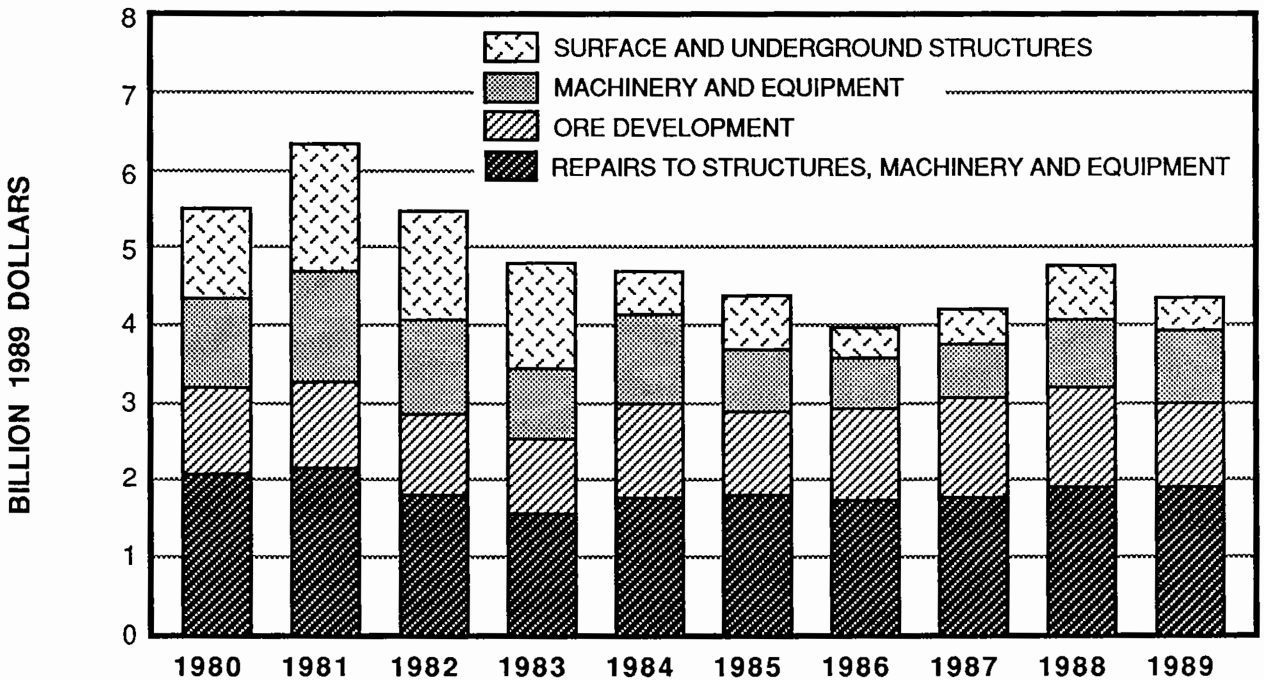
MINE INVESTMENT IN CANADA, 1989
BY PROVINCE AND TERRITORY
$4.4 BILLION



Source: EMR Canada. Based on Statistics Canada Survey of Exploration, Development and Capital Expenditures for Mining, 1989 Preliminary Statistics.

Figure 5

MINE INVESTMENT IN CANADA, 1980-89
BY TYPE



Source: EMR Canada. Based on Statistics Canada Survey of Exploration, Development and Capital Expenditures for Mining, 1989 Preliminary Statistics.

TABLE 5

TONNAGE AND GRADE OF ADDITIONAL BASE-METAL AND PRECIOUS-METAL DEPOSITS CONSIDERED, IN FEBRUARY, 1991, PROMISING FOR FUTURE PRODUCTION

- DEPOSITS: Individual deposits have been selected on the basis of public information on: (a) results of recent exploration work, (b) tonnage and grade, and (c) other factors affecting viability. This list excludes deposits committed for production as at January 1, 1991.
- TONNAGE and GRADE: As reported by companies or, where necessary, from the secondary source that appeared to be the most reliable. Imperial units reported were converted to metric units and rounded. Tonnage and grade descriptions such as "probable and possible" are those reported by companies.
- COMPANIES: Where two or more companies are identified with a deposit, the first is usually the operator.

DEPOSITS	COMPANIES	TONNAGE AND GRADE DESCRIPTION	TONNAGE	GRADE						
				Cu	Ni	Pb	Zn	Mo	Ag	Au
			(tonnes)[1]	(%)	(%)	(%)	(%)	(%)	(g/t)[2]	(g/t)[2]
NEWFOUNDLAND										
Cape Ray	Dolphin Explorations Ltd.	Potentially mineable and additional	424 000	–	–	–	–	–	–	10.3
Duck Pond	Noranda Inc. BP Resources Canada Limited		5 100 000	3.3	–	. .	7.2	–	. .	. .
Ming's Bight - Lightning and Thunder	Corona Corporation Varna Gold Inc.		1 200 000	–	–	–	–	–	–	5.4
Nugget Pond	Bitech Corporation	Drill indicated geological	513 000	–	–	–	–	–	–	14.
Rambler - Main Mine	Petromet Resources Limited Newfoundland Exploration Company Limited Teck Corporation	Pillars and unmined reserves	454 000	3.66	–	–	–	–	–	2.
Rambler - Ming West	Petromet Resources Limited Newfoundland Exploration Company Limited Teck Corporation	Drill indicated geological	100 000	5.6	–	–	0.37	–	–	2.4
Rambler - Tailings	Petromet Resources Limited Newfoundland Exploration Company Limited Teck Corporation	Potential mineable	1 163 671	0.31	–	–	–	–	–	1.7
Rendell-Jackman	Noranda Inc. Major General Resources Ltd.	Geological	390 000	–	–	–	–	–	–	12.
NOVA SCOTIA										
Goldboro	Exploration Orex Inc. Minnova Inc.	Probable	1 043 890	–	–	–	–	–	–	6.2

Lower Seal Harbour	Scotia Prime Minerals, Incorporated Ashgrove Resources Limited	Geological	247 306	–	–	–	–	–	–	4.1
Mooseland	Acadia Mineral Ventures Limited	Inferred	414 400	–	–	–	–	–	–	16.
NEW BRUNSWICK										
Captain North Extension	Stratabound Minerals Corp.	In-situ open pit	425 075	–	–	2.04	5.66	–	69.3	–
Half-Mile Lake	Noranda Inc. Conwest Exploration Company Limited	Undiluted geological	5 300 000	0.08	–	3.25	10.26	–	29.	–
Mount Pleasant[3]	NovaGold Resources Inc. LAC Minerals Ltd. Billiton Metals Canada Inc.	Geological	8 400 000	–	–	–	–	0.20	–	–
Murray Brook Copper	NovaGold Resources Inc.	Geological	354 000	4.58	–	–	–	–	45.9	–
Nash Creek	Falconbridge Limited	Potential	2 000 000	–	–	0.9	4.6	–	27.	–
Restigouche	Marshall Minerals Corp.	Open pit	1 040 000	0.38	–	5.96	7.71	–	124.	1.
QUEBEC										
Aldermac	Deak Resources Corporation	Mineable	1 573 040	1.54	–	–	4.12	–	31.	0.48
Arntfield	Deak Resources Corporation Noranda Inc. Nova-Cogesco Resources Inc.		633 000	–	–	–	–	–	–	4.83
Astoria	Yorbeau Resources Inc.	Proven, probable and possible	1 066 898	–	–	–	–	–	–	6.9
Beaufort	Louvem Mines Inc. Aurizon Mines Ltd.	Undiluted	382 100	–	–	–	–	–	–	8.6
Casa Berardi - Domex	TVX Gold Inc. Golden Knight Resources Inc.	Geological	1 401 998	–	–	–	–	–	–	8.6
Casa Berardi - Principal	Inco Gold Company Golden Knight Resources Inc.	Geological	2 833 997	–	–	–	–	–	–	6.9
Connell Corner - D Zone	Aurizon Mines Ltd. Ezekiel Explorations Ltd.		83 000	1.9	–	–	–	–	–	–
Connell Corner - E Zone	Aurizon Mines Ltd. Ezekiel Explorations Ltd.		673 000	2.36	–	–	–	–	–	0.7
Courvan (Cournor/Beaufor)	Louvem Mines Inc. Courvan Mining Company Limited Aabarock Inc.	Probable	216 900	–	–	–	–	–	–	7.2

TABLE 5 (cont'd)

DEPOSITS	COMPANIES	TONNAGE AND GRADE DESCRIPTION	TONNAGE	GRADE Cu	Ni	Pb	Zn	Mo	Ag	Au
			(tonnes)[1]	(%)	(%)	(%)	(%)	(%)	(g/t)[2]	(g/t)[2]
QUEBEC (cont'd)										
Courville	Placer Dome Inc. Explorations Cache Inc. Parquet Resources Inc.	Probable	123 000	–	–	–	–	–	–	6.9
Croinor	Cambior inc. Dominion Explorers Inc.	Proven, probable and possible	840 663	–	–	–	–	–	–	6.2
Douay Vezza - Central Zone	TVX Gold Inc. Société d'Exploration Minière Vior Inc.		505 000	–	–	–	–	–	–	7.2
Douay Vezza - West Zone	TVX Gold Inc. Société d'Exploration Minière Vior Inc.	Geological	585 000	–	–	–	–	–	–	9.3
Doyon - Warrenmac Zone	LAC Minerals Ltd. Cambior inc.	Mineral inventory	170 000	–	–	–	3.2	–	27.	6.9
Doyon - Westwood Zone	LAC Minerals Ltd. Cambior inc.	Mineral inventory	417 000	–	–	–	–	–	–	9.3
Dubuisson East	Minefinders Corporation Ltd.	Drill indicated	437 000	–	–	–	–	–	–	5.1
Duquesne Mine	Radisson Mining Resources Inc.	Probable and possible	678 822	–	–	–	–	–	–	8.56
Duvay Obalski	Sphinx Exploration Inc.	Indicated	725 000	–	–	–	–	–	–	3.4
Eagle West	Agnico-Eagle Mines Limited	Probable diluted	367 000	–	–	–	–	–	–	9.77
East Amphi (Darius Joint Venture)	Breakwater Resources Ltd. Bond Gold Canada Inc.	Probable and possible	641 000	–	–	–	–	–	–	9.3
Eastmain	Meston Lake Resources Inc. MSV Resources Inc.	Proven and probable geological	864 000	–	–	–	–	–	–	12.
Elder	Aunore Resources Inc. Nova Beaucage Mines Limited	Proven, probable and possible	1 792 000	–	–	–	–	–	–	5.01
Fontana	Bay Resources and Services Inc. Exploration Duverny Inc. Jilbey Exploration Ltd. St. Geneviève Resources Ltd.	Probable and possible	878 295	–	–	–	–	–	–	5.66
Fourax II	Bay Resources and Services Inc. Augmitto Explorations Limited	Possible	388 000	–	–	–	–	–	–	3.50

Gagné Duchesne	Alotta Resources Ltd.	Drill indicated	149 000	0.60	0.58	–	–	–	–	–
Goldex - Main and West Zones	Goldex Mines Limited	Proven diluted	778 229	–	–	–	–	–	–	2.5
Goldex - Extension Zone	Goldex Mines Limited Ormico Exploration Ltée	Drill indicated	9 010 000	–	–	–	–	–	–	3.0
Goldstack - New Discovery	Sphinx Exploration Inc. Goldstack Resources Ltd.	Probable and possible	659 978	–	–	–	–	–	–	5.97
Goldstack Mine - Residual Tonnage	Sphinx Exploration Inc. Goldstack Resources Ltd.	Possible	454 000	–	–	–	–	–	–	6.5
Grevet "B"	VSM Exploration Inc. Sérem-Québec Inc.	Diluted probable mining reserves	477 000	0.58	–	–	9.67	–	24.00	–
Grevet "M" - Zones III, IV and 97	VSM Exploration Inc. Sérem-Québec Inc.	Diluted probable and possible mining reserves	12 264 000	0.49	–	–	8.92	–	36.70	–
Gwillim Lake - Mop II	Muscocho Explorations Ltd. Flanagan McAdam Resources Inc. Noranda Inc.	Drill indicated	205 700	–	–	–	–	–	–	11.
Gwillim Mine	Flanagan McAdam Resources Inc. Muscocho Explorations Ltd. Greenstone Resources Ltd.	Proven, probable and possible	301 966	–	–	–	–	–	–	10.3
Hebecourt	Deak Resources Corporation Noranda Inc.		880 000	2.83	–	–	–	–	–	–
Hewfran - East	Aur Resources Inc. Bachelor Lake Gold Mines Inc.	Proven and probable diluted	131 000	–	–	–	–	–	–	6.2
Hewfran - West	Aur Resources Inc. Bachelor Lake Gold Mines Inc.	Geological	408 000	–	–	–	–	–	–	6.2
Inmont	Vior Inc. Teck Corporation Mazarin Mining Exploration Inc.	Probable	123 000	1.6	–	–	–	–	–	4.8
Joubi	Western Quebec Mines Inc. Messeguay Mines Inc.		541 370	–	–	–	–	–	–	5.82
Lac Fortune	Rouyn Mining Resources Inc.	Proven, probable and possible	234 050	–	–	–	–	–	–	5.37
Louvicourt	Aur Resources Inc. Louvem Mines Inc.	Geological	33 652 170	3.60	–	–	1.59	–	21.	0.89
Magusi	Deak Resources Corporation	Zinc and other zones	4 179 064	1.14	–	–	2.94	–	28.	0.89
McWatters	McAdam Resources Inc.	Preliminary	826 300	–	–	–	–	–	–	6.5

TABLE 5 (cont'd)

DEPOSITS	COMPANIES	TONNAGE AND GRADE DESCRIPTION	TONNAGE	GRADE Cu	Ni	Pb	Zn	Mo	Ag	Au
			(tonnes)[1]	(%)	(%)	(%)	(%)	(%)	(g/t)[2]	(g/t)[2]
QUEBEC (cont'd)										
Monique	Monique Exploration Inc. Louvem Mines Inc. Société québécoise d'exploration minière (SOQUEM)		1 078 000	–	–	–	–	–	–	5.73
Mouska	Cambior Inc.	Mining reserves	1 633 000	–	–	–	–	–	–	6.2
Norlartic Mine	Aur Resources Inc. Nova-Cogesco Resources Inc.	Proven, probable and possible	888 021	–	–	–	–	–	–	5.1
Noyon - RJ Zone	Northway Explorations Limited TOTAL Énergold Corporation	Preliminary	304 580	–	–	–	–	–	–	5.5
O'Brien - 36E Zone	Breakwater Resources Ltd.	In-situ drill indicated	227 000	–	–	–	–	–	–	11.
Orenada - Zone 4	Aur Resources Inc.	Preliminary geological	3 629 000	–	–	–	–	–	–	2.
Parbec	St. Geneviève Resources Ltd. Augmitto Explorations Limited	Possible	413 000	–	–	–	–	–	–	4.63
Pelletier Lake	Thunderwood Resources Inc. Falconbridge Limited	Drill indicated	883 000	–	–	–	–	–	–	6.9
Philibert	Société québécoise d'exploration minière (SOQUEM) Cambior Inc.	Inventory	525 000	–	–	–	–	–	–	6.13
Poirier - West Part	Ressources Minière Forbex Inc. Bonanza Metals Inc.	Mineable	793 602	1.31	–	–	8.69	–	–	–
R M Nickel[4]	Equinox Resources Ltd. Technigen Corporation Minnova Inc.	Mineable open pit	132 000	0.79	0.46	–	–	–	–	–
Scott Lake	Thunderwood Resources Inc. Greenstone Resources Ltd.	Geological	705 000	0.41	–	6.87	–	–	12.	0.3
Simon Ouest	Louvem Mines Inc. Monique Exploration Inc.	Probable	100 800	–	–	–	–	–	–	6.58
Stadacona East (Forbex)	Cambior Inc. Ressources Minière Forbex Inc.		499 000	–	–	–	–	–	–	5.8

Taché - Main Zone	Teck Corporation Bitech Corporation Greenstone Resources Ltd.	Probable and possible	1 399 000	–	–	–	3.31	–	–	1.9
Vendome - Main Deposit	Abcourt Mines Inc. Val d'Or Resources Inc.		544 000	0.45	–	0.31	7.4	–	52.	1.
Vezza Twp.	Agnico-Eagle Mines Limited Dundee-Palliser Resources Inc. North American Rare Metals Limited	Drill indicated diluted	1 923 000	–	–	–	–	–	–	5.04
Wasamac	Rouyn Mining Resources Inc. LAC Minerals Ltd.	Probable, drill indicated and possible	1 883 336	–	–	–	–	–	–	4.46
ONTARIO										
Anoki	Queenston Mining Inc. Inco Gold Company		590 000	–	–	–	–	–	–	4.66
Armistice - Kerr and Sheldon zones	Armistice Resources Ltd. GSR Mining Corporation	Drill indicated probable and possible	502 000	–	–	–	–	–	–	5.1
Bannockburn	Mono Gold Mines Inc.	Modified geological	170 000	–	–	–	–	–	–	7.68
Bateman	McFinley Red Lake Mines Limited	Drill indicated geological	807 000	–	–	–	–	–	–	6.5
Beatty Hislop	Noranda Inc. Glimmer Resources Inc.	Geological	692 000	–	–	–	–	–	–	11.
Bristol - Main Zone	Chevron Minerals Ltd. Holmer Gold Mines Limited		400 000	–	–	–	–	–	–	5.1
Brookbank	Placer Dome Inc. Ontex Resources Limited	Drill indicated	594 035	–	–	–	–	–	–	9.29
Cadieux	Cameco Corporation Breakwater Resources Ltd.	Drill indicated	825 005	–	–	0.96	9.62	–	–	–
Cameron Lake	Nuinsco Resources Limited	Proven, probable and possible	2 866 838	–	–	–	–	–	–	5.76
Cedar Island (Shoal Lake)	Bond Gold Canada Inc. Kenora Prospectors & Miners, Limited		1 271 692	–	–	–	–	–	–	8.6
Chester Twp.	Gold Bar Resources Inc.	Preliminary	386 000	–	–	–	–	–	–	9.9
Chester Twp.	Chesbar Resources, Inc. Murgold Resources Inc.	Proven, probable and possible	384 234	–	–	–	–	–	–	7.64
Cochenour Willans	Inco Gold Company Wilanour Resources Limited Pronto Explorations Limited	Potential	1 200 000	–	–	–	–	–	–	8.4
Dixie Lake	Teck Corporation Mutual Resources Ltd.	Geological	454 000	–	-	–	–	–	–	4.5

TABLE 5 (cont'd)

DEPOSITS	COMPANIES	TONNAGE AND GRADE DESCRIPTION	TONNAGE	GRADE Cu	Ni	Pb	Zn	Mo	Ag	Au
			(tonnes)[1]	(%)	(%)	(%)	(%)	(%)	(g/t)[2]	(g/t)[2]
ONTARIO (cont'd)										
Duport	Consolidated Professor Mines Limited	Geological	1 800 000	–	–	–	–	–	–	12.
Eagle River	Hemlo Gold Mines Inc. Central Crude Ltd.	Diluted proven, probable and possible	2 595 000	–	–	–	–	–	–	8.6
Edwards	Spirit Lake Explorations Limited	Drill indicated	172 626	–	–	–	–	–	–	12.
Fuller	Vedron Limited		345 000	–	–	–	–	–	–	5.5
Garrison Twp.	Perrex Resources Inc. LAC Minerals Ltd. GSR Mining Corporation		410 000	–	–	–	–	–	–	4.97
Garrison Twp.	Jonpol Explorations Limited T & H Resources Ltd.	Drill indicated	466 100	–	–	–	–	–	–	9.6
Goldlund	Noranda Inc. Camreco Inc.	Proven and probable	708 000	–	–	–	–	–	–	4.7
Goudreau	Ego Resources Limited	Drill indicated	318 000	1.62	–	–	–	–	–	3.91
Goudreau	Canamax Resources Inc. Algoma Steel Corporation, Limited, The	Drill indicated and inferred	260 000	–	–	–	–	–	–	9.2
Hemlo-Interlake	Hemlo Gold Mines Inc. Teck Corporation Franco-Nevada Mining Corporation Limited		8 600 000	–	–	–	·	–	–	6.34
Hislop - East	St. Andrew Goldfields Ltd. Goldpost Resources Inc. New Kelore Mines Limited	Diluted drill indicated and possible	758 000	–	–	–	–	–	–	5.8
Hislop - Creek Zone	Stroud Resources Ltd.	Drill proven and drill indicated	921 931	–	–	–	–	–	–	6.38
Hislop - Main Zone	Stroud Resources Ltd.	Drill proven and drill indicated	93 000	–	–	–	–	–	–	5.83
Hislop - Matachewan	Noranda Inc. Alban Explorations Ltd. Matachewan Consolidated Mines, Limited	Geological	181 000	–	–	–	–	–	–	3.1

Horseshoe Island	Noranda Inc. Noront Resources Ltd.		810 578	–	–	–	–	-	–	4.8
Iris Deposit[5]	Perrex Resources Inc. Alberta Gold Exploration Corporation, The		1 000 000	–	–	–	–	–	–	3.
Jacobson Twp.	Sprit Lake Explorations Limited		148 000	–	–	–	–	–	–	37.0
Kanichee Deposit[6]	Northern Platinum Ltd.		1 143 550	0.48	0.31	–	–	–	..	..
Kasagiminnis Lake	Moss-Power Resources Inc.		454 000	–	–	–	–	–	–	5.1
Larder Lake - Cheminis	Rockford Minerals Inc. Northfield Minerals Inc.	Proven, probable and possible	2 396 409	–	–	–	–	–	–	5.83
Leckie	Stroud Resources Ltd.		299 000	–	–	–	–	–	–	7.37
Lindsley[7]	Falconbridge Limited		7 000 000	1.5	1.6	–	–	–	–	–
Lochalsh	Canamax Resources Inc.	Proven, probable and possible	224 750	–	–	–	–	–	–	5.1
Marathon[8]	Fleck Resources Ltd. Euralba Mining (Canada) Ltd.		37 000 000	0.31	0.04	–	–	–	1.31	0.07
Mishi	Granges Inc. MacMillan Gold Corp.	Undiluted geological	1 194 000	–	–	–	–	–	–	5.69
Moss Lake	Noranda Inc. Central Crude Limited Storimin Exploration Limited Tandem Resources Ltd.	Probable and possible	74 583 172	–	–	–	–	–	–	1.1
Nickel Offsets	Noranda Inc. Golden Princess Mining Corporation		544 000	–	–	–	–	–	–	7.9
Nighthawk Lake	Giant Yellowknife Mines Limited Pamorex Minerals Inc.	Probable and possible	1 445 000	–	–	–	–	–	–	5.73
Purdex	Noranda Inc. Consolidated Jalna Resources Limited	Drill indicated	218 000	–	–	–	–	–	–	7.75
Richardson Lake	Golden Terrace Resources Corporation	Probable	91 000	–	–	–	–	–	–	7.
Ronnoco	Trader Resource Corp. Ronnoco Gold Mines, Limited	Drill indicated	2 259 000	–	–	–	–	–	–	4.01
Stock Township - East	St. Andrew Goldfields Ltd.		590 000	–	–	–	–	–	–	3.77

TABLE 5 (cont'd)

DEPOSITS	COMPANIES	TONNAGE AND GRADE DESCRIPTION	TONNAGE	GRADE Cu	Ni	Pb	Zn	Mo	Ag	Au
			(tonnes)[1]	(%)	(%)	(%)	(%)	(%)	(g/t)[2]	(g/t)[2]
ONTARIO (cont'd)										
Tully	Intex Mining Company Limited Frankfield Explorations Ltd.		272 000	–	–	–	–	–	–	7.5
MANITOBA										
Big Island Lake	Minnova Inc. Westfield Minerals Limited New Goldbrae Developments Ltd.		130 000	1.	–	–	17.	–	72.	3.8
Ferro - Kus	Pierce Mountain Resources Ltd.		194 000	–	–	–	–	–	–	12.
Island Lake	Wydmar Development Corporation Bighorn Development Corporation	Proven, probable and drill indicated	387 000	–	–	–	–	–	–	10.
Little Stull Lake	Westmin Resources Limited Tanqueray Resources Ltd. Eastaurum Mines Ltd.	Geological	750 000	–	–	–	–	–	–	10.5
Minago	Black Hawk Mining Inc.	Probable and possible geological	11 861 000	–	1.25	–	–	–	–	–
Oxford Lake - Rusty Zone	Noranda Inc. Rusty Lake Resources Ltd.		907 000	–	–	–	–	–	–	6.
San Antonio Mine	Rea Gold Corporation	Diluted proven, probable and possible	1 361 000	–	–	–	–	–	–	7.41
Sannorm	Bakra Resources Ltd.		181 000	–	–	–	–	–	–	4.18
Snow Lake Mine	TVX Gold Inc. High River Resources Ltd.	Proven, probable and possible geological	3 816 889	–	–	–	–	–	–	6.40
SASKATCHEWAN										
Athona	RJK Mineral Corp. Greater Lenora Resources Corp. Cominco Ltd.	Probable, possible and potential	5 000 000	–	–	–	–	–	–	2.2
Box Mine	RJK Mineral Corp. Greater Lenora Resources Corp. Cominco Ltd.	Probable, possible and potential	14 900 000	–	–	–	–	–	–	2.0

Brabant Lake	Gamsan Resources Ltd.		3 695 381	0.55	–	0.27	4.84	–	18.63	0.18
Corner Lake	Goldsil Resources Ltd.	Possible resource	136 000	–	–	–	–	–	–	16.
Jojay	Cameco Corporation Shore Gold Fund Inc.	In-situ	259 000	–	–	–	–	–	–	7.5
Komis - Komis and EP	Waddy Lake Resources Inc.	Probable drill indicated geological	510 000	–	–	–	–	–	–	14.8
McIlvena Bay (Hanson Lake)	Cameco Corporation Billiton Resources Canada Inc.		11 153 000	1.09	–	–	5.18	–	23.	0.7
North Lake	Radcliffe Resources Ltd.	Preliminary geological	2 359 000	–	–	–	–	–	–	2.4
Preview Lake – Bakos Zone	Cameco Corporation Uranerz Exploration and Mining Limited Westward Explorations Ltd.		1 572 314	–	–	–	–	–	–	8.9
Preview Lake - Pap SW Zone	Cameco Corporation Uranerz Exploration and Mining Limited Westward Explorations Ltd.	Drill indiated probable and possible geological	544 200	–	–	–	–	–	–	12.
Tower East	Golden Rule Resources Ltd. Goldsil Resources Ltd. Cameco Corporation		538 000	–	–	–	–	–	–	6.93
Weedy Lake - B Zone	Tyler Resources Inc. Golden Rule Resources Ltd. Cameco Corporation	Inferred geological	314 000	–	–	–	–	–	–	4.8
Weedy Lake - Golden Heart	Tyler Resources Inc. Golden Rule Resources Ltd. Cameco Corporation	Geological	665 700	–	–	–	–	–	–	8.23
BRITISH COLUMBIA										
Alpine Mine - Stockpile	Cove Resources Corporation		23 000	–	–	–	–	–	–	14.
Alpine Mine - Underground	Cove Resources Corporation		907 000	–	–	–	–	–	–	17.
Bralorne	Corona Corporation Cathedral Gold Corporation	Proven, possible and probable	965 000	–	–	–	–	–	–	8.9
Canty	Golden North Resource Corporation	Drill indicated geological	595 800	–	–	–	–	–	–	5.28
Chu Chua[9]	Minnova Inc. Pacific Cassiar Limited International Vestor Resources Ltd. Quinterra Resources Inc.		1 043 000	2.98	–	–	0.3	–	10.	0.55

TABLE 5 (cont'd)

DEPOSITS	COMPANIES	TONNAGE AND GRADE DESCRIPTION	TONNAGE	GRADE						
				Cu	Ni	Pb	Zn	Mo	Ag	Au
			(tonnes)[1]	(%)	(%)	(%)	(%)	(%)	(g/t)[2]	(g/t)[2]
BRITISH COLUMBIA (cont'd)										
Cirque	Curragh Resources Inc. Asturiana de Zinc S.A.	Possible	52 200 000	–	–	2.	8.	–	. .	–
Debbie and Yellow	Westmin Resources Limited Pacific Gold Corp.	Probable	243 000	–	–	–	–	–	–	5.1
Discovery	Rea Gold Corporation	Drill proven	145 000	1.06	–	3.72	4.99	–	120.	8.47
Dolly Varden - North Star	Dolly Varden Minerals Inc.	Geological proven and probable	128 436	–	–	–	5.	–	401.5	–
Eskay Creek	Prime Resources Group Inc. Stikine Resources Ltd.	Probable and possible geological	3 959 000	–	–	–	–	–	998.4	26.
Fairview	Oliver Gold Corporation	Indicated and inferred	1 691 000	–	–	–	–	–	5.8	0.58
Fireweed - West Zone	Minnova Inc. Mansfield Minerals Inc.	Preliminary drill indicated	581 000	–	–	1.34	2.22	–	342.	–
Frasergold	ASARCO Incorporated Eureka Resources, Inc.	Drill indicated geological	11 000 000	–	–	–	–	–	–	2.
Giant Copper - AM Breccia	Bethlehem Resources Corporation	Open pit	20 684 000	0.75	–	–	–	–	12.	0.41
Goldwedge	Catear Resources Ltd.	Drill indicated and inferred	338 583	–	–	–	–	–	38.	26.
Harrison - Jenner Stock	Bema Gold Corporation Abo Resource Corp.	Drill indicated	2 204 000	–	–	–	–	–	–	4.1
Hushamu (Expo)	Moraga Resources Ltd. BHP-Utah Mines Ltd.	Mineable	97 000 000	0.29	–	–	–	0.01	–	0.3
J&L	Cheni Gold Mines Inc. Equinox Resources Ltd. Pan American Minerals Corp.	Proven and probable geological	808 000	–	–	2.5	5.2	–	65.7	7.2
Kerr	Placer Dome Inc.	Potential	120 000 000	0.75	–	–	–	–	2.4	0.3
Lara	Minnova Inc. Laramide Resources Ltd.	Drill indicated	529 000	1.01	–	1.22	5.87	–	100.	4.73
Midway	Regional Resources Ltd.	Geological	1 185 000	–	–	7.0	9.6	–	410.	–

Millie Mack	Greenstone Resources Ltd. Dragoon Resources Ltd.	Open pit	1 500 000	–	–	–	–	–	206.	5.73
Mt. Milligan	Placer Dome Inc.	Drill indicated	400 000 000	0.20	–	–	–	–	–	0.48
Mt. Polley	Imperial Metals Corporation	Open pit mineable	48 700 000	0.38	–	–	–	–	–	0.55
Mt. Washington - Lakeview Domineer	Better Resources Ltd.	Drill indicated	550 300	–	–	–	–	–	32.	6.75
Polaris Taku	Suntac Minerals Corporation Rembrandt Gold Mines Ltd.	Potential	1 315 000	–	–	–	–	–	–	13.
Porcher Island - AT Zone	Cathedral Gold Corporation		1 361 000	–	–	–	–	–	–	6.86
QR (Quesnel River)	QPX Minerals Inc. Placer Dome Inc.		1 200 000	–	–	–	–	–	–	5.22
Redbird[10]	Golden Eye Minerals Ltd. Hecla Mining Company of Canada Ltd.	Geological	900 000	–	–	..	8.	–	69.	–
Red Mountain	Bond International Gold, Inc.	Preliminary	846 000	–	–	–	–	–	–	13.
Reliance - Imperial	Menika Mining Ltd.	Proven and indicated	454 000	–	–	–	–	–	–	6.14
SB	Westmin Resources Limited Tenajon Resources Corp.	Probable and possible	279 000	–	–	–	–	–	36.7	17.3
Silver Queen[11]	Pacific Houston Resources, Inc.	Proven, probable and indicated	1 726 000	–	–	–	6.19	–	328.	2.7
Similco Mine - Alabama	Princeton Mining Corporation	Possible	9 000 000	0.32	–	–	–	–	–	..
Similco Mine - Virginia	Princeton Mining Corporation	Probable	14 000 000	0.40	–	–	–	–	–	0.2
Ski (Eskay Creek)	Adrian Resources Ltd.		153 000	–	–	–	–	–	599	23.
Takla Rainbow	Eastfield Resources Ltd. Cathedral Gold Corporation	Drill indicated, inferred and potential	290 000	–	–	–	–	–	–	8.6
Tam	Varitech Resources Ltd. Major General Resources Ltd.		6 500 000	0.55	–	–	–	–	–	–
Taseko	ASARCO Incorporated Westpine Metals Ltd.		6 763 200	0.73	–	–	–	–	2.	0.82
Tillicum Mtn.	Columbia Gold Mines Ltd.		460 000	–	–	–	–	–	–	11.
Toodoggone (AL)	Cheni Gold Mines Inc.	Drill proven	227 000	–	–	–	–	–	–	9.6
Treasure Mountain	Huldra Silver Inc.	Proven and probable	146 000	–	–	4.9[e]	4.9[e]	–	878.	–

TABLE 5 (cont'd)

DEPOSITS	COMPANIES	TONNAGE AND GRADE DESCRIPTION	TONNAGE	GRADE						
				Cu	Ni	Pb	Zn	Mo	Ag	Au
			(tonnes)[1]	(%)	(%)	(%)	(%)	(%)	(g/t)[2]	(g/t)[2]
BRITISH COLUMBIA (cont'd)										
Tulsequah Chief	Cominco Ltd. Redfern Resources Ltd.	Geological	5 262 000	1.6	–	1.3	7.0	–	99.	2.7
Vault	Inco Limited Seven Mile High Group Inc.	Drill indicated mineral resource	152 000	–	–	–	–	–	–	14.
Vine	Kokanee Exploration Ltd. Cominco Ltd.	Drill indicated proven, probable and possible	1 061 000	0.13	–	3.76	1.07	–	40.1	2.
Windy Craggy[12]	Geddes Resources Limited Northgate Exploration Limited	Probable and possible	166 000 000	1.9	–	–	. .	–	. .	. .
NORTHWEST TERRITORIES										
Bugow - Andrew	Aber Resources Ltd.		64 000	–	–	–	–	–	–	5.5
Bugow - Cabin Creek	Aber Resources Ltd.	Drill indicated	91 000	–	–	–	–	–	–	10.
Butterfly	Cominco Ltd. Cogema Canada Limited Aber Resources Ltd.		91 000	–	–	–	–	–	–	21.
Cache (Southwin)	Noble Peak Resources Ltd.		363 000	–	–	–	–	–	–	8.9
Con Mine - tailings	NERCO, Inc.		5 200 000	–	–	–	–	–	0.3	1.4
Coronation Gulf	Canuc Resources Inc.	Geological indicated	780 000	–	–	–	–	–	–	7.5
George Lake (several deposits)	Homestake Mining Company Kerr-McGee Corporation	Geological	2 000 000	-	–	–	–	–	–	10.
Nicholas Lake	Athabasca Gold Resources Ltd. Chevron Minerals Ltd.	Drill indicated and inferred	953 000	–	–	–	–	–	–	12.2
Ren	Westview Resources Inc. Cominco Ltd.	Potential	2 000 000	–	–	–	–	–	–	9.9
Sunrise Lake	Aber Resources Ltd. Hemisphere Development Corp.	Probable and possible	1 866 000	0.1	–	4.22	8.88	–	405.	0.96

YUKON TERRITORY

Blende	Billiton Metals Canada Inc. NDU Resources Ltd.	Preliminary	11 400 000	–	–	3.	2.2	–	50.1	–
Brewery Creek	Loki Gold Corporation Noranda Inc.	Geological	10 073 738	–	–	–	–	–	–	1.80
Dy (Underground)	Curragh Resources Inc.	Diluted probable	11 300 000	–	–	5.82	6.84	–	83.	0.94
Marg	NDU Resources Ltd. Cameco Corporation	Drill indicated diluted	2 860 000	1.62	–	2.25	4.17	–	55.9	0.89
Mel[13]	Barytex Resources Corp. Breakwater Resources Ltd.	Drill indicated	5 238 000	–	–	2.09	7.86	–	–	–
Mount Nansen	B.Y.G. Natural Resources Inc.	Proven, probable and possible	953 383	–	–	–	–	–	190.	9.39
Wellgreen[14]	All-North Resources Ltd.	Probable and possible	49 895 000	0.35	0.36	–	–	–	–	–
Williams Creek	Western Copper Holdings Limited Archer, Cathro and Associates	Geological	14 817 400	1.15	–	–	–	–	–	0.7

[1] One tonne = 1.1023113 short tons. [2] One gram per tonne (g/t) = 0.02916668 troy ounces per short ton. [3] The Mount Pleasant deposit also grades 0.39% tungsten. A further 4 600 000 t grades 0.79% tin. [4] The RM Nickel deposit also contains platinum and palladium. [5] The Iris deposit also contains tungsten. [6] The Kanichee deposit also contains gold, silver, platinum and palladium. [7] The Lindsley deposit also contains gold, silver, platinum, palladium and cobalt. [8] The Marathon deposit also contains cobalt, platinum and palladium. [9] The Chu Chua deposit also contains cobalt, talc and magnetite. [10] The Redbird deposit also contains lead, cadmium and germanium. [11] The Silver Queen deposit also contains germanium and indium. [12] The Windy Craggy deposit also contains zinc, gold, silver and cobalt. [13] The Mel deposit also grades 48.9% barite. [14] The Wellgreen deposit also contains platinum and palladium.
– Nil; . . Not available; [e] Author's estimate.

Canadian Mineral Exploration

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THE FEDERAL-PROVINCIAL EXPLORATION SURVEY

Greater coordination among federal, provincial and territorial officials as of 1985 has resulted in the compilation of more reliable and detailed data on Canadian exploration that permit nationwide comparisons.

Beginning with the year 1989, the Department of Energy, Mines and Resources (EMR) has coordinated the collection of statistics for expenditures on general exploration while Statistics Canada has coordinated the collection of statistics on expenditures for on-property exploration, which it needs for preparation of information on the National Accounts. Both federal agencies cooperate with the provinces and territories in assembling and publishing comprehensive annual national exploration statistics.

ACTIVITY

Exploration Expenditures[1]

In 1989,[2] Canadian exploration expenditures, exclusive of those on the search for oil and natural gas, totalled $828 million, down significantly from the $1350 million spent in 1988 and the $1300 million spent in 1987. Fieldwork (Figure 1a) accounted for $704 million, and the remaining $124 million was spent on overhead. Senior companies spent $555 million of the $828 million and junior companies spent $273 million. With respect to exploration locale, $713 million was spent on general exploration. The remaining $115 million was directed to on-property (minesite) exploration, defined as the search for new mines on the properties of existing mines.[3]

Based on information currently available, EMR estimates that Canadian exploration expenditures in 1990 totalled about $750 million.

Financing Through the Issue of Flow-Through Shares

In 1989, funds raised through the sale of flow-through shares (Table 1) financed about 40% of Canadian exploration expenditures. In 1990 they funded an estimated 30% of such outlays. EMR estimates that companies listed on Canadian stock exchanges sold $350 million of flow-through shares in 1989 and $205 million-$225 million in 1990.

Claim Staking

In 1989, the overall area of claims staked in Canada, exclusive of that for coal, 5 063 568 hectares (Table 2, Figure 1b), was down by 20% relative to 1988. Total areas staked were up in Alberta, Quebec and New Brunswick. Staking was down somewhat in British Columbia. There were notable declines in the areas of claims staked in Newfoundland, Ontario, the Northwest Territories, the Yukon, Saskatchewan and Nova Scotia.

In 1990, the area of claims staked in Canada fell by a mere 1% to 4 997 490 hectares. This was mostly due to the fact that staking in Alberta increased to a remarkable 807 910 hectares, largely because of exploration for diamonds which had spread from Saskatchewan following the discovery of kimberlite intrusions there in 1988 and 1989. Staking was up somewhat in the Yukon, Ontario and British Columbia, stayed about the same in Nova Scotia, but was down significantly in Manitoba, Newfoundland, Quebec and Saskatchewan.

Canadian Mineral Exploration

Exploration Drilling

In 1989, 3 165 438 m of surface exploration drilling (Table 3, Figure 1c) was completed in Canada, a decrease of 41% from 1988. Diamond drilling (2 984 455 m) represented 94% of this amount. In 1989, spending on drilling represented 43% of Canadian field exploration expenditures and 36% of total exploration expenditures. Underground drilling totalled 1 071 156 m.

Exploration Expenditures by Province and Territory–1989

The most active exploration areas (Table 3, Figure 2) in 1989 were Ontario ($217.8 million), British Columbia ($186.6 million) and Quebec ($185.0 million), which jointly accounted for 71% of Canadian exploration expenditures. Although total exploration expenditures in British Columbia slightly exceeded those in Quebec, field expenditures in Quebec were higher than those in British Columbia. Exploration expenditures in Ontario exceeded those in Quebec for the second year in succession. Prior to 1988, this had not happened since 1977.

Exploration expenditures in Alberta ($6.3 million) remained about the same as in 1988. Expenditures in New Brunswick ($13.6 million), Manitoba ($37.0 million), Saskatchewan ($63.3 million), British Columbia, and Newfoundland ($36.2 million) were slightly to moderately lower than in 1988; those in the Northwest Territories ($45.7 million), Ontario and Quebec were only about half the corresponding totals for the previous year. In Nova Scotia ($21.4 million) and the Yukon ($15.1 million), 1989 exploration expenditures were, respectively, less than half and about one third of those of the previous year.

Expenditures by Commodity Sought–1989

Precious metals and base metals were the main exploration targets in 1989 (Tables 4 and 5, Figure 3). Some $552 million (67%) of exploration expenditures was directed to precious metals, nearly all of it for gold; exploration expenditures for platinum group metals amounted to about $8.3 million, down from an estimated $19.5 million in 1988. The $184 million in expenditures on the search for base metals accounted for 22% of 1989 exploration expenditures, slightly lower, after adjustment for inflation, than the approximately $181 million spent in 1988.

Exploration expenditures on precious metals were only about half the amount spent in 1988. They were up slightly for base metals, up about one third for uranium, but were down by about one fifth for coal. More than $5 million each was spent on exploration for diamonds and graphite (Table 6).

Regional Expenditures by Commodity Sought–1989

Gold was the principal exploration target in most provinces and territories (Figure 4). In New Brunswick and Manitoba, base metals were the principal metals sought (as opposed to gold in 1988), while in Saskatchewan, the search was directed mainly at uranium (versus gold in 1987 and 1988). In Alberta, the principal target was coal.

Regional Expenditures by Type of Company–1989

Producing companies and their affiliates dominated exploration spending in all provinces and territories except Nova Scotia and British Columbia (Table 7, Figure 5). In Nova Scotia, expenditures by junior companies were more than double those of producers and affiliates, while in British Columbia, junior company expenditures slightly exceeded those of the producers and affiliates.

In Quebec, producers and affiliates spent close to double the amount that the juniors did on exploration. This was the first year since 1984 that junior companies were not the dominant exploration spenders in that province.

Expenditures by Types of Companies and Commodities–1989

Junior companies directed 80% of their 1989 exploration expenditures at precious metals and 11% at base metals (Table 11b, Figure 6). In contrast, producing companies and affiliates directed 60% of their exploration spending at precious metals and spent 30% of it looking for base metals. All other types of companies combined accounted for only 10% of spending on the search for precious metals and only 8% on the search for base metals.

Close to half of total exploration expenditures incurred by foreign companies in Canada was directed at precious metals, a further one third of their expenditures was spent on the search for uranium.

Type of Company Engaged in Exploration–1989

Table 8 gives 1989 exploration expenditures and percentages of total Canadian exploration expenditures by company type. The proportion of total exploration expenditures accounted for by junior companies rose during the 1980s, especially after changes to the income tax regulations for flow-through shares that came into effect in 1983. Expenditures by junior companies began to decline in 1988 (Figure 7). Because it has been increasingly difficult for junior companies to raise exploration funds, this decline is expected to continue through 1991.

Oil companies, which in the 1970s accounted for more than one quarter (28% in 1977) of total exploration expenditures on the search for non-petroleum minerals, provided only 3% of Canadian exploration spending in 1989.

Exploration expenditures (in current dollars) by foreign companies remained at about the same level as they were for the previous two years.

Canadian Exploration and Discovery Trends

In contrast to the 1970s, the record high prices for gold and relatively low prices for base metals that prevailed during most of the 1980s resulted in a spectacular shift in Canadian exploration activity away from base metals to gold. Exploration for uranium, which had peaked in 1979 following a sharp rise in the price of uranium that peaked in 1978, dropped off sharply in the early 1980s. Exploration expenditures in 1989 fell from the record highs achieved in 1987 and 1988 because the price of gold was lower than in previous years.

Gold accounts for some 10% of the value of Canada's non-petroleum mineral production, but in the past several years 75%-85% of Canada's non-petroleum mineral exploration expenditures were directed at the search for gold. Emphasis on exploration for gold in the 1980s resulted in the discovery of all-time record numbers of gold deposits and record quantities of gold. However, few of the newly discovered deposits appear to be outstanding in terms of either tonnage or grade, and few new large gold mines have been developed other than the three that resulted from the discovery at Hemlo in 1981, and those on the Golden Pond deposits in Quebec. Few prospective new gold mines are currently on the horizon.

The values in terms of contained gold of Canadian gold deposits found to date have generally been lower than that of Canadian base-metal deposits. Only one of the 30 largest metal deposits found in Canada is a gold deposit–the vein system associated with the Pearl Lake Porphyry, worked from the Hollinger and McIntyre mines at Timmins, Ontario. Canadian gold mines have also tended to have substantially lower annual production values than Canadian base-metal deposits.

The search for base-metal deposits in Canada was not particularly successful in the 1980s. On average, base-metal exploration expenditures were not much lower, after adjustment for inflation, than those of earlier years, but there were relatively few outstanding discoveries. The most notable in terms of the value of contained metals are: Duck Pond (Cu, Zn) in Newfoundland; Louvicourt or Aur-Louvem (Cu, Zn), Grevet M (Zn, Cu) and Île Dieu Mattagami (Zn, Cu, Ag) in Quebec; Winston Lake (Zn) in Ontario; McIlvena Bay (Hanson Lake) (Zn, Cu) in Saskatchewan; Mount Milligan (Au, Cu) and Kerr (Cu) in British Columbia; Mt. Hundere-Jewel Box Hill and North Hill deposits (Zn, Pb, Ag) and Logan (Zn) in the Yukon; and Gondor Lake (Zn, Cu, Pb, Ag, Au) in the Northwest Territories.

As well as these discoveries and a number of other smaller ones, additional work on several other large base-metal deposits found in earlier years resulted in substantial increases to their economic potential. Among these are: Windy Craggy (Cu, Co, Au), Mount Polley

(Cariboo Belle) (Cu, Au), and Tulsequah Chief (Zn, Cu, Ag, Au) in British Columbia; Lindsley (Ni, Cu) in Ontario; and Raglan (Ni, Cu) in Quebec.

In all, the average number of significantly valuable discoveries found in Canada in the 1980s would appear to have been about only half the average of 2.3 such deposits found each year in the 31-year period 1949-79. No world-class base-metal deposits such as Sullivan, Brunswick No. 12, a number of world-class deposits at Sudbury, Thompson, Pipe, Kidd Creek, Valley Copper, Howard's Pass (Anniv and XY deposits) and Schaft Creek were found in Canada during the 1980s. Even if the size of each of the largest Canadian base-metal discoveries of the 1980s ultimately turns out to be twice its currently-known size, the average metal content of these discoveries made in the 1980s will be only about half that of similar base-metal discoveries made in the 1949-79 period. Windy Craggy is the only deposit currently under exploration that appears to be world-class, but it was first discovered during the 1960s.

The highlight of Canadian exploration in the 1980s was the outstanding discovery record for uranium. More than 25 uranium deposits were found, many of them exceptionally high-grade world-class deposits. Especially notable are Cigar Lake, Eagle Point, McArthur River (P-2 South and P-2 North deposits), Sue (4 deposits), Jeb, Dominique-Peter, Dominique-Janine, and South Dominique-Janine, all in Saskatchewan. Given the current price for uranium, most of these deposits are unlikely to produce in the next few years.

It is difficult to see how the Canadian mineral industry can continue to discover the new reserves needed to maintain Canadian production of non-petroleum minerals, of which gold makes up only 10%, when in the past years three quarters of Canadian exploration expenditures have been directed at exploration for gold. Recent exploration efforts have not yielded the new mines that will be needed if the Canadian mineral industry is to continue producing most mineral commodities other than gold at current levels of output. On the basis of currently available information on Canadian mineral deposits discovered during the 1980s, it is by no means certain that the Canadian mineral exploration effort of the past 10 or 15 years has yielded an overall economic return, given the amount of exploration money that was spent to find those deposits.

The main hope for our being able to maintain Canadian output of copper, nickel, zinc and lead appears to lie in the development of various metal deposits that were discovered during the 1950s, 1960s and 1970s but have not yet been brought into production. This offers only a relatively short-term solution to a longer term problem.

REFERENCES

1 Unless otherwise specified, exploration expenditures in the text refer to field expenditures plus overhead.

Overhead consists of: 1) mineral lease rental and other land costs, excluding payments for property options and purchase of claims or mining rights; 2) administration and general overhead in the field; and 3) head office expenses in the province for which operations are being reported. In 1989, overhead amounted to 15% of total Canadian exploration expenditures (Table 3).

2 Preliminary data for 1990 and a forecast for 1991, not available at the time of publication, can be obtained by contacting the authors.

3 Drilling and underground work to better define known orebodies (and to search for extensions to known orebodies in producing mines and deposits committed to production) are not counted as exploration but are included in minesite development, which includes all work done to outline, block out and gain access to ore and to prepare it for production. The Federal-Provincial Exploration Survey also gathers data on minesite development expenditures; it totalled $988 million in 1989.

Note: Information contained in this review was current as of mid-January 1991.

TABLE 1. FUNDS RAISED BY COMPANIES LISTED ON CANADIAN STOCK EXCHANGES THROUGH THE ISSUE OF FLOW-THROUGH SHARES FOR COMPANIES LISTED ON CANADIAN STOCK EXCHANGES, 1983-90

Year	Value of Funds Raised
	($ million)
1983	34
1984	139
1985	275
1986	673
1987	1 183
1988	850
1989	350
1990	205-225[e]

Sources: Compiled by Mineral Policy Sector, EMR Canada from Montreal, Toronto and Vancouver Stock Exchange records.
[e] Estimated.

TABLE 2. AREA[1] OF NEW MINERAL CLAIMS STAKED IN CANADA, 1983-90

	1983		1984		1985		1986		1987		1988		1989		1990	
	(hectares(	(%)	(hectares)	(%)	(hectares)	(%)	(hectares)	(%)	(hectares)	(%)	(hectares)	(%)	(hectares)	(%)	(hectares)	(%)
Newfoundland	76 024	1.3	186 155	4.0	262 653	5.9	258 605	4.3	376 362	5.4	419 184	6.7	275 040	5.4	163 568	3.3
Nova Scotia	483 075	8.1	309 014	6.7	449 907	10.1	577 260	9.6	624 508	8.9	423 019	6.7	174 456	3.4	176 609	3.5
New Brunswick	69 760	1.2	43 250	0.9	81 860	1.8	44 872	1.0	72 748	1.0	110 976	1.8	139 776	2.8	69 776	1.4
Prince Edward Island	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Quebec	529 193	8.9	457 549	9.9	641 995	14.5	1 165 262	19.4	890 977	12.7	537 217	8.6	823 452	16.3	483 289	9.7
Ontario	1 138 187	19.1	653 494	14.2	464 431	10.5	983 386	16.4	949 231	13.5	598 632	9.6	390 619	7.7	419 259	8.4
Manitoba	173 055	2.9	201 058	4.4	136 736	3.1	301 974	5.0	212 139	3.0	162 264	2.6	209 483	4.1	127 342	2.5
Saskatchewan	283 375	4.8	119 516	5.8	630 972	14.2	467 051	7.8	700 459	10.0	741 944	11.8	418 832	8.3	184 939	3.7
Alberta	..	..	..	..	1 472	0.03	48 664	0.8	9 408	0.1	20 757	0.3	50 240	1.0	807 910	16.2
British Columbia	2 649 550	44.5	2 135 000	46.3	1 326 525	29.9	1 613 775	26.9	2 269 925	32.4	2 212 125[a]	35.3	1 946 000[a]	38.4	2 014 250	40.3
Yukon	224 994	3.8	269 354	5.8	147 406	3.3	176 962	2.9	357 576	5.1	301 713	4.8	178 683	3.5	195 202	3.9
Northwest Territories	330 592	5.5	240 900	5.2	294 887	6.6	360 361	6.0	552 385	7.9	739 928	11.8	456 987	9.0	355 346	7.1
Total	5 957 805	100.0	4 615 290	100.0	4 438 844	100.0	5 998 172	100.0	7 015 718	100.0	6 267 755	100.0	5 063 568	100.0	4 997 490	100.0

1 Excludes coal.

a Excludes placer leases; – Nil; .. Not available.

Note: Percentages may not balance due to rounding.

TABLE 3. EXPLORATION ACTIVITIES BY PROVINCE AND TERRITORY, 1989

	Field Expenditures On- and Off-Property 1988	1989	1989 as a % of 1988 Field Expenditures	1989 Overhead Expenditures	1989 Total Expenditures Including Overhead		Surface Drilling	
	($ millions)		(%)	($ millions)	($ millions)	(%)	(metres)	(%)
Newfoundland	37.7	28.5	75.6	7.7	36.2	4	104 907	3
Nova Scotia	46.7	17.7	37.9	3.7	21.4	3	28 572	1
New Brunswick	13.8	11.2	81.3	2.4	13.6	2	42 237	1
Prince Edward Island	–	–	–	–	–	–	–	–
Quebec	328.2	165.8	50.5	19.2	185.0	22	824 472	26
Ontario	343.6	185.3	53.9	32.5	217.8	26	889 681	28
Manitoba	30.0	32.3	107.5	4.7	37.0	4	115 004	4
Saskatchewan	61.0	55.5	91.0	7.8	63.3	8	271 338	9
Alberta	4.3	4.3	99.1	2.0	6.3	1	112 908	4
British Columbia	196.8	149.7	76.1	36.9	186.6	22	626 750	20
Northwest Territories	66.5	39.6	59.5	6.1	15.0	6	107 539	3
Yukon Territory	38.6	13.5	35.0	1.5	45.7	2	42 030	1
Total	1 167.2	703.5	60.3	124.5	828.0	100[a]	3 165 438	100[a]

Source: Federal-Provincial Exploration Survey.
[a] May not balance due to rounding; – Nil.

TABLE 4. CANADIAN EXPLORATION EXPENDITURES BY PRINCIPAL COMMODITY GROUP, 1989

Commodity Groups	Expenditures	Percentage of Canadian Total
	($ million)	(%)
Base metals (Cu, Ni, Pb, Zn)	184.3	22.3
Precious metals (Ag, Au, Pt group)	552.1	66.7
Iron ore	0.6	0.1
Uranium	33.6	4.1
Other metals	8.4	1.0
Nonmetals	27.3	3.3
Coal	11.1	1.3
Unspecified commodities	10.5	1.3
Total	827.9	100.0

Source: From data in Table 11b.
Note: Percentages may not balance due to rounding.

TABLE 5. PERCENTAGES OF CANADIAN EXPLORATION EXPENDITURES DIRECTED TO THE SEARCH FOR BASE METALS AND PRECIOUS METALS, 1975-89

Year	Base Metals[1]	Precious Metals[2]
	(percent)[3]	
1975	63	7
1977	42	7
1979	35	12
1981	34	25
1983	42	29
1985	20	65
1986	14	76
1987	11	83
1988	13	82
1989	23	67

Sources: 1975-83 compiled by EMR from individual company responses to Statistics Canada exploration questionnaires; 1985-89 from the federal-provincial exploration survey.
[1] Nickel, copper, zinc and lead. [2] Gold, silver and platinum group metals. Gold exploration has accounted for 95% of exploration expenditures on precious metals in recent years. [3] Expenditures for unspecified commodities have been pro-rated and assigned to the various commodity groups.

TABLE 6. CANADIAN EXPLORATION EXPENDITURES FOR SELECTED INDUSTRIAL MINERALS, 1989

Commodity	Expenditures	Percentage of Total Expenditures in 1989
	($ million)	(percent)
Graphite	7.3	0.9
Diamond	5.1	0.6
Limestone	3.7	0.4
Silica	2.6	0.3

Source: Federal-Provincial Exploration Survey.

TABLE 7. EXPLORATION EXPENDITURES BY TYPES OF COMPANIES ENGAGED IN EXPLORATION

Group	1988 Exploration	Expenditures	1889 Exploration	Expenditures
	($ million)	(% of Canadian total)	($ million)	(% of Canadian total)
1. Producing companies (those with a producing mine in Canada) and their affiliates	622	46	462	56
2. Oil companies (excluding group 1 above)	19	1	24	3
3. Foreign companies (excluding groups 1 and 2 above)	41	3	47	6
4. Junior companies and prospectors	637	47	272	33
5. Other companies	31	2	23	3
Total	1 350[a]	100	828	100

Source: Federal-Provincial Exploration Survey.
[a] Overhead expenditures included in the 1988 total were calculated by EMR by multiplying the federal/provincial field expenditures by the ratio total/field from Statistics Canada.
Note: Percentages may not balance due to rounding.

TABLE 8. PERCENTAGE OF CANADIAN EXPLORATION EXPENDITURES BY COMPANY TYPE, 1989

Type of Company	Expenditures	Percentage of Canadian Total
	($ million)	(percent)
Producers and their affiliates	462.4	56
Oil	23.9	3
Foreign	46.9	6
Junior	272.2	33
Others	22.3	3
Total	827.9	100

Source: Federal-Provincial Exploration Survey.
Note: Totals may not balance due to rounding.

GENERAL EXPLORATION PLUS MINESITE EXPLORATION[1] SURVEY RESULTS, 1989

RÉSULTATS DE L'ENQUÊTE SUR L'EXPLORATION DE NATURE GÉNÉRALE ET L'EXPLORATION À LA MINE[1], 1989

TABLE 9 / TABLEAU 9

SOURCE:
Federal-Provincial Survey of Mining and Exploration Companies
Relevé fédéral-provincial auprès des sociétés d'exploration et d'exploitation minière

PREPARED BY / ÉTABLI PAR
Department of Energy, Mines and Resources of Canada
Ministère de l'Énergie, des Mines et des Ressources du Canada

PROVINCIAL DISTRIBUTION BY TYPE OF WORK (in thousands of dollars)
RÉPARTITION PROVINCIALE PAR TYPE DE TRAVAUX (en milliers de dollars)

Province	Drilling (surface and underground) Forage (surface et souterrain)				Surveys - Other Exploration Work / Levés - autres travaux d'exploration						Total Field Expenditures Total des dépenses de terrain	Total Including Overhead[2] Total avec frais généraux[2]
	Diamond / Diamant		Other / Autres		Geochemical Géochimie	Geology Géologie	Geophysical/Géophysique		Rock Work Travaux dans la roche	Other Field Costs\Coût des autres travaux		
	Metres (10^3)	Cost Coût	Metres (10^3)	Cost Coût			Ground Au sol	Airborne Aéroportée				
Newfoundland Terre-Neuve	104	8 346	0	78	2 837	7 347	2 129	516	2 439	4 827	28 519	36 200
Nova Scotia Nouvelle-Écosse	32	2 134	1	30	217	1 645	579	0	8 273	4 838	17 715	21 436
New Brunswick Nouveau-Brunswick	47	3 837	1	51	1 063	1 818	1 146	693	1 644	940	11 193	13 590
Quebec Québec	1 100	70 014	0	0	6 179	20 236	7 098	1 474	16 424	44 371	165 798	185 010
Ontario	1 188	85 174	25	1 922	5 041	23 594	10 885	1 875	35 481	21 376	185 348	217 780
Manitoba	217	17 794	0	2	578	2 686	2 490	855	4 094	3 788	32 286	36 974
Saskatchewan	289	24 940	28	1 591	2 136	6 279	3 457	1 769	2 402	12 950	55 523	63 291
Alberta	5	452	108	2 666	111	148	163	0	5	719	4 265	6 250
British Columbia Colombie-Britannique	717	57 418	127	2 569	9 016	19 605	7 020	2 290	22 516	29 298	149 732	186 623
N.W.T. T. N.-O.	203	16 100	0	2	1 842	11 258	2 793	993	3 023	3 606	39 617	45 708
Yukon Territory Yukon	37	5 190	6	560	951	2 057	519	79	1 435	2 705	13 496	15 066
CANADA	3 940	291 399	297	9 471	29 971	96 674	38 278	10 545	97 736	129 418	703 491	827 928

1. Exploration activity does not include exploration for extensions to deposits already being mined or committed to production, but includes only the search for new mines.

2. Overhead expenditures include land costs, field administration costs and exploration-related head office expenses.

1. L'activité d'exploration vise seulement la découverte de nouveaux gisements; elle exclut donc le prolongement de gisements déjà en production ou destinés à la production.

2. Les frais généraux incluent les frais d'acquisition des terres, les frais d'administration sur place et les frais d'administration centrale en rapport avec l'exploration.

GENERAL EXPLORATION PLUS MINESITE EXPLORATION[1] SURVEY RESULTS, 1989

RÉSULTATS DE L'ENQUÊTE SUR L'EXPLORATION DE NATURE GÉNÉRALE ET L'EXPLORATION À LA MINE[1], 1989

TABLE 10 / TABLEAU 10

SOURCE :
Federal-Provincial Survey of Mining and Exploration Companies
Relevé fédéral-provincial auprès des sociétés d'exploration et d'exploitation minière

PREPARED BY / ÉTABLI PAR
Department of Energy, Mines and Resources of Canada
Ministère de l'Énergie, des Mines et des Ressources du Canada

DISTRIBUTION OF ACTIVITIES BY TYPE OF COMPANY (in thousands of dollars)
RÉPARTITION DES ACTIVITÉS PAR TYPE DE SOCIÉTÉ (en milliers de dollars)

Type of Company / Type de société	Drilling (surface and underground) / Forage (surface et souterrain)				Surveys - Other Exploration Work / Levés - autres travaux d'exploration						Total Field Expenditures / Total des dépenses de terrain	Total Including Overhead[2] / Total avec frais généraux[2]
	Diamond / Diamant		Other / Autres		Geochemical / Géochimie	Geology / Géologie	Geophysical/Géophysique		Rock Work / Travaux dans la roche	Other Field Costs / Coût des autres travaux		
	Metres (10^3)	Cost / Coût	Metres (10^3)	Cost / Coût			Ground / Au sol	Airborne / Aéroportée				
1. Companies with a producing mine in Canada / Sociétés possédant une mine en production au Canada	1 997	144 774	136	4 884	10 371	35 400	12 724	3 785	31 152	55 342	298 430	335 373
2. Affiliates of (1) / Sociétés affiliées à (1)	514	40 299	133	2 231	5 841	19 978	7 100	2 461	13 979	13 177	105 066	126 982
3. Oil companies / Société pétrolières	73	5 376	0	2	954	2 239	832	169	4 504	2 928	17 003	23 859
4. Foreign companies excluding (3) / Sociétés étrangères, excluant (3)	208	12 764	1	68	1 886	6 049	2 367	779	2 755	8 569	35 237	46 870
5. Junior companies and prospectors / Petites sociétés et prospecteurs	1 066	81 543	25	2 050	9 631	29 567	14 134	2 856	43 917	46 362	230 060	272 589
6. Others / Autres	82	6 643	1	236	1 289	3 440	1 121	495	1 429	3 042	17 695	22 254

1. Exploration activity does not include exploration for extensions to deposits already being mined or committed to production, but includes only the search for new mines.

2. Overhead expenditures include land costs, field administration costs and exploration-related head office expenses.

1. L'activité d'exploration vise seulement la découverte de nouveaux gisements; elle exclut donc le prolongement de gisements déjà en production ou destinés à la production.

2. Les frais généraux incluent les frais d'acquisition des terres, les frais d'administration sur place et les frais d'administration centrale en rapport avec l'exploration.

GENERAL EXPLORATION PLUS MINESITE EXPLORATION[1] SURVEY RESULTS, 1989

RÉSULTATS DE L'ENQUÊTE SUR L'EXPLORATION DE NATURE GÉNÉRALE ET L'EXPLORATION À LA MINE[1], 1989

SOURCE: Federal-Provincial Survey of Mining and Exploration Companies
Relevé fédéral-provincial auprès des sociétés d'exploration et d'exploitation minière

PREPARED BY / ÉTABLI PAR Department of Energy, Mines and Resources of Canada
Ministère de l'Énergie, des Mines et des Ressources du Canada

TABLE 11a / TABLEAU 11a

DISTRIBUTION OF EXPENDITURES BY COMMODITY SOUGHT, NOT INCLUDING OVERHEAD[2] (in thousands of dollars)
RÉPARTITION DES DÉPENSES PAR PRODUIT MINÉRAL CHERCHÉ, SANS FRAIS GÉNÉRAUX[2] (en milliers de dollars)

Province	Metals / Métaux					Nonmetals Non-métaux	Coal Charbon	Commodity Not Specified Produit minéral non défini	Total Field Expenditures Total des dépenses de terrain
	Base Communs	Precious Précieux	Iron Fer	Uranium	Other Metals Autres métaux				
Newfoundland Terre-Neuve	8 142	16 420	364	17	1 347	1 384	0	846	28 519
Nova Scotia Nouvelle-Écosse	779	15 628	30	0	316	307	583	72	17 715
New Brunswick Nouveau-Brunswick	6 301	4 296	0	0	247	230	32	86	11 193
Quebec Québec	43 292	110 667	65	51	3 706	8 016	0	0	165 798
Ontario	42 934	134 575	21	0	72	5 020	0	2 725	185 348
Manitoba	17 250	14 446	0	0	354	15	0	221	32 286
Saskatchewan	10 083	17 748	0	22 753	0	3 757	251	932	55 523
Alberta	0	38	0	800	0	37	3 314	76	4 265
British Columbia Colombie-Britannique	27 610	116 166	5	0	1 244	961	2 531	1 215	149 732
N.W.T. T. N.-O.	4 220	31 034	15	3 159	0	548	0	642	39 617
Yukon Territory Yukon	2 701	9 607	0	16	7	0	0	1 166	13 496
CANADA	163 311	470 625	499	26 794	7 292	20 277	6 712	7 980	703 491

1. Exploration activity does not include exploration for extensions to deposits already being mined or committed to production, but includes only the search for new mines.

2. Overhead expenditures include land costs, field adminsitration costs and exploration-related head office expenses.

1. L'activité d'exploration vise seulement la découverte de nouveaux gisements; elle exclut donc le prolongement de gisements déjà en production ou destinés à la production.

2. Les frais généraux incluent les frais d'acquisition des terres, les frais d'administration sur place et les frais d'administration centrale en rapport avec l'exploration.

GENERAL EXPLORATION PLUS MINESITE EXPLORATION[1] SURVEY RESULTS, 1989

RÉSULTATS DE L'ENQUÊTE SUR L'EXPLORATION DE NATURE GÉNÉRALE ET L'EXPLORATION À LA MINE[1], 1989

TABLE 11b / TABLEAU 11b

SOURCE :
Federal-Provincial Survey of Mining and Exploration Companies
Relevé fédéral-provincial auprès des sociétés d'exploration et d'exploitation minière

PREPARED BY / ÉTABLI PAR
Department of Energy, Mines and Resources of Canada
Ministère de l'Énergie, des Mines et des Ressources du Canada

DISTRIBUTION OF EXPENDITURES BY COMMODITY SOUGHT, INCLUDING OVERHEAD[2] (in thousands of dollars)
RÉPARTITION DES DÉPENSES PAR PRODUIT MINÉRAL CHERCHÉ, AVEC FRAIS GÉNÉRAUX[2] (en milliers de dollars)

Province	Metals / Métaux					Nonmetals Non-métaux	Coal Charbon	Commodity Not Specified Produit minéral non défini	Total Including Overhead[2] Total avec frais généraux[2]
	Base Communs	Precious Précieux	Iron Fer	Uranium	Other Metals Autres métaux				
Newfoundland Terre-Neuve	9 375	19 585	384	53	1 443	4 210	0	1 150	36 200
Nova Scotia Nouvelle-Écosse	1 036	18 213	35	0	351	828	856	117	21 436
New Brunswick Nouveau-Brunswick	7 447	5 018	0	0	511	278	32	304	13 590
Quebec Québec	47 723	123 729	65	51	4 080	9 363	0	0	185 010
Ontario	48 553	158 705	54	30	175	6 535	0	3 728	217 780
Manitoba	20 336	15 990	0	0	389	16	0	243	36 974
Saskatchewan	10 575	18 875	0	27 733	0	4 269	776	1 064	63 291
Alberta	0	64	0	1 332	0	37	4 738	80	6 250
British Columbia Colombie-Britannique	31 850	146 099	6	0	1 404	1 165	4 701	1 399	186 623
N.W.T. T. N.-O.	4 382	35 162	77	4 411	0	610	0	1 066	45 708
Yukon Territory Yukon	3 026	10 694	0	18	12	1	0	1 315	15 066
CANADA	184 301	552 133	621	33 627	8 366	27 311	11 103	10 465	827 928

1. Exploration activity does not include exploration for extensions to deposits already being mined or committed to production, but includes only the search for new mines.

2. Overhead expenditures include land costs, field administration costs and exploration-related head office expenses.

1. L'activité d'exploration vise seulement la découverte de nouveaux gisements; elle exclut donc le prolongement de gisements déjà en production ou destinés à la production.

2. Les frais généraux incluent les frais d'acquistion des terres, les frais d'administration sur place et les frais d'administration centrale en rapport avec l'exploration.

GENERAL EXPLORATION PLUS MINESITE EXPLORATION[1] SURVEY RESULTS, 1989

RÉSULTATS DE L'ENQUÊTE SUR L'EXPLORATION DE NATURE GÉNÉRALE ET L'EXPLORATION À LA MINE[1], 1989

SOURCE : Federal-Provincial Survey of Mining and Exploration Companies
Relevé fédéral-provincial auprès des sociétés d'exploration et d'exploitation minière

PREPARED BY / ÉTABLI PAR Department of Energy, Mines and Resources of Canada
Ministère de l'Énergie, des Mines et des Ressources du Canada

TABLE 12a / TABLEAU 12a

DISTRIBUTION OF EXPENDITURES BY TYPE OF COMPANY AND BY COMMODITY SOUGHT, NOT INCLUDING OVERHEAD[2] (in thousands of dollars)
RÉPARTITION DES DÉPENSES PAR TYPE DE SOCIÉTÉ ET PAR PRODUIT MINÉRAL CHERCHÉ, SANS FRAIS GÉNÉRAUX[2] (en milliers de dollars)

Type of Company / Type de société	Metals / Métaux					Nonmetals / Non-métaux	Coal / Charbon	Commodity Not Specified / Produit minéral non défini	Total Field Expenditures / Total des dépenses de terrain
	Base / Communs	Precious / Précieux	Iron / Fer	Uranium	Other Metals / Autres métaux				
1. Companies with a producing mine in Canada / Sociétés possédant une mine en production au Canada	102 115	166 495	284	13 243	2 207	5 733	5 595	2 758	298 430
2. Affiliates of (1) / Sociétés affiliées à (1)	24 448	75 774	0	362	655	193	411	3 223	105 066
3. Oil companies / Sociétés pétrolières	1 445	14 368	0	257	130	134	670	0	17 003
4. Foreign companies excluding (3) / Sociétés étrangères, excluant (3)	2 847	18 617	0	11 425	0	2 349	0	0	35 237
5. Junior companies and prospectors / Petites sociétés et prospecteurs	25 296	185 358	215	1 508	4 286	11 488	36	1 872	230 060
6. Others / Autres	7 161	10 014	0	0	14	379	0	127	17 695

1. Exploration activity does not include exploration for extensions to deposits already being mined or committed to production, but includes only the search for new mines.

2. Overhead expenditures include land costs, field administration costs and exploration-related head office expenses.

1. L'activité d'exploration vise seulement la découverte de nouveaux gisements; elle exclut donc le prolongement de gisements déjà en production ou destinés à la production.

2. Les frais généraux incluent les frais d'acquisition des terres, les frais d'administration sur place et les frais d'administration centrale en rapport avec l'exploration.

GENERAL EXPLORATION PLUS MINESITE EXPLORATION[1] SURVEY RESULTS, 1989

RÉSULTATS DE L'ENQUÊTE SUR L'EXPLORATION DE NATURE GÉNÉRALE ET L'EXPLORATION À LA MINE[1], 1989

TABLE 12b / TABLEAU 12b

SOURCE :
Federal-Provincial Survey of Mining and Exploration Companies
Relevé fédéral-provincial auprès des sociétés d'exploration et d'exploitation minière

PREPARED BY / ÉTABLI PAR
Department of Energy, Mines and Resources of Canada
Ministère de l'Énergie, des Mines et des Ressources du Canada

DISTRIBUTION OF EXPENDITURES BY TYPE OF COMPANY AND BY COMMODITY SOUGHT, INCLUDING OVERHEAD[2] (in thousands of dollars)
RÉPARTITION DES DÉPENSES PAR TYPE DE SOCIÉTÉ ET PAR PRODUIT MINÉRAL CHERCHÉ, AVEC FRAIS GÉNÉRAUX[2] (en milliers de dollars)

Type of Company / Type de société	Metals / Métaux					Nonmetals / Non-métaux	Coal / Charbon	Commodity Not Specified / Produit minéral non défini	Total Including Overhead[2] / Total avec frais généraux[2]
	Base / Communs	Precious / Précieux	Iron / Fer	Uranium	Other Metals / Autres métaux				
1. Companies with a producing mine in Canada / Sociétés possédant une mine en production au Canada	109 942	187 580	368	15 485	2 493	7 729	7 853	3 923	335 373
2. Affiliates of (1) / Sociétés affiliées à (1)	29 602	91 392	3	402	804	202	482	4 094	126 982
3. Oil companies / Sociétés pétrolières	1 834	18 764	0	321	130	140	2 669	1	23 859
4. Foreign companies excluding (3) / Sociétés étrangères, excluant (3)	3 748	23 570	0	15 670	0	3 866	15	0	46 870
5. Junior companies and prospectors / Petites sociétés et prospecteurs	30 265	218 152	246	1 749	4 924	14 874	83	2 295	272 589
6. Others / Autres	8 908	12 675	4	0	15	500	0	152	22 254

1. Exploration activity does not include exploration for extensions to deposits already being mined or committed to production, but includes only the search for new mines.

2. Overhead expenditures include land costs, field administration costs and exploration-related head office expenses.

1. L'activité d'exploration vise seulement la découverte de nouveaux gisements; elle exclut donc le prolongement de gisements déjà en production ou destinés à la production.

2. Les frais généraux incluent les frais d'acquisition des terres, les frais d'administration sur place et les frais d'administration centrale en rapport avec l'exploration.

GENERAL EXPLORATION PLUS MINESITE EXPLORATION[1] SURVEY RESULTS, 1989

RÉSULTATS DE L'ENQUÊTE SUR L'EXPLORATION DE NATURE GÉNÉRALE ET L'EXPLORATION À LA MINE[1], 1989

TABLE 13 / TABLEAU 13

SOURCE :
Federal-Provincial Survey of Mining and Exploration Companies
Relevé fédéral-provincial auprès des sociétés d'exploration et d'exploitation minière

PREPARED BY / ÉTABLI PAR
Department of Energy, Mines and Resources of Canada
Ministère de l'Énergie, des Mines et des Ressources du Canada

DISTRIBUTION OF SURFACE AND UNDERGROUND DRILLING BY COMMODITY SOUGHT (in thousands of metres)
RÉPARTITION DU FORAGE DE SURFACE ET SOUTERRAIN PAR PRODUIT MINÉRAL CHERCHÉ (en milliers de mètres)

Province	Metals / Métaux					Nonmetals Non-métaux	Coal Charbon	Total
	Base Communs	Precious Précieux	Iron Fer	Uranium	Other Metals Autres métaux			
Newfoundland Terre-Neuve	43	60	0	0	0	2	0	105
Nova Scotia Nouvelle-Écosse	5	24	0	0	2	1	2	33
New Brunswick Nouveau-Brunswick	28	16	0	0	3	1	1	48
Quebec Québec	311	743	0	0	6	40	0	1 100
Ontario	290	898	0	0	2	24	0	1 213
Manitoba	142	71	0	0	4	0	0	217
Saskatchewan	63	86	0	153	0	7	9	317
Alberta	0	0	0	4	0	1	108	113
British Columbia Colombie-Britannique	132	693	0	0	5	2	11	844
N.W.T. T. N.-O.	23	172	0	8	0	0	0	203
Yukon Territory Yukon	15	28	0	0	0	0	0	42
CANADA	1 051	2 790	0	164	22	79	130	4 236

1. Exploration activity does not include exploration for extensions to deposits already being mined or committed to production, but includes only the search for new mines.

1. L'activité d'exploration vise seulement la découverte de nouveaux gisements; elle exclut donc le prolongement de gisements déjà en production ou destinés à la production.

GENERAL EXPLORATION PLUS MINESITE EXPLORATION[1] SURVEY RESULTS, 1989

RÉSULTATS DE L'ENQUÊTE SUR L'EXPLORATION DE NATURE GÉNÉRALE ET L'EXPLORATION À LA MINE[1], 1989

TABLE 14 / TABLEAU 14

SOURCE :
Federal-Provincial Survey of Mining and Exploration Companies
Relevé fédéral-provincial auprès des sociétés d'exploration et d'exploitation minière

PREPARED BY / ÉTABLI PAR
Department of Energy, Mines and Resources of Canada
Ministère de l'Énergie, des Mines et des Ressources du Canada

DISTRIBUTION OF SURFACE AND UNDERGROUND DRILLING BY TYPE OF COMPANY AND BY COMMODITY SOUGHT (in thousands of metres)
RÉPARTITION DU FORAGE DE SURFACE ET SOUTERRAIN PAR TYPE DE SOCIÉTÉ ET PAR PRODUIT MINÉRAL CHERCHÉ (en milliers de mètres)

Type of Company / Type de société	Metals / Métaux					Nonmetals / Non-métaux	Coal / Charbon	Total
	Base / Communs	Precious / Précieux	Iron / Fer	Uranium	Other Metals / Autres métaux			
1. Companies with a producing mine in Canada / Sociétés possédant une mine en production au Canada	684	1 204	0	98	10	23	113	2 133
2. Affiliates of (1) / Sociétés affiliées à (1)	165	462	0	1	3	0	17	648
3. Oil companies / Sociétés pétrolières	7	65	0	1	0	0	0	73
4. Foreign companies excluding (3) / Sociétés étrangères, excluant (3)	31	118	0	57	0	3	0	209
5. Junior companies and prospectors / Petites sociétés et prospecteurs	135	889	0	6	10	50	0	1 091
6. Others / Autres	27	54	0	0	0	2	0	84

1. Exploration activity does not include exploration for extensions to deposits already being mined or committed to production, but includes only the search for new mines.

1. L'activité d'exploration vise seulement la découverte de nouveaux gisements; elle exclut donc le prolongement de gisements déjà en production ou destinés à la production.

GENERAL EXPLORATION PLUS MINESITE EXPLORATION[1] SURVEY RESULTS, 1989

RÉSULTATS DE L'ENQUÊTE SUR L'EXPLORATION DE NATURE GÉNÉRALE ET L'EXPLORATION À LA MINE[1], 1989

TABLE 15a / TABLEAU 15a

SOURCE : Federal-Provincial Survey of Mining and Exploration Companies
Relevé fédéral-provincial auprès des sociétés d'exploration et d'exploitation minière

PREPARED BY / ÉTABLI PAR
Department of Energy, Mines and Resources of Canada
Ministère de l'Énergie, des Mines et des Ressources du Canada

PROVINCIAL DISTRIBUTION OF EXPENDITURES BY TYPE OF COMPANY, NOT INCLUDING OVERHEAD[2] (in thousands of dollars)
RÉPARTITION PROVINCIALE DES DÉPENSES PAR TYPE DE SOCIÉTÉ, SANS FRAIS GÉNÉRAUX[2] (en milliers de dollars)

Province	(1) Companies With a Producing Mine in Canada / Sociétés possédant une mine en production au Canada	(2) Affiliates of (1) / Sociétés affiliées à (1)	(3) Oil Companies / Sociétés pétrolières	(4) Foreign Companies Excluding (3) / Sociétés étrangères, excluant (3)	(5) Junior Companies and Prospectors / Petites sociétés et prospecteurs	(6) Others / Autres	Total Field Expenditures / Total des dépenses de terrain
Newfoundland / Terre-Neuve	5 488	10 198	1 464	136	11 233	0	28 519
Nova Scotia / Nouvelle-Écosse	1 223	2 574	0	2 111	11 790	18	17 715
New Brunswick / Nouveau-Brunswick	4 122	2 512	0	71	4 349	139	11 193
Quebec / Québec	81 871	15 507	285	5 796	52 482	9 857	165 798
Ontario	84 244	36 597	3 539	7 836	51 119	2 012	185 348
Manitoba	14 973	13 801	9	354	2 564	586	32 286
Saskatchewan	31 466	2 009	2 201	9 622	10 226	0	55 523
Alberta	3 743	411	0	0	111	0	4 265
British Columbia / Colombie-Britannique	52 065	15 281	5 742	5 125	66 883	4 636	149 732
N.W.T. / T. N.-O.	15 202	3 558	1 100	4 163	15 457	138	39 617
Yukon Territory / Yukon	4 034	2 618	2 664	23	3 847	310	13 496
CANADA	298 430	105 066	17 003	35 237	230 060	17 695	703 491

1. Exploration activity does not include exploration for extensions to deposits already being mined or committed to production, but includes only the search for new mines.

2. Overhead expenditures include land costs, field administration costs and exploration-related head office expenses.

1. L'activité d'exploration vise seulement la découverte de nouveaux gisements; elle exclut donc le prolongement de gisements déjà en production ou destinés à la production.

2. Les frais généraux incluent les frais d'acquisition des terres, les frais d'administration sur place et les frais d'administration centrale en rapport avec l'exploration.

GENERAL EXPLORATION PLUS MINESITE EXPLORATION[1] SURVEY RESULTS, 1989

RÉSULTATS DE L'ENQUÊTE SUR L'EXPLORATION DE NATURE GÉNÉRALE ET L'EXPLORATION À LA MINE[1], 1989

TABLE 15b / TABLEAU 15b

SOURCE :
Federal-Provincial Survey of Mining and Exploration Companies
Relevé fédéral-provincial auprès des sociétés d'exploration et d'exploitation minière

PREPARED BY / ÉTABLI PAR
Department of Energy, Mines and Resources of Canada
Ministère de l'Énergie, des Mines et des Ressources du Canada

PROVINCIAL DISTRIBUTION OF EXPENDITURES BY TYPE OF COMPANY, INCLUDING OVERHEAD[2] (in thousands of dollars)
RÉPARTITION PROVINCIALE DES DÉPENSES PAR TYPE DE SOCIÉTÉ, AVEC FRAIS GÉNÉRAUX[2] (en milliers de dollars)

Province	(1) Companies with a Producing Mine in Canada Sociétés possédant une mine en production au Canada	(2) Affiliates of (1) Sociétés affiliées à (1)	(3) Oil Companies Sociétés pétrolières	(4) Foreign Companies Excluding (3) Sociétés étrangères, excluant (3)	(5) Junior Companies and Prospectors Petites sociétés et prospecteurs	(6) Others Autres	Total Including Overhead[2] Total avec frais généraux[2]
Newfoundland Terre-Neuve	6 713	11 940	1 930	164	15 453	0	36 200
Nova Scotia Nouvelle-Écosse	2 324	3 093	7	2 328	13 658	26	21 436
New Brunswick Nouveau-Brunswick	4 771	2 977	0	79	5 613	152	13 590
Quebec Québec	89 042	18 056	310	6 741	58 471	12 388	185 010
Ontario	92 029	48 541	5 539	10 437	58 641	2 593	217 780
Manitoba	18 139	14 899	9	454	2 841	632	36 974
Saskatchewan	34 236	2 250	2 270	13 200	11 335	0	63 291
Alberta	5 391	482	235	0	142	0	6 250
British Columbia Colombie-Britannique	61 992	17 727	8 751	7 687	84 520	5 946	186 623
N.W.T. T. N.-O.	16 243	4 200	1 845	5 748	17 489	182	45 708
Yukon Territory Yukon	4 493	2 816	2 963	32	4 426	336	15 066
CANADA	335 373	126 982	23 859	46 870	272 589	22 254	827 928

1. Exploration activity does not include exploration for extensions to deposits already being mined or committed to production, but includes only the search for new mines.

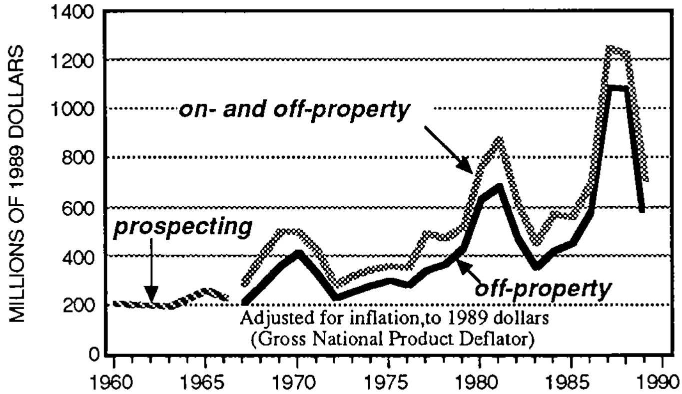
2. Overhead expenditures include land costs, field administration costs and exploration-related head office expenses.

1. L'activité d'exploration vise seulement la découverte de nouveaux gisements; elle exclut donc le prolongement de gisements déjà en production ou destinés à la production.

2. Les frais généraux incluent les frais d'acquisition des terres, les frais d'administration sur place et les frais d'administration centrale en rapport avec l'exploration.

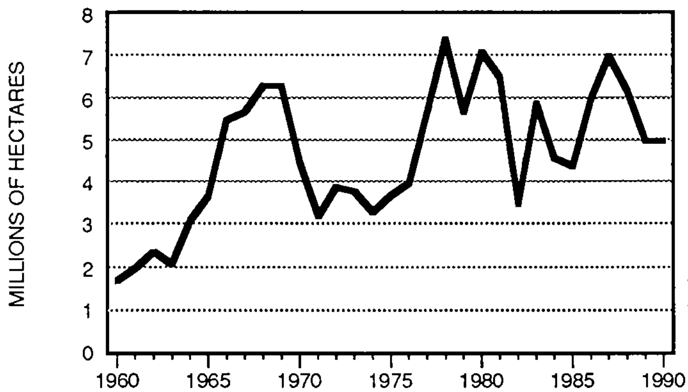
Figure 1

SELECTED MEASURES OF EXPLORATION ACTIVITY



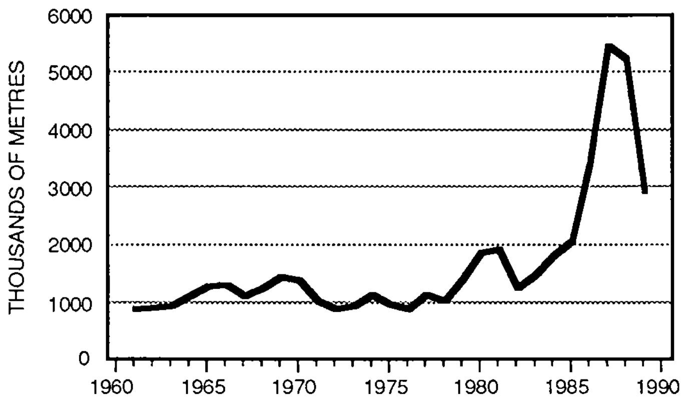
(a)
FIELD EXPENDITURES ON MINERAL EXPLORATION (All minerals except oil and gas)

Sources: 1967-89 Statistics Canada's Annual Survey of Exploration Development, Capital and Repair Expenditures (Catalogue 61-216) and Federal-Provincial Exploration Survey. 1960-66 Statistics Canada and EMR "Cost of Prospecting".



(b)
AREA OF MINING CLAIMS AND CLAIM BLOCKS RECORDED

Sources: Gathered by EMR from Provincial and Territorial Mining Recorders.



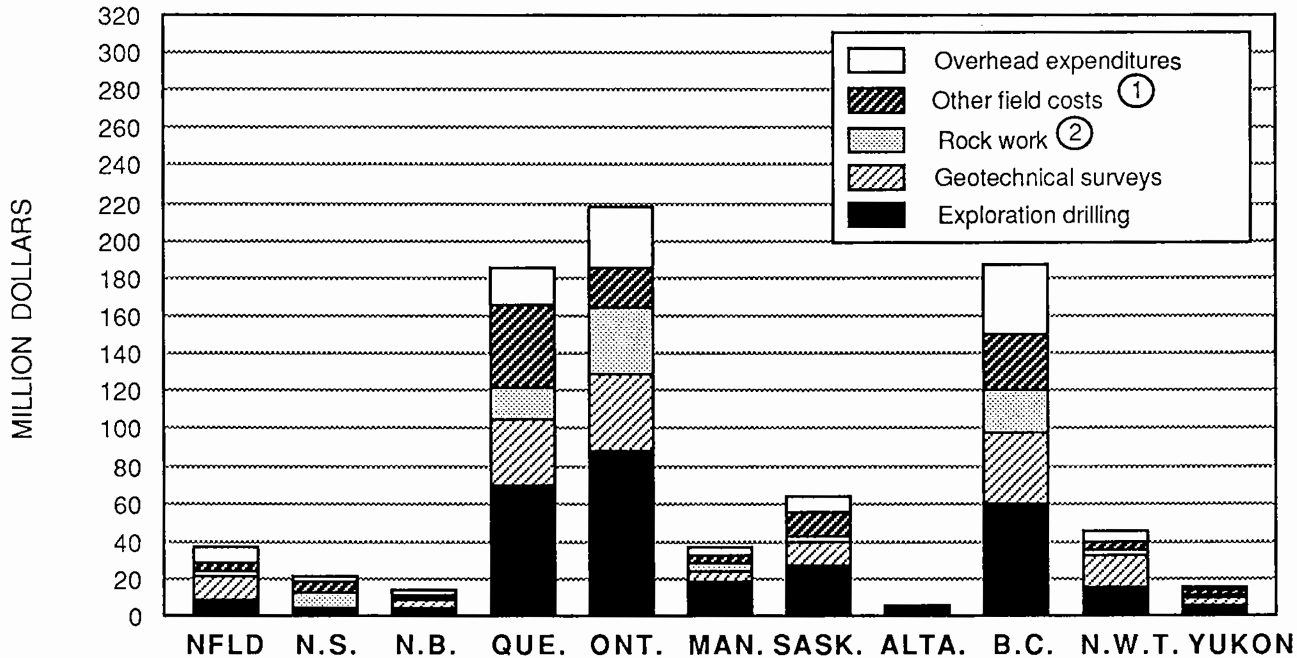
(c)
SURFACE DIAMOND DRILLING (All minerals except oil and gas)

Sources: Statistics Canada's (Catalogue 26-201) and Federal-Provincial Exploration Survey.

Figure 2

FIELD EXPLORATION EXPENDITURES BY PROVINCE AND TERRITORY - 1989

Physical Work and Surveys



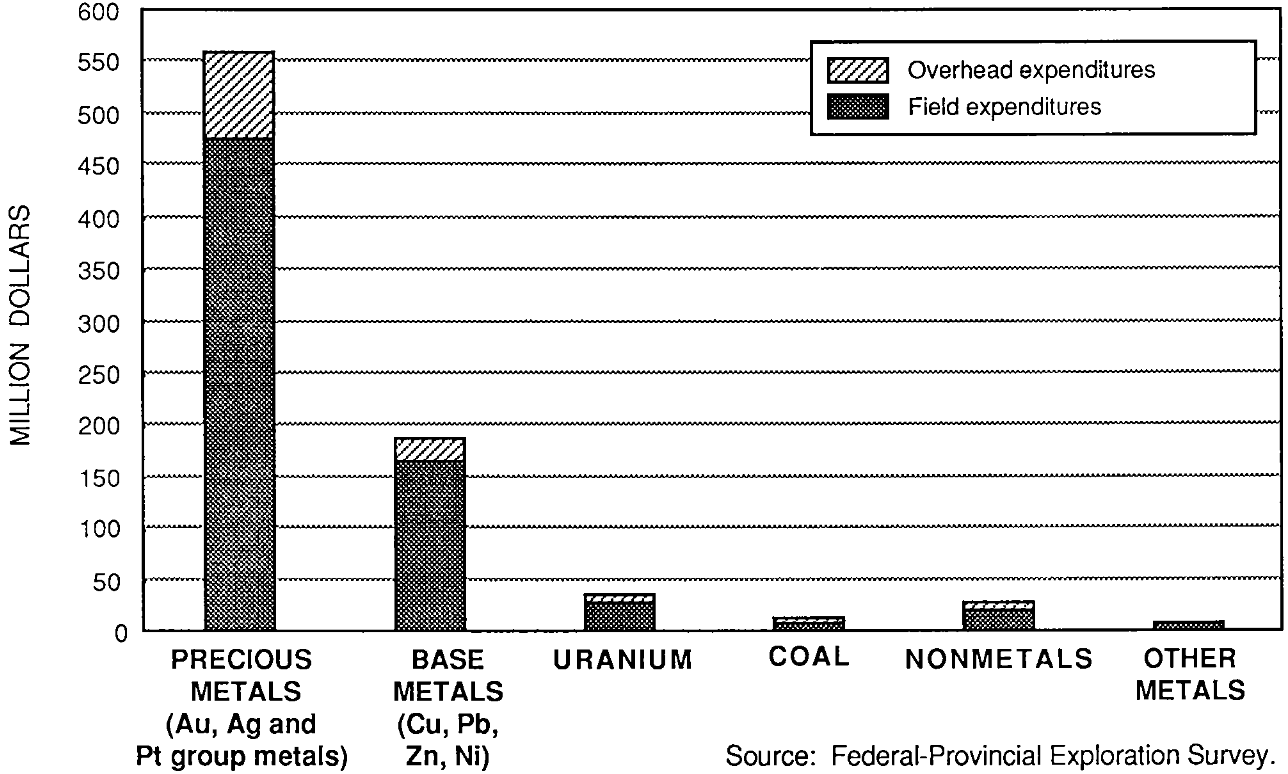
(1) Such as Field Supervision and Line Cutting.

(2) Such as Stripping, Trenching, Shaft-Sinking and Underground Work.

Source: Federal-Provincial Exploration Survey.

Figure 3

EXPLORATION EXPENDITURES BY COMMODITY SOUGHT - 1989 (1)

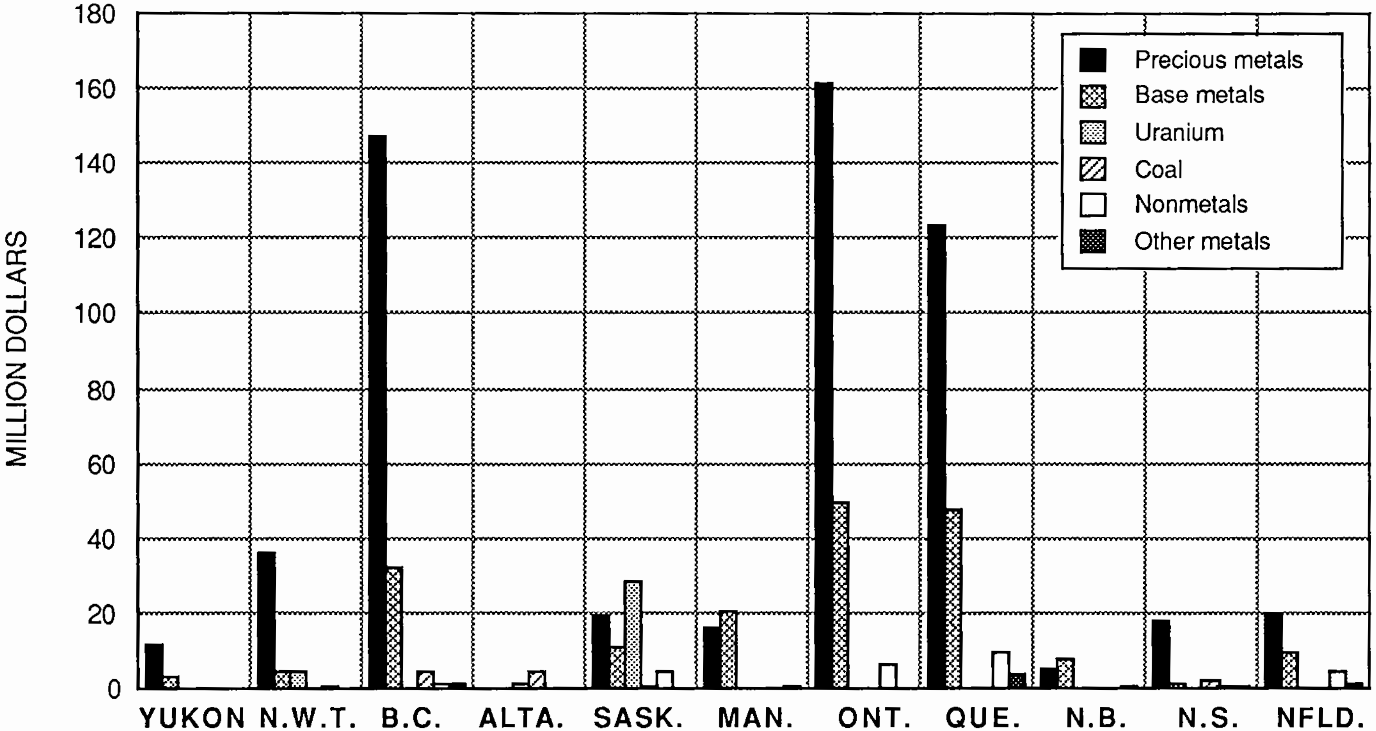


Source: Federal-Provincial Exploration Survey.

(1) Some $10.5 million of exploration expenditures were for unspecified commodities. This amount has been pro-rated among the six commodity groups shown here.

Figure 4

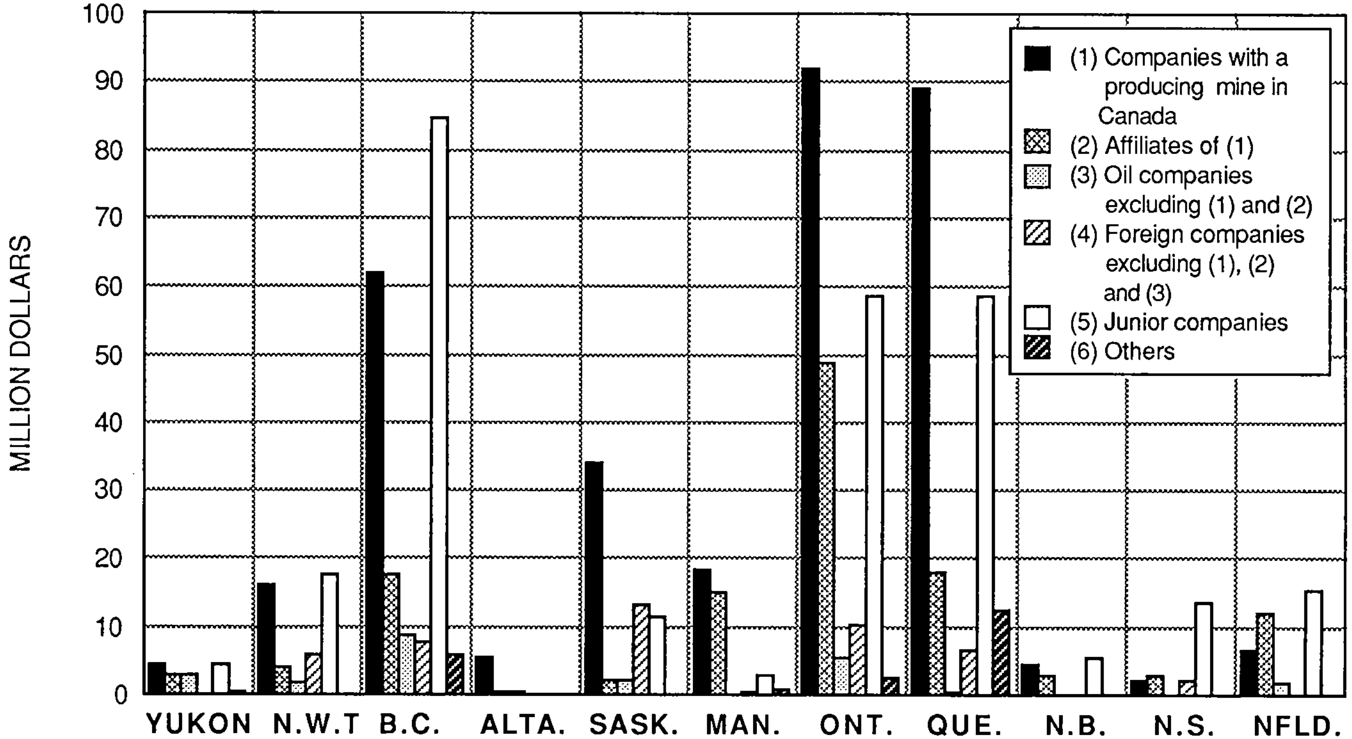
REGIONAL EXPLORATION EXPENDITURES BY COMMODITY SOUGHT - 1989



Source: Federal-Provincial Exploration Survey.

Figure 5

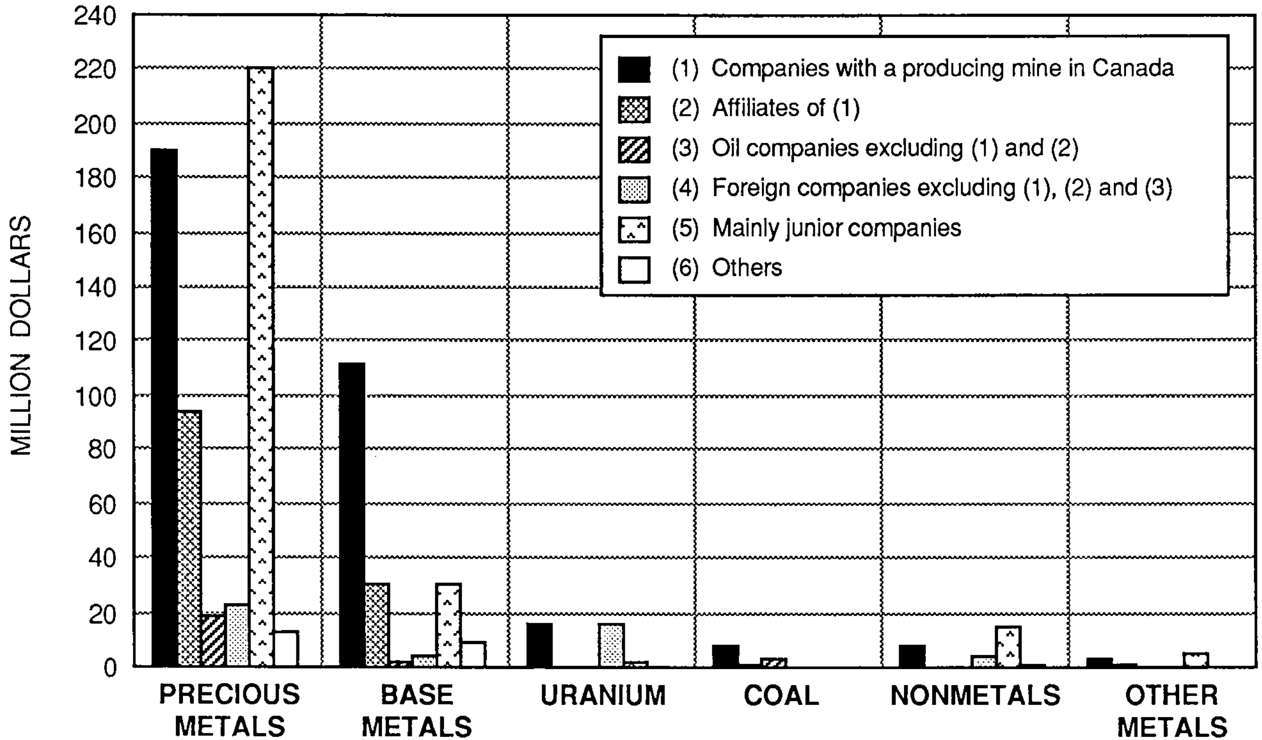
REGIONAL EXPLORATION EXPENDITURES BY TYPE OF COMPANY - 1989



Source: Federal-Provincial Exploration Survey.

Figure 6

EXPLORATION EXPENDITURES BY TYPE OF COMPANY AND COMMODITIY - 1989 (1)

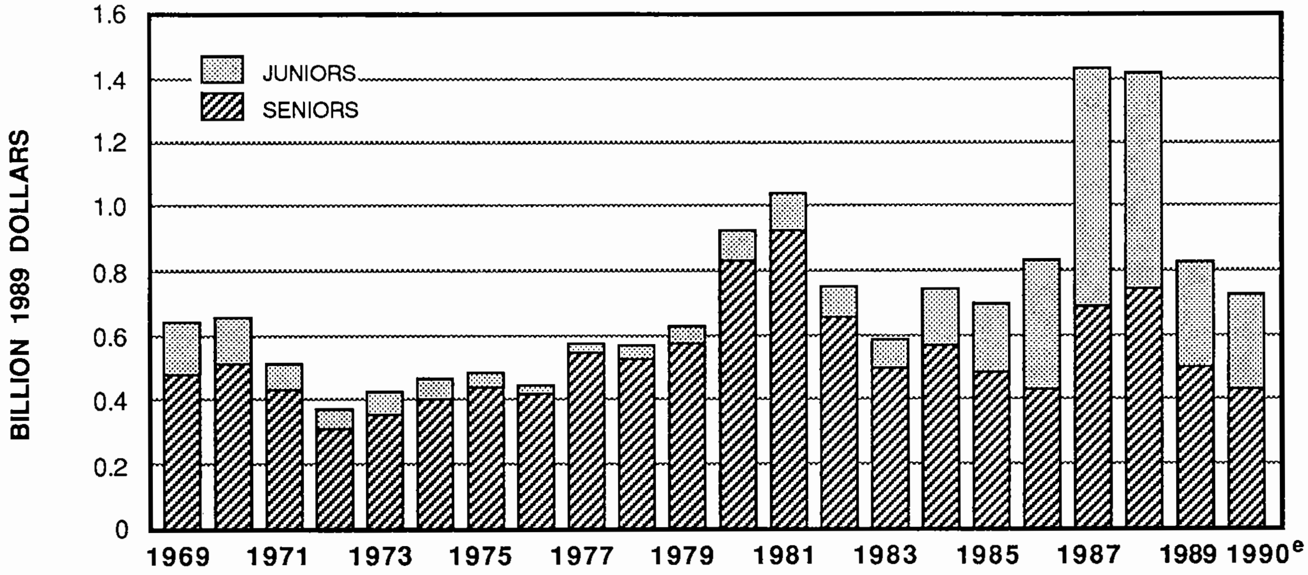


Source: Federal-Provincial Exploration Survey.

(1) Some $10.5 million of exploration expenditures were for unspecified commodities. This amount has been pro-rated among the six commodity groups shown here.

Figure 7

TOTAL EXPLORATION EXPENDITURES BY JUNIOR AND SENIOR COMPANIES 1969-90



Total exploration expenditures for 1975 to 1981 are overstated by an average of about 17% relative to earlier and later years because of different methodologies used by Statistics Canada for those years.
Expenditures include overhead and were adjusted using the GDP Implicit Price Index.

e EMR estimate indicates expected total expenditures of about $750 million 1990 dollars and expected junior company expenditures of about $300 million 1990 dollars. These estimates have been converted to 1989 dollars on the graph.

Sources: Statistics Canada and EMR.

Aluminum

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Despite the economic slowdown in North America in the second half of 1990, world aluminum demand remained relatively strong. While aluminum prices staged a modest recovery in the second half of the year, prices had eased by year-end. The weakness of prices, particularly at the end of 1990, was due in part to anticipated increases in aluminum inventory levels.

With the completion of two greenfield smelter projects as well as major expansions at two existing smelters, Canada's relative importance in world aluminum production will increase dramatically over the next several years. Together with other capacity which came on stream in the 1980s or will be added in the late 1990s, as part of a continuing modernization program, Canada will also possess one of the most modern aluminum industries by the year 2000.

CANADIAN DEVELOPMENTS

Canadian production of primary aluminum in 1990 was 1.567 Mt compared to 1.555 Mt in 1989. At the end of 1990, Canadian primary aluminum smelters were operating at or above their nameplate capacity of about 1.635 Mt. Exports of primary smelter products from Canada during the first nine months of 1990 were 944 400 t, compared to 874 600 t for the same period in 1989. Exports to the United States totalled 660 500 t compared to 608 200 t for the same period in 1989.

In November, Alcan Aluminium Limited (Alcan) commenced the start-up of phase III of its new 200 000 t/y Laterrière smelter, with the start-up of phase IV expected to be completed by the end of February 1991. Alcan also began the permanent closure of three Söderberg potlines at its Arvida smelter in Jonquière, which will lower capacity at that plant to about 230 000 t/y. This capacity will be further reduced to 140 000 t/y when the four remaining Söderberg potlines at Arvida are replaced by the company's proposed new smelter at Alma, which will likely be built in the late 1990s.

The $800 million Laterrière project incorporates pollution control technology which will capture more than 99% of the dust particles and fluorides in process gases. For the Saguenay-Lac-St-Jean region, the start-up of the new smelter and the permanent closure of an equal amount of old Söderberg capacity will reduce emissions of polycyclic aromatic hydrocarbons (PAH) by 60% and fluoride emissions by 50%.

In July, workers at Alcan's Kitimat aluminum smelter in British Columbia staged a three-day strike after rejecting a tentative agreement. While non-union staff continued to operate the plant during the work stoppage, a small amount of production was lost when management was forced to start the shutdown of one potline.

Alcan announced that it would reduce capital spending in 1991, but would still provide $200 million for further work on its $1 billion Kemano hydroelectric project in British Columbia. When completed in 1994, the company's hydroelectric capacity at Kemano will increase from 896 megawatts (MW) to 1436 MW. The company has stated that until such time as market and financial conditions warrant the construction of additional smelting capacity in British Columbia, it will sell surplus Kemano power to the British Columbia Hydro Power Authority.

During 1990, Alcan commenced production of DURALCAN aluminum composite material at its new Dubuc plant in Jonquière. DURALCAN composites are metal matrix composites made of aluminum and ceramic materials. The plant, which cost $36 million, will produce foundry ingot, wrought extrusion billet and sheet ingot. The capacity of this facility will be about 11 000 t/y.

Aluminum

Alcan announced in July that it had completed the acquisition of collection and processing units for aluminum used beverage cans (UBCs) in Quebec and Ontario. This includes Reliable Recycling Inc. and the assets of UBC Recycling Inc. in Ontario, plus the assets of R. Johnson Management Services Ltd. and Camco Recycling Services Ltd. in Quebec. With these facilities and those acquired earlier in the year by the purchase of the UBC recycling operation of Pacific Metals Limited in British Columbia, Alcan's recycling capacity in Canada totals 28 000 t/y or 2 billion containers, making it the largest collector and UBC processor in the country.

At the end of December, Canadian Reynolds Metals Company, Limited (Canadian Reynolds) began the start-up of its new 120 000 t/y potline at its Baie Comeau smelter in Quebec. The company expects that the new capacity will be fully operational in May 1991, significantly earlier than originally anticipated. When the project is completed, the capacity of the Baie Comeau plant will increase to 400 000 t/y.

In July, Canadian Reynolds began construction of a new $49 million redraw rod plant at Bécancour, Quebec. It is expected that production at the facility will begin at the end of 1991, with completion of the 80 000 t/y capacity plant in mid-1992.

Reynolds Metals Company announced in October that it had agreed to acquire a 75% interest in an aluminum wheel plant in Collingwood, Ontario, from Lemmerz Canada, Inc. Lemmerz will retain a 25% ownership share of the two-year-old plant, which has an annual capacity of one million wheels.

Reynolds Metals Company had previously indicated that it intended to build its own wheel plant at Louiseville, Quebec. However, when anticipated orders to support the construction of a new facility were not forthcoming, the company decided instead to purchase an interest in the existing Collingwood plant, which would allow Reynolds Metals Company to immediately respond to new wheel business.

On October 29, Aluminerie de Bécancour Inc. (A.B.I.) commenced the start-up of its new third potline at its Bécancour smelter. It is expected that the line will be fully on stream in the spring of 1991. With the completion of the new line, capacity at the smelter will increase from 240 000 t/y to 360 000 t/y. A.B.I. is owned by Pechiney Reynolds Québec, Inc. (a subsidiary of Pechiney Corporation and Reynolds Metals Company), Alumax Inc. and Société générale de financement du Québec.

Faced with significant cost overruns, the principals of the Aluminerie Alouette Inc. consortium, including Vereinigte Aluminium-Werke AG (VAW), Austria Metall Aktiengesellschaft, Hoogovens Groep BV, Société générale de financement du Québec, Kobe Steel, Ltd. and Marubeni Corp., were forced to re-evaluate the smelter project at Sept-Îles, Quebec. While the consortium decided at the end of July to continue with the project, it introduced various modifications to the plant in order to keep costs at an acceptable level. This included the decision to alter the technology used for the anode baking furnace, as well as to produce 50-lb remelt ingots only, as opposed to sheet metal ingots, extrusion ingots and wirebars. Even with the changes, the cost of the 215 000 t/y smelter is expected to increase to $1.4 billion from an original estimate of $1.25 billion.

It is now expected that Alouette will come on stream in June 1992, two months later than originally scheduled. At the end of 1990, the project was well under way with approximately 30% of construction having been completed.

During 1990, Aluminerie Lauralco, Inc. (owned by Alumax Inc. of the United States) began construction of its new 215 000 t/y aluminum smelter at Deschambault, Quebec, 60 km west of Quebec City. The company expects that the $1 billion plant will be fully on stream in mid-1992. After plans to build alumina unloading facilities in Quebec City ran into stiff opposition from local residents, Lauralco confirmed at the end of the year that it would utilize existing port facilities at Trois-Rivières during the first five years of operation.

In November, the five existing and prospective aluminum producers in Quebec, including Alcan Aluminium Limited, Aluminerie Alouette Inc., Aluminerie de Bécancour Inc., Aluminerie Lauralco, Inc. and Canadian Reynolds Metals Company Limited, announced the creation of the Quebec Aluminum Association. The role of the Association will be to provide information to the public, to promote among member companies the solutions to common problems by research in fields of a non-competitive nature, and to make representations to governments in the drafting of policies dealing with the aluminum industry.

WORLD DEVELOPMENTS

Western World primary aluminum production (including Yugoslavia) in 1990 was estimated at 14.43 Mt compared to 14.47 Mt in 1989. According to the International Primary Aluminium Institute (IPAI), Western World primary aluminum smelting capacity (excluding Yugoslavia), which was 14.733 Mt in December 1990, is expected to reach 15.083 Mt at the end of 1991 and 16.208 Mt at the end of 1993. The IPAI also reported that average daily production of aluminum in January 1991 was 39 700 t, compared to 39 800 t in December 1990 and 38 500 t in January 1990.

According to press reports of a study by Anthony Bird Associates, the average aluminum production costs in mid-1990 for market economy countries was US64¢/lb compared to 61¢ in 1989. The study attributed higher alumina costs as the principal reason for the increase. On an individual country basis, Venezuela had the lowest cost at 47¢, followed by Canada at 53¢, Australia at 58¢ and the United States at 67¢, while Spain, Germany and Italy had costs between 73¢ and 75¢/lb.

United States

With one exception, U.S. primary smelters were operating at full capacity at the end of 1990. In June, Ravenswood Aluminum Corp. was forced to close a 41 000 t/y potline at its West Virginia smelter due to the shortage of skilled potroom workers and labour problems. At the time of the closure, the Ravenswood smelter was operating at about 75% of its 165 000 t/y capacity. At the beginning of November, the company instituted a lock-out of its employees, although production continued at the existing level using salaried and temporary personnel. Despite the continuing labour problems at the plant, Ravenswood restarted one of the two idled potlines in the first quarter of 1991 and stated that it was considering the re-opening of the last potline as well.

In March 1990, Ormet Corp. closed a 37 000 t/y potline at its Hannibal, Ohio, smelter due to labour problems. Following the ratification of a new labour agreement, the company restarted this potline in August.

In June, the Aluminum Company of America (Alcoa) restarted a 42 000 t/y potline at its Wenatchee, Washington smelter, which had been closed since August 1989. Also in 1990, Alcoa completed the closure of its bauxite mining and refining operations in Arkansas. The closure was attributed to a lack of bauxite reserves.

Hydro Aluminium a.s. announced in July that it had agreed to acquire Bohn Aluminum and Brass Division from Wickes Mfg. Co. Bohn Aluminum is the market leader for extruded aluminum tubes for automotive heat transfer applications. Also in July, Alcan Aluminium Corporation purchased Alumax Aluminum Corporation's building specialties division. This consists of fabrication and distribution facilities at seven locations in the United States.

During 1990, Crown Cork & Seal Co., Inc. purchased the U.S. beverage and food can manufacturing operations of Continental Can Co. Inc. Crown Cork had purchased the assets of Continental Can Canada Inc. in 1989.

Alcan continued with its program to strengthen the company's position as a quality and technology leader in the market for rolled aluminum products in the United States. During 1990, the company completed a new US$75 million foil mill at Terre Haute, Indiana, and continued with a US$135 million project at Oswego, New York, that will upgrade the hot rolling line and include state-of-the-art melting and casting operations. At Logan Aluminum Inc., a company jointly owned with Atlantic Richfield Company (ARCO), Alcan is participating in a $255 million expansion of cold rolling facilities.

Aluminum

In April, the 635 000 t/y alumina refinery of Virgin Islands Alumina Inc. was restarted. The plant, which had been operated by Martin Marietta Corporation, had been closed since 1985.

Jamaica

Alcan completed a prefeasibility study in 1990 for a new alumina refinery on Jamaica's northwest coast. It was reported that Kaiser Aluminum & Chemical Corporation, Hydro Aluminium a.s. and the Jamaican government had signed an agreement in principle covering an expansion of the Alpart alumina refinery from 1 Mt/y to as much as 2 Mt/y.

South America

Despite the long list of companies which had previously announced plans for new primary aluminum smelting capacity in Venezuela, little progress was achieved during 1990 in furthering any of these projects. However, in March 1991, it was reported that the Venezuelan government had awarded a US$1.24 billion contract to a consortium comprised of Alcoa, Corporacion Venezolana de Guayana (CVG) and Sural CA for the construction of a new 230 000 t/y smelter.

In Guyana, Alcan Aluminium Limited submitted a proposal to the government for the establishment of a bauxite joint venture. The bauxite industry in Guyana has experienced significant problems since it was nationalized in the early 1970s. Until this nationalization, Alcan had extensive holdings in the area near Linden. Also in Guyana, it was reported that Aroaima Mining Co., a joint venture between the Government of Guyana and Reynolds Metals Company, would begin bauxite shipments in 1991 from a new bauxite mine.

In Surinam, the Suriname Aluminum Company (Suralco), a subsidiary of Alcoa, was forced to close its Moengo bauxite mine in May because of fighting between the government and rebels. The mine was recaptured by government forces in June, but not before rebels had destroyed the company's offices and loading facilities. Shipments of bauxite resumed on July 7, 1990.

In Brazil, Consorcio Alumar SA completed a 96 000 t/y expansion to its existing smelter in January 1991, bringing the capacity of the plant to 350 000 t/y. Alumar is owned by Alcoa Aluminio S.A. (56%) and Billiton Metais SA (44%). Also in January 1991, the Brazilian government approved a US$450 million expansion of Alumar's alumina refinery that will increase capacity from less than 1 Mt/y to 2.1 Mt/y. It is expected that the additional output from the refinery will be exported. The feed for this incremental capacity at the alumina plant is expected to come from a new mine being developed by Billiton and Alcoa in the Amazon state of Para. Also in Brazil, work continued on an expansion to the Aluminio Brasileiro SA (Albras) smelter, which will increase capacity from 160 000 t/y to 320 000 t/y in 1991 and to 350 000 t/y by 1993/94. The smelter is owned by Companhia Vale do Rio Doce (CVRD) (51%) and Nippon Amazon Aluminum Co. (NAAC) (49%). Another joint-venture project between CVRD and NAAC is the Alunorte alumina refinery which was suspended in 1986. While it has been reported that CVRD is ready to resume construction of the project, NAAC has stated that it will participate only if Brazil reaches an accord with the International Monetary Fund with regard to the country's foreign debt problems.

In Chile, it was reported that Projectos de Aysen SA would undertake a feasibility study for a new 200 000 t/y aluminum smelter in the southern part of the country. Construction of the plant could begin in 1992.

Australia

During 1989, Comalco Limited announced that it was contemplating an expansion at the Boyne Island smelter that would increase capacity to 400 000 t/y. However, the company later reported that it was shelving plans for the expansion due to a failure to reach agreement with the Queensland government for the purchase of the coal-fired power plant that serves the smelter.

Alcoa of Australia Limited (AA) began construction on a second stage at its Wagerup alumina refinery in Western Australia. The US$300 million project will increase alumina capacity from 850 000 t/y to 1.48 Mt/y by 1993.

Elsewhere in Australia, the Government of the Northern Territory granted Swiss Aluminium Australia Ltd. and Gove Aluminium Ltd. permission to export an additional 40 Mt of bauxite from their Gove Joint Venture operation within the next 20 years. During 1990, the partners also announced that they would undertake a modernization of their alumina plant and increase capacity from 1.45 Mt to 1.6 Mt/y.

Alcan and Comalco announced in November that they would undertake a feasibility study for a new 1 Mt/y alumina refinery in North Queensland.

Asia

In Japan, Sumitomo Light Metals Industries Ltd. announced that it would increase its aluminum sheet capacity at its Nagoya works by 6000 t/m to 24 000 t/m by the end of 1992. Also in Japan, Mitsubishi Metal Corporation commissioned a new aluminum can-making plant in April. Annual capacity of the plant is estimated at approximately 450 million cans. This facility, which is located at Yuki in Ibaragi prefecture, will increase Mitsubishi's annual can-making capacity to 3.2 billion units. In December, it was reported that Nippon Light Metal Company, Ltd. (NLM) would begin to produce aluminum wheels at its Tomakomai casting plant by December 1991. The wheel capacity of this facility is expected to be about 45 000 units/month. In addition, NLM will increase the capacity of its Kambara mill from 75 000 units/month to 120 000 units/month by April 1991. It was also reported that NLM would build a new secondary aluminum facility at Fukushima, north of Tokyo. The plant, which will have a capacity of about 36 000 t/y, is expected to come on stream in 1992.

During 1990, work continued on Aluminium of Korea Ltd.'s new US$350 million rolling mill at Ulsan. The mill, which will have a capacity of about 100 000 t/y, is expected to reach full production in 1994. Ingot feed for the mill will be imported. Production at South Korea's only existing smelter, which has a capacity of 20 000 t/y, was suspended in March due to high operating costs.

The People's Republic of China was reported to have produced 770 000 t of aluminum in the first 11 months of 1990, a 14% increase over the same period in 1989. It was also reported that the second phase of the Qinghai aluminum smelter was under construction. This expansion is expected to increase the plant's capacity to 200 000 t/y by 1993. At the end of 1990, it was reported that Kuwait would provide China with a loan to finance the construction of an aluminum foil plant in the southwestern city of Chengdu. The plant is expected to produce 6000 t/y of aluminum plate and 6000 t/y of aluminum foil.

In Indonesia, it was reported that PT Inalum would produce only 180 000 t of aluminum in its fiscal year ending March 1991 due to light rainfall and hydro-electric power shortages. The smelter has a capacity of 225 000 t/y of primary aluminum. Elsewhere in southeast Asia, it was reported that Hydro Aluminium a.s. was considering the construction of a new aluminum smelter in Sarawak, Malaysia. The plant would have an initial capacity of 120 000 t/y.

In India, National Aluminium Co. Ltd. (Nalco) was forced to reduce output in March at its Angul smelter after a fire damaged a power plant. The company planned to resume full operation by the end of the second quarter. In order to improve the reliability of power supplies to their aluminum smelters, both Nalco and Hindalco Industries Ltd. announced plans in 1990 to construct captive power plants.

During 1990, work continued on the expansion of Aluminium Bahrain's Alba smelter in Bahrain, despite the Gulf crisis. The US$1.45 billion project, which includes the addition of a fourth potline, will increase capacity from 230 000 t/y to 460 000 t/y by 1994. Aluminium Bahrain is 75% owned by the state of Bahrain, with the remainder held by the Kingdom of Saudi Arabia and Breton Investments of Germany. Elsewhere in the Gulf region, an expansion at Dubai Aluminium Company Limited (Dubal), which will increase capacity from 170 000 t/y to 240 000 t/y, is expected to be completed by March 1991.

In August, Pechiney of France announced that it had cancelled a contract for the technology and design of a new 215 000 t/y smelter in Iraq. This action was taken in accordance with a European Communities (EC) directive issued after the Iraqi invasion of Kuwait. The war in the Persian Gulf was reported to have also delayed the start of aluminum smelter projects that were announced in 1989 for Saudi Arabia and Qatar.

In September, Turkey and the U.S.S.R. signed a protocol regarding cooperation in the aluminum industry. One project under consideration is the modernization of Turkey's only existing smelter in Anatolia. Plans for a greenfield smelter were also reported to have been deferred because of the Gulf war.

Africa

In November, it was reported that Reynolds Metals Company of the United States and Ferrostaal AG of Germany would participate in the new 180 000 t/y ALSCON aluminum smelter project being planned for Nigeria. The Nigerian government would be the majority shareholder. The project, which could come on stream in 1993, would take advantage of Nigeria's abundant reserves of natural gas.

Europe

In October, Alumax Inc., Gränges AB (purchased by Alcoa in 1990), Koninklijke Nederlandsche Hoogovens en Staalfabrieken NV and the Icelandic government signed a memorandum of understanding covering the construction of the 200 000 t/y Atlantal smelter project in Iceland. The US$1 billion smelter is expected to be built in southern Iceland near the existing smelter of Alusuisse-Lonza Holding Ltd.

In Norway during 1990, Hydro Aluminium a.s. announced that it would undertake a major modernization and expansion of its Norwegian smelting capacity in the late 1990s. This will include the closure of old Söderberg potlines (117 000 t/y) at its Ardal and Sunndalsora plants and the construction of about 350 000 t/y of new capacity. This expansion, however, is dependent upon the company's ability to secure favourable long-term contracts for hydro power and to obtain permission to construct a new gas-fired generating station. Also in Norway, Hydro Aluminium a.s. and Alusuisse announced an expansion of their jointly owned Soral plant at Husnes from 65 000 t/y to 100 000 t/y. In addition, Elkem Aluminium ANS was reportedly considering an expansion of its Mosjoen and Lista smelters from a total capacity of 200 000 t/y to 365 000 t/y.

In Germany, Alcan and VAW announced a 900 million Deutsche Mark expansion of their Norf rolling mill. This includes the construction of a 700 000 t/y hot rolling mill and a two-stand tandem cold rolling mill. The project is expected to be completed in 1993.

In Greece, work continued on a new 600 000 t/y alumina refinery, a joint venture between the Greek government and the U.S.S.R. The plant, which has experienced several delays, is now expected to reach full production in 1994.

Alcan Aluminium Limited sold its 24% interest in Industria Espanola del Aluminio S.A. (Inespal) of Spain to Instituto Nacional de Industria (INI). In addition, it was reported that the Spanish government had authorized the purchase by Inespal of Productos de Aluminio de Consumo (Palco), a joint venture of Inespal and Alcan. Also in Spain, Norsk Hydro AS announced in November that its aluminum division would purchase the Spanish aluminum extruder, Riego Wright SA.

In recent years, the U.S.S.R. has entered into a number of joint venture aluminum projects with Western companies in an effort to increase the size and efficiency of its aluminum industry, as well as to diversify its aluminum products. Soviet smelting capacity in 1989 was estimated at about 2.9 Mt/y.

During 1990, Kaiser Aluminum & Chemical Corporation of the United States signed an agreement with the U.S.S.R. to modernize the 725 000 t/y smelter at Krasnoyarsk in Siberia. This project is in addition to Kaiser's participation in the modernization of a 250 000 t/y smelter at Irkutsk in Siberia. It was also reported that three Japanese trading companies had formed a joint venture with the U.S.S.R. to produce secondary aluminum. The project will include the construction of a 30 000 t/y facility at Khabarovsk. Production from the plant will be sold in the U.S.S.R. and Japan. In March, it was reported that the U.S.S.R. and Comalco Limited were involved in a project to develop an advanced aluminum casting process using Soviet electromagnetic casting technology.

RECYCLING

The production of secondary aluminum in the market economy countries during 1990, excluding the direct use of scrap, was estimated at about 5.1 Mt, approximately equal to the record volumes produced in 1988 and 1989. This compares to 4.5 Mt in 1987 and 4.0 Mt in 1985. The recent increase of secondary production is due primarily to continuing improvements in the scrap collection system and increased recycling promotion by governments and environmental groups. From both commercial and environmental perspectives, additional increases in aluminum recycling are supported by the fact that recycling requires less than 5% of the energy used to make the original metal.

In 1989, the largest secondary producers were the United States at 1.843 Mt, Japan at 1.349 Mt, West Germany at 0.537 Mt, Italy at 0.377 Mt, and France at 0.225 Mt. Canadian consumption in 1989 was 77 000 t compared to approximately 113 000 t in 1988 (these figures exclude the direct use of scrap).

The most important sources of aluminum scrap in the United States are from the packaging (principally used beverage containers) and transportation sectors. During 1989, calculations made by the Aluminum Association, the Can Manufacturers Institute and the Institute of Scrap Recycling Industries reported that a record 56 billion cans were recycled in the United States, representing a recycling rate of about 60% of the total 83 billion cans shipped. In terms of recycling rates worldwide, Canada ranked second in 1989 at 63%, behind Sweden at 87%.

In Ontario, the soft-drink manufacturer, The Coca-Cola Company, recently began to switch the majority of its single-serving beverage containers from aluminum to cheaper bimetal cans. The bimetal can, which has a steel body with an aluminum lid and bottom, can be recycled by steel mills. However, for those Ontario municipalities who rely on the income from the more valuable aluminum containers to fund their "blue-box" curbside recycling programs, The Coca-Cola Company's announcement has been viewed negatively.

In recent years, concerns have arisen with respect to the potential recycling problems associated with newly developed aluminum alloys, in particular lithium alloys. The presence of as little as 5 ppm (parts per million) lithium can result in discolouration of the metal, surface defects in castings and unwanted changes in ductility.

CONSUMPTION AND USES

Western World consumption of primary aluminum fell to an estimated 14.62 Mt in 1990 from 14.65 Mt in 1989. Canadian consumption of primary aluminum in 1990 was estimated at 459 000 t, compared to 447 000 t in 1989. Total Canadian aluminum consumption in 1989, including secondary ingot and scrap, was almost 525 000 t.

Aluminum is a ductile, non-magnetic, silvery white metal, with a density only one third that of steel. While pure aluminum has a relatively low tensile strength, this can be improved by alloying and appropriate thermal and mechanical treatment. In addition, aluminum has a high degree of corrosion resistance and is an excellent conductor of heat and electricity as well as a good reflector of light and radiant heat. Aluminum can be fabricated by all known metal-working processes. The metal can be joined by welding, brazing, soldering, adhesive bonding, rivetting, stitching and stapling, and will accept a wide variety of mechanical and chemical finishes.

The metal, in alloyed and unalloyed forms, is suitable for use in a wide variety of products for both the consumer and capital goods markets. The largest markets for aluminum are: transportation (27%), building and construction (20%), packaging (20%), electrical (9%), consumer durables (7%), and machinery and equipment (7%).

The transportation sector, the largest single market for aluminum worldwide, can be broken down into a variety of sub-markets. These include the manufacture of automobiles, buses, trucks, trailers, ships, rail and subway rolling stock, as well as in aerospace applications and mobile homes. In recent years, aluminum has made significant inroads into the automobile parts manufacturing industry at the expense of steel/cast iron and copper/brass. Important applications include wheels, radiators, automotive air conditioning units, engine heads and blocks, intake manifolds, pistons, transmission housings, drive shafts and other power-train parts. It is expected that the average North American automobile, which contained about 80 kg of aluminum in 1990, representing 5% of the average total weight of a car, will contain over 90 kg by the year 2000. This compares to about 37 kg in 1973, which represented only 2% of gross vehicle weight. In Japan, it is expected that the average automobile will contain about 10% aluminum (approximately 100 kg) by 1995. The principal reasons for this increase are related to general weight and size reductions of automobiles in order to improve fuel efficiency, and to the unique weight distribution requirements of front-wheel-drive vehicles. With current trends favouring more stringent fuel economy standards, it is expected that aluminum use in automobile applications will continue to grow.

A potential new application for aluminum in the automotive industry is in the production of car bodies. There are several different variations of this technology, including Alcan's Aluminum Structural Vehicle Technology (ASVT) process which utilizes adhesively bonded sheet aluminum. Alcan claims that its ASVT structure offers a 50% weight reduction over steel with equal stiffness, strength and crashworthiness.

While aluminum faces intense competition from titanium and a new generation of polymer, ceramic and composite materials that are lighter and stronger than conventional aluminum alloys, the metal remains the principal structural material in the aircraft industry. In 1989, consumption of aluminum for aircraft/aerospace applications in the United States was estimated at over 240 000 t, or approximately 16% of transportation sector shipments. Despite the competitive threat from new materials, a number of the composites are aluminum-based, such as silicon carbide fibre aluminum and silicon carbide whisker aluminum. For this reason, aluminum's future in the aviation/aerospace industry would seem assured, although it may play a lesser role than in the past.

In response to the changing needs of aircraft manufacturers and, undoubtedly, to breakthroughs in the development of substitute materials, the aluminum industry has expended considerable effort to develop and market new aluminum-lithium alloys. These offer weight savings of up to 15% in new design applications without requiring changes to tooling or fabrication techniques. In the future, it is expected that new aluminum-iron-cerium and aluminum-scandium alloys, as well as aluminum laminates, such as Alcoa's "Arall" material which contains alternate layers of aluminum and aramid fibre-reinforced epoxy, will also find application in this industry.

In the rail equipment industry, Alcan Aluminium Limited, through a joint venture with Thrall Car Manufacturing Co., has developed a new coal car that can carry 20 000 lb more than a conventional steel car. While more expensive to purchase, the user is more than compensated through operating savings of 8%-10% and lower maintenance costs. In the case of subway cars, it is estimated that the difference in cost is made up in as little as 1.5-2.0 years.

In addition to the advantages of aluminum in rail rolling stock in terms of lower operating costs, rail passenger equipment manufacturers can utilize the metal to build high-speed trains that can compete effectively with aircraft for short-to-medium-haul travel. In Japan, a new high-speed train under development in which cars will be magnetically levitated using linear induction motors will likely utilize aluminum to reduce weight.

Within the building and construction sector, major aluminum uses include residential siding, roofing, eavestroughs, windows, doors, frames, screens, awnings and canopies. Aluminum faces intense competition from vinyl, particularly in the siding market and from wood in framing applications. A new fire-resistant building panel, developed by Reynolds Metals Company, could provide aluminum with significant new growth opportunities in building and construction. The product, known as

"Reynobond," consists of a thermoplastic compound plastic core between two sheets of aluminum. In addition to its fire resistance, this lightweight panel has been designed to maintain flatness and to offer durability in different weather extremes.

Unlike the other uses in which consumption is fairly evenly distributed between regions, the United States dominates the containers and packaging sector with over 75% of the total. Within this broad market classification, the major uses of aluminum are for foil, flexible packaging, beverage and food containers, and other cans and closures. The largest single segment of this market is aluminum beverage cans. Can shipments in the United States during 1990 were estimated at 87 billion units, compared to 83 billion units in 1989. While aluminum has dominated, and continues to dominate, the U.S. beverage industry with over 95% of the market, there has been renewed interest in steel in recent years. This was particularly true in 1988 when aluminum prices achieved record highs. However, with a return to lower prices in 1989 and 1990, the potential advantages from substitution largely disappeared. Although aluminum has often been a somewhat more expensive packaging material than steel for beverage can applications, the metal does benefit from long-standing consumer acceptance and a good record as a recyclable material.

The food can market, which in the United States accounts for about 28 billion containers per year in total, has been targeted by the aluminum industry as an area for future growth. At present, aluminum's share of the U.S. market is about 10%, which in itself represents a 100% increase over the last five years.

Much of aluminum's success to date has been with shallow-drawn cans, and particularly with cat food cans. Unlike the beverage can market, which in North America is dominated by the 12-ounce container, the food can market is characterized by a diversity of container sizes and a multitude of different packaging requirements. While the industry has solved certain problems associated with aluminum usage for larger food containers such as low internal strength through the nitrogen-injection process, development work for some applications is still ongoing. Alcoa announced in August 1990 that it intends to develop an easy-open aluminum soft-drink can that can be resealed and stacked. Currently this market is dominated by plastics.

In January 1990, it was announced that Reynolds Metals Company had signed a long-term contract with Campbell Soup Company to eventually supply all of Campbell's juice can requirements, including both 5.5- and 11.5-ounce container sizes.

In the electrical sector, aluminum extensively replaced copper in wiring and power transmission in the 1960s but, while it has maintained the market for power transmission applications, local restrictions and consumer resistance have substantially lessened the demand for aluminum in electrical wiring. Aluminum has, however, gained acceptance in various communications and computer applications. While there have been some gains for aluminum in electrical applications both in Japan and in Europe, overall consumption has remained fairly constant due to slumping demand in the United States.

Some of the most promising new applications for aluminum are based on a family of new metal matrices. One example, developed by Alcan, is "Duralcan" which is aluminum reinforced with silicone carbide ceramic particles. While out-performing traditional aluminum alloys, it can be fabricated with the same techniques. Duralcan also has greater specific strength, is lighter than steel and is less expensive than titanium. Initial markets for this material are expected in sporting goods, cast products and small engine components. Potential applications are also expected in the automotive and aerospace industries.

A promising new use for the metal is in the new aluminum air-cell battery that has been developed by Alcan. The main advantages of the battery are long shelf life, low weight before activation and constant power output. One of the many potential uses for the battery is in electric vehicles. When used in combination with a conventional lead-acid battery, the range of an electric vehicle increases from approximately 75 km to over 300 km.

TARIFFS AND TRADE

The European Communities' 6% import tariff on aluminum ingot continues to be an irritant for aluminum exporters in North America, South America and Australia, and for a growing number of aluminum fabricators in Europe itself. While the Uruguay round of General Agreement on Tariffs and Trade (GATT) negotiations offered hope of at least a partial resolution of this problem, no progress had been achieved by the end of 1990. Further talks were scheduled to begin in January 1991.

During 1990, it was reported that the European Communities and the Gulf Cooperation Council had held talks on the establishment of a trade accord to improve access to each other's markets. For aluminum producers in the Persian Gulf, such an accord would ultimately permit duty-free access for Gulf aluminum to the EC. It was reported that the EC might establish a duty-free quota system for aluminum imports from the Gulf region.

In August, the U.S. Court of International Trade overturned the rulings of the International Trade Commission, made in 1988, that resulted in the imposition of a 38.4% countervailing duty and a dumping margin of 5.8% on aluminum redraw bar imported into the United States from Venezuela.

HEALTH, SAFETY AND ENVIRONMENT

Alzheimer's disease is a degenerative condition affecting the brain, the cause of which is not known. However, there have been suggestions that aluminum and/or aluminum compounds may play a role in the development of this disease. In this regard, early studies reported that Alzheimer sufferers had a higher-than-normal concentration of aluminum in their brain tissue. In addition, the injection of aluminum salts into the brains of laboratory animals was reported to have produced lesions in those brains.

However, more recent research has revealed that the aluminum-induced lesions are quite different, both chemically and structurally, from the lesions found in diseased human brains. In addition, it has been found that aluminum levels in the brain increase slightly with the aging process, but not necessarily in association with the progression of Alzheimer's disease. The most recent evidence from researchers has isolated a defective gene in the DNA of sufferers of some forms of the disease, suggesting a genetic link to the cause of the disease.

Evidence presented to the Second International Conference on Alzheimer's Disease held in Toronto in September 1990 suggested a link between aluminum exposure from airborne aluminum powder used to control silicosis in miners and cognitive impairment. The study was conducted to test mental ability and not to diagnose Alzheimer's disease. The practice of exposing miners to aluminum dust, widely carried out in Canadian gold mines from 1944 to 1979, was intended to bind silica dust with aluminum powder and to create a harmless, inert compound. The practice was stopped in 1979 when no scientific justification for its use could be found. Clinical evaluations are continuing and, to date, no conclusive link between aluminum exposure and Alzheimer's disease has been established. Exhaustive research on both the affects of aluminum in the body and Alzheimer's disease is continuing.

Aside from the possible health hazards of aluminum use, there are several environmental issues pertaining to the production of both alumina and aluminum.

The waste product from the processing of bauxite to alumina (Bayer process), an alkaline residue known as red mud, presents a significant problem because of its toxicity and the large volume of production (estimated at 40 Mt/y of solids worldwide). While the construction of sealed impoundment areas has been an effective method for dealing with this problem, it is relatively expensive and space intensive, making use of space that will be unsuitable for any other use. In response to this problem, the industry has developed various dry-stacking techniques which are useful both in terms of reducing the land requirements for a specific volume of waste material and, most importantly, for permitting the utilization of the land for purposes such as agriculture at some future date. An alternative method of disposal, and one which the industry is deeply involved in, is the development of uses for red mud. One of the most promising applications is in the production of concrete products.

A more serious environmental issue for the aluminum industry relates to the emission of fluorides from the Hall-Heroult smelting process. For older smelters which utilize Söderberg technology, the production of polycyclic aromatic hydrocarbons (PAHs), which are suspected cancer-causing agents, is another serious concern.

As stated earlier in this report, Alcan is building a new smelter at Laterrière, Quebec which, when commissioned, will replace most of the company's Söderberg potlines at Jonquière. The latest generation of aluminum smelters, including Laterrière, utilizes a pre-baked anode which largely eliminates harmful emissions of PAHs. Moreover, newer smelters incorporate fume-collection systems that utilize scrubbers to remove most fluorides.

As governments, particularly in the United States and Europe, move to reduce emissions of sulphur dioxides and nitrogen oxides from coal-fired electric generating stations, power costs to many aluminum smelters are expected to rise significantly. In the United States, it has been estimated that electricity costs for the industry could increase from US$94 million to $150 million as a result of the introduction of acid rain legislation. For producers in the east-central part of the country, smelting costs could increase by as much as US7.7¢/lb.

During 1990, The U.S. Environmental Protection Agency (EPA) ordered that non-fibrous aluminum oxide, the form of alumina that is used to produce aluminum, be deleted from its list of toxic chemicals. Also in the United States, new environmental rules were scheduled to come into effect at the beginning of 1991 which would require aluminum producers to transport spent potliner to combustion facilities for disposal. According to Aluminum Association Incorporated, this requirement would cost up to US$1000/t. The EPA designated spent potliner as a hazardous waste in 1988.

PRICES AND STOCKS

Prices on the London Metal Exchange (LME), which averaged around US70¢/lb during the first half of 1990, rose sharply at the end of July due to strong physical demand combined with a variety of technical and speculative factors. This rise continued through August and into September when prices exceeded US$1.00/lb. Prices eased during the fourth quarter of 1990, with the price of aluminum averaging 69¢ in December.

In May, the LME approved the establishment of four new delivery points for aluminum in the United States. Warehouses will be located in the cities of Baltimore, Bridgeport/New Haven, Chicago and Toledo. The LME will establish Bilbao, Spain as another delivery point. The LME network currently operates 17 delivery points in Europe, 6 in Japan, and 1 in Singapore. It is expected that this expansion will stabilize prices and reduce the spread between metal prices in Europe and North America. The LME announced that it was examining the possibility of establishing a secondary aluminum contract.

The IPAI reported that total aluminum inventories in the Western World in December 1990 were 3.155 Mt, compared to 3.093 Mt in November and 3.220 Mt in December 1989. The IPAI also reported that inventories of primary aluminum in December 1990 were 1.539 Mt, compared to 1.476 Mt in November and 1.576 Mt in December 1989.

At the end of 1990, spot alumina prices were reported to be between US$225/t and $250/t. This compares to a price of between $450/t and $500/t at the end of 1989.

OUTLOOK

With the completion of the two new greenfield smelters and two expansion projects in Quebec, Canadian primary aluminum smelting capacity will increase from about 1.635 Mt at the end of 1990 to over 2.261 Mt at the end of 1992 or early 1993. While it had been expected that these projects, plus other planned capacity in the world, would result in an oversupply and exert downward pressure on prices, it appears likely that demand will be higher than previously forecast. In addition, it is expected that a number of smelter projects, currently in the planning stages, will experience delays. This includes projects in Venezuela where continuing difficulties in arranging financing are expected, and also in the Middle East.

In the longer term, it is anticipated that significant additional capacity will be needed to meet the strong growth of demand which is forecast for aluminum through the 1990s. Moreover, it is also expected that a large amount of new capacity will be required to replace ageing plants in Europe and the United States which are inefficient to operate and pollute the environment.

With significant growth expected in the packaging and transportation sectors, overall aluminum consumption is forecast to grow at an average annual rate of at least 2.0% through the 1990s.

It is expected that aluminum prices will weaken somewhat in the first half of 1991 as the economic slowdown persists in North America and possibly spreads in Europe. However, it is anticipated that lower interest rates will stimulate economic activity in the second half of the year and thereby boost aluminum prices. For 1991 as a whole, it is expected that the price of aluminum will average US65¢/lb. For the remainder of the 1990s, Energy, Mines and Resources Canada forecasts that the price of aluminum will average between US68¢ and US79¢/lb (constant 1990 cents).

Note: Information contained in this review was current as of mid-January 1991.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
76.01	Unwrought aluminum				
7601.10	Aluminum, not alloyed				
7601.10.10	Billets, blocks, ingots, notched bars, pigs, slabs and wire bars	Free	Free	Free	Free
7601.10.91	Granules, cut from ingots, for use in the manufacture of cleaning compounds	1.98¢/kg	Free	Free	Free
7601.10.99	Other	10.3%	6.5%	Free	Free
7601.20	Aluminum alloys				
7601.20.10	Billets, blocks, ingots, notched bars, pigs, slabs and wire bars	Free	Free	Free	Free
7601.20.91	Granules, cut from ingots, for use in the manufacture of cleaning compounds	1.98¢/kg	Free	Free	Free
7601.20.99	Other	10.3%	6.5%	Free	Free
7602.00	Aluminum waste and scrap	Free	Free	Free	Free
76.03	Aluminum powders and flakes	9.2% to 10.3%	Free to 6.5%	Free	2.3% to 3.4%
76.04	Aluminum bars, rods and profiles	2.1% to 10.3%	Free to 6.5%	0.8% to 4.1%	0.9% to 3%
76.05	Aluminum wire	2.1% to 10.3%	Free to 6.5%	Free to 4.1%	1.5% to 2.5%
76.06	Aluminum plates, sheets and strip, of a thickness exceeding 0.2 mm	Free to 10.3%	Free to 6.5%	Free to 7.2%	Free to 5.2%
76.07	Aluminum foil not exceeding 0.2 mm	Free to 12.2%	Free to 8%	Free to 8.5%	2.4% to 4.6%
76.08	Aluminum tubes and pipes	8.1%	Free	3.2%	3.4%
76.09	Aluminum tube or pipe fittings	10.3%	6.5%	Free	4.5%
76.10	Aluminum structures (excluding prefabricated buildings of heading No. 94.06) and parts of structures, aluminum plates, rods, profiles, tubes and the like, prepared for use in structures	10.3%	6.5%	7.2%	4.5%
7611.00	Aluminum reservoirs, tanks, vats and similar containers	Free to 10.3%	Free to 6.5%	Free to 7.2%	2%
76.12	Aluminum casks, drums, cans, boxes and similar containers	10.3%	6.5%	7.2%	1.9% to 4.5%
7613.00	Aluminum containers for compressed or liquefied gas	10.3%	6.5%	7.2%	4%
76.14	Stranded wire, cables, plaited bands and the like, of aluminum, not electrically insulated	10.2%	6.5%	7.1%	3.9% to 4.5%
76.15	Table, kitchen or other household articles and parts thereof, of aluminum	10.2% to 11.4%	Free to 6.5%	7.1% to 7.9%	3% to 4.5%
76.16	Other articles of aluminum	Free to 10.3%	Free to 6.5%	Free to 7.2%	3.7% to 5%

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States effective January 1, 1990.

Aluminum

TABLE 1. CANADA, ALUMINUM PRODUCTION AND TRADE, 1989 AND 1990

Item No.		1989		1990p	
		(tonnes)	($000)	(tonnes)	($000)
Production		1 554 753	..	1 567 395	..
Imports				(Jan.-Sept.)	
2606.00.00	Aluminum ores and concentrates				
	Brazil	1 329 306	46 951	921 536	30 534
	Guinea	382 582	18 173	188 852	9 024
	Australia	132 233	7 262	140 245	4 991
	United States	38 382	9 146	26 709	4 730
	Sierra Leone	308 790	12 352	71 758	3 219
	Guyana	184 894	8 637	13 038	737
	Other countries	164 507	8 266	87 777	4 131
	Total	2 540 694	110 787	1 449 915	57 370
2620.40.00	Ash and residues containing mainly aluminum	2 187	1 544	1 699	681
2818.20.00	Aluminum oxide (excluding artificial corundum)				
	United States	917 901	291 040	503 924	158 604
	Australia	496 876	138 380	529 680	130 646
	Jamaica	524 560	173 149	382 071	107 083
	Japan	78 410	21 093	67 075	17 544
	France	2 281	2 373	1 117	1 362
	West Germany	243	835	189	624
	United Kingdom	220	302	702	310
	Other countries	10 732	2 090	1 013	793
	Total	2 031 223	629 262	1 485 771	416 970
2818.30.00	Aluminum hydroxide	9 748	7 094	7 146	4 898
76.01	Unwrought aluminum				
7601.10	Aluminum, not alloyed				
7601.10.10	Billets, blocks, ingots, notched bars, pigs, slabs and wire bars				
	United States	13 790	35 544	14 363	29 489
	France	2 069	7 006	3 253	10 918
	Norway	243	942	81	286
	Brazil	42	124	–	–
	Other countries	24	81	167	488
	Total	16 168	43 697	17 864	41 184
7601.10.91	Granules, cut from ingots, for use in the manufacture of cleaning compounds	29	82	–	–
7601.10.99	Other	2 698	8 758	1 754	2 887
7601.20	Aluminum alloys				
7601.20.10	Billets, blocks, ingots, notched bars, pigs, slabs and wire bars				
	United States	42 063	104 183	34 352	71 993
	United Kingdom	394	1 755	338	1 403
	Brazil	1 245	3 714	41	81
	Norway	47	148	–	–
	Other countries	301	812	1 344	3 388
	Total	44 050	110 612	36 075	76 865
7601.20.91	Granules, cut from ingots, for use in the manufacture of cleaning compounds	–	–	–	–
7601.20.99	Other	873	2 090	2 372	4 525
7602.00.00	Aluminum waste and scrap	58 224	92 523	40 470	56 306
76.03	Aluminum powders and flakes	2 155	7 521	1 703	5 855

TABLE 1 (cont'd)

Item No.		1989		Jan.-Sept. 1990p	
		(tonnes)	($000)	(tonnes)	($000)
Imports (cont'd)					
76.04	Aluminum bars, rods and profiles				
7604.10	Of aluminum, not alloyed				
	United States	8 258	35 405	3 437	19 361
	Other countries	1 191	5 383	539	2 235
	Total	9 449	40 788	3 976	21 596
7604.21 to 7604.29	Of aluminum alloys				
	United States	9 979	43 826	7 835	31 998
	Other countries	1 679	6 446	966	3 923
	Total	11 658	50 272	8 801	35 921
76.05	Aluminum wire	3 124	12 081	2 542	9 475
76.06	Aluminum plates, sheets and strip, of a thickness exceeding 0.2 mm	289 229	960 096	221 762	632 991
76.07	Aluminum foil not exceeding 0.2 mm	22 496	96 802	18 387	74 991
76.08	Aluminum tubes and pipes	6 261	29 120	4 337	19 526
76.09	Aluminum tube or pipe fittings	..	8 950	..	7 572
		(number 000)		**(number 000)**	
76.10	Aluminum structures (excluding prefabricated buildings of heading No. 94.06) and parts of structures, aluminum plates, rods, profiles, tubes and the like, prepared for use in structures	..	50 312	..	36 939
76.11	Aluminum reservoirs, tanks, vats and similar containers	...	187	...	1 192
76.12	Aluminum casks, drums, cans, boxes and similar containers	278 417	30 704	413 275	35 217
76.13	Aluminum containers for compressed or liquefied gas	65	4 535	211	3 561
76.14	Stranded wire, cables, plaited bands and the like, of aluminum, not electrically insulated	520	1 393	435	1 461
		(tonnes)		**(tonnes)**	
76.15	Table, kitchen or other household articles and parts thereof, of aluminum	..	30 251	..	25 465
76.16	Other articles of aluminum	..	127 458	..	94 379
Exports					
2606.00	Aluminum ores and concentrates				
	United States	3 933	3 341	365	52
	Total	3 933	3 341	365	52
2620.40	Ash and residues containing mainly aluminum	5 263	2 912	45 940	4 559
76.01	Unwrought aluminum				
7601.10	Aluminum, not alloyed				
	United States	323 067	799 964	281 056	527 612
	Japan	81 244	172 170	60 310	105 425

TABLE 1 (cont'd)

Item No.		1989 (number 000)	1989 ($000)	Jan.-Sept. 1990p (number 000)	Jan.-Sept. 1990p ($000)
Exports (cont'd)					
	South Korea	41 765	102 858	24 438	45 747
	Turkey	14 863	32 959	20 056	39 769
	Netherlands	58 100	104 346	15 457	27 439
	France	29 573	72 749	10 519	22 749
	Other countries	65 517	164 714	51 413	98 917
	Total	614 129	1 449 760	463 249	867 658
7601.20	Aluminum alloys				
	United States	422 134	1 060 435	379 431	740 841
	Japan	62 165	143 698	52 089	101 455
	South Korea	6 060	15 461	7 893	16 186
	Turkey	7 645	20 601	7 554	16 100
	Netherlands	22 069	49 096	7 614	14 461
	Belgium	35	70	6 752	13 460
	Israel	5 607	15 626	6 130	12 919
	Hong Kong	4 407	11 997	990	2 082
	Other countries	14 304	38 729	12 670	26 761
	Total	544 426	1 355 713	481 123	944 265
7602.00	Aluminum waste and scrap				
	United States	136 491	279 133	119 927	175 757
	Japan	16 751	31 240	15 079	23 828
	United Kingdom	2 287	3 782	261	327
	Taiwan	2 859	3 604	1 664	1 932
	Other countries	5 520	10 191	5 360	7 721
	Total	163 908	327 950	142 291	209 565
76.03	Aluminum powders and flakes	876	1 410	201	452
76.04	Aluminum bars, rods and profiles	2 046	8 257	1 198	4 838
76.05	Aluminum wire	16 623	50 407	7 295	18 415
76.06	Aluminum plates, sheets and strip, of a thickness exceeding 0.2 mm	132 707	398 768	127 314	320 190
76.07	Aluminum foil not exceeding 0.2 mm	3 870	21 630	5 166	32 573
76.08	Aluminum tubes and pipes	444	1 985	1 081	6 934
7609.00	Aluminum tube or pipe fittings	..	2 621	..	1 734
76.10	Aluminum structures (excluding prefabricated buildings of heading No. 94.06) and parts of structures, aluminum plates, rods, profiles, tubes and the like, prepared for use in structures	..	28 907	..	36 978
7611.00	Aluminum reservoirs, tanks, vats and similar containers	210	4 384	166	826
76.12	Aluminum casks, drums, cans, boxes and similar containers	151 829	29 263	166 755	18 592
7613.00	Aluminum containers for compressed or liquefied gas	1 266	878	41	3 003

TABLE 1 (cont'd)

Item No.		1989		Jan.-Sept. 1990p	
		(tonnes)	($000)	**(tonnes)**	($000)
Exports (cont'd)					
76.14	Stranded wire, cables, plaited bands and the like, of aluminum, not electrically insulated	1 454	4 131	5 686	16 059
76.15	Table, kitchen or other household articles and parts thereof, not aluminum	. .	6 313	. .	5 681
76.16	Other articles of aluminum	. .	72 538	. .	45 718

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary; . . Not available or not applicable; . . . Amount too small to be expressed; – Nil.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, ALUMINUM SMELTER CAPACITY

Company	As of December 31, 1990
	(tonnes/year)
Alcan Aluminium Limited	
Quebec	
Grande Baie	171 000
Jonquière	282 000
Îsle-Maligne	73 000
Shawinigan	84 000
Beauharnois	47 000
Laterrière	150 000
British Columbia	
Kitimat	268 000
Total Alcan capacity	1 075 000
Canadian Reynolds Metals Company, Limited	
Quebec	
Baie Comeau	280 000
Aluminerie de Bécancour Inc.	
Quebec	
Bécancour	280 000
Total Canadian capacity	1 635 000

Source: Energy, Mines and Resources Canada.

TABLE 3. CANADA, CONSUMPTION[1] OF ALUMINUM METAL AT FIRST PROCESSING STAGE, 1987-89

	1987	1988	1989p[4]
		(tonnes)	
Castings			
Sand	2 168	2 367	2 841
Permanent mould	17 897r	23 249	24 208
Die and other	32 311r	52 217	55 074
Total	52 376r	77 833	82 123
Wrought products			
Extrusions, including tubing	107 669	147 213r	138 656
Sheet, plate, coil and foil	170 949	153 877	152 340
Other wrought products (including rods, forgings and slugs)	56 157	75 637	71 763
Total	334 775	376 727r	362 759
Other uses			
Destructive uses (deoxidizer), non-aluminum base alloys, powder and paste and other uses	26 086	34 139	79 855
Total consumed	413 237r	488 699r	524 737
Secondary aluminum[2]	73 489	113 131	76 518

	Metal Entering Plant			On Hand December 31		
	1987	1988r	1989p	1987	1988r	1989p
Primary aluminum ingot and alloys	371 604	444 580	437 997	20 048	33 394	24 247
Secondary aluminum	43 262r	56 254	65 622	3 032r	4 303	3 711
Scrap originating outside plant	99 181	136 885	115 994	6 957	10 102	6 820
Total	514 047r	637 719	619 613	30 037r	47 799	34 778
Aluminum shipments[3]				26 039	26 577	33 735

[1] Available data as reported by consumers. [2] Aluminum metal used in the production of secondary aluminum is not included in consumption totals. [3] Aluminum metal shipped without change. Does not refer to shipments of goods of own manufacture. [4] Increase in number of companies being surveyed. Therefore, 1988 closing inventory does not equal 1989 opening inventory.
p Preliminary; r Revised.

TABLE 4. AVERAGE ALUMINUM PRICES

Year	Month	LME Cash[1]	M.W. U.S. Markets[1]
		(US¢/lb)	
Annual averages			
1979		72.7	70.7
1980		80.7	76.1
1981		57.3	59.8
1982		45.0	46.8
1983		65.3	68.3
1984		56.5	61.1
1985		47.9	48.8
1986		52.2	55.9
1987		70.8	72.3
1988		117.3	110.1
1989		88.5	87.8
1990		74.4	74.0
Monthly averages			
1989	January	108.7	107.7
	February	99.0	99.6
	March	94.0	95.8
	April	96.4	96.4
	May	102.5	97.8
	June	86.8	87.7
	July	79.6	80.4
	August	81.6	81.4
	September	77.9	78.3
	October	82.5	79.8
	November	78.7	75.8
	December	74.1	73.6
1990	January	69.3	69.7
	February	66.0	65.5
	March	71.1	70.9
	April	69.2	71.6
	May	69.3	72.3
	June	71.0	73.1
	July	71.3	72.6
	August	80.8	80.3
	September	93.7	88.1
	October	88.3	82.2
	November	73.4	72.5
	December	69.1	69.8

Source: "Metals Week."
[1] Highest grade sold.

TABLE 5. WORLD MINE PRODUCTION OF BAUXITE

	1987	1988	1989
		(000 tonnes)	
Europe			
France	1 388.2	977.0	719.8
Greece	2 467.0	2 533.0	2 576.0
Italy	–	17.1	11.7
Spain	3.0	2.5	–
Yugoslavia	3 394.0	3 034.0	3 252.0
Total	7 252.2	6 563.6	6 559.5
Africa			
Ghana	196.2	285.0	347.7
Guinea	13 500.0	16 800.0	17 500.0
Mozambique	5.1	6.5	5.5
Sierra Leone	1 391.0	1 403.0	1 548.0
Zimbabwe	25.0	–	–
Total	15 117.3	18 494.5	19 401.2
Asia			
India	2 816.0	4 013.0	4 345.0
Indonesia	635.3	513.1	862.3
Iran	–	92.5	100.0
Malaysia	482.1	361.0	355.0
Pakistan	4.0	2.5	2.0
Turkey	258.0	269.0	561.5
Total	4 195.4	5 251.1	6 225.8
Americas			
United States	576.0	588.0	670.0
Brazil	6 566.5	7 727.6	7 893.8
Guyana	2 785.0	1 774.0	1 340.0
Jamaica	7 660.0	7 409.0	9 395.0
Surinam	2 581.1	3 434.0	3 530.0
Venezuela	217.0	555.0	702.0
Dominican Republic	–	167.8	164.5
Total	20 385.6	21 650.4	23 695.3
Australasia			
Australia	34 102.0	36 370.0	38 583.0
Eastern countries			
China	3 200.0	3 500.0	3 650.0
Hungary	3 101.1	2 906.0	2 352.0
Romania	480.0	435.4	345.2
U.S.S.R.	5 700.0	5 750.0	5 750.0
Total	12 481.1	12 591.4	12 097.2
World total	93 533.6	100 921.0	106 562.0

Source: Energy, Mines and Resources Canada.
– Nil.

TABLE 6. WORLD PRODUCTION OF ALUMINA (HYDRATE)

	1987	1988	1989
		(000 tonnes)	
Europe			
France	866.0	737.0	624.0
Germany, Federal Republic of	1 313.0	1 163.0[a]	1 174.0
Greece	529.0	532.0	533.0
Ireland	787.0	842.8	891.0
Italy	700.0	705.0	722.2
Spain	801.0	880.5	949.1
United Kingdom	110.0	114.0	116.2
Yugoslavia	1 112.0	1 174.0	1 240.0
Total	6 218.0	6 148.3	6 249.8
Africa			
Guinea	542.0	593.0	626.8
Asia			
India	650.0	1 188.0	1 418.5
Japan	711.0	414.6	863.4
Turkey	95.2	182.0	200.6
Total	1 456.2	1 784.6	2 482.5
Americas			
Brazil	1 396.0	1 417.0	1 624.4
Canada	952.7	992.6	1 048.4[a]
Jamaica	1 572.0	1 514.0	2 205.0
Surinam	1 363.0	1 632.0	1 567.1
United States	4 150.0	4 995.0	4 670.0[a]
Venezuela	1 360.0	1 284.0	1 290.2
Total	10 793.7	11 834.6	12 405.1
Australasia			
Australia	10 109.0	10 511.0	10 823.0
Eastern countries			
Czechoslovakia	75.0	75.0	. .
Germany, Democratic Republic of	50.9	64.0	63.0
Hungary	868.0	881.0	891.0
Romania	584.0	620.0	611.0
U.S.S.R.	4 425.0	4 600.0	4 550.0
China, People's Republic of	1 450.0	1 530.0	16 500.0[a]
Total	7 452.9	7 770.0	7 765.0
World total	36 571.8	38 641.5	40 352.2

Source: Energy, Mines and Resources Canada.
[a] Calcined; . . Not available.

TABLE 7. WORLD PRODUCTION OF ALUMINUM

	1987	1988	1989	1990e
	(000 tonnes)			
Europe				
France	322.5	327.7	334.9	332.4
Germany, Federal Republic of	737.7	744.1	742.0	711.2
Italy	232.6	226.3	219.5	228.4
Netherlands	268.7	270.7	274.1	291.6
Norway	797.8	826.6	859.0	862.7
Spain	341.0	293.9	352.5	353.5
United Kingdom	294.4	300.2	297.3	287.1
Yugoslavia	322.0	350.0	368.0	346.4
Other	459.0	497.0	498.3	486.7
Total	3 775.7	3 836.5	3 945.6	3 900.0
Africa				
Total	571.6	598.7	603.6	595.0
Asia				
Bahrain	180.3	182.8	186.9	186.4
Dubai	155.9	162.5	168.0	168.0
India	267.2	334.5	423.4	416.8
Indonesia	201.4	185.0	196.9	198.4
Japan	40.6	35.3	35.0	34.1
Other	103.8	113.3	124.2	119.3
Total	949.2	1 013.4	1 134.4	1 123.0
Americas				
Brazil	843.5	873.5	887.9	886.0
Canada	1 540.4	1 534.5	1 554.8	1 567.4
United States	3 343.0	3 943.5	4 030.0	4 023.3
Venezuela	439.6	443.4	546.0	593.5
Other	217.2	235.5	264.3	246.8
Total	6 383.7	7 030.4	7 283.0	7 317.0
Australasia				
Australia	1 024.2	1 141.3	1 242.0	1 234.0
New Zealand	252.0	265.7	258.8	260.0
Total	1 276.2	1 407.0	1 500.8	1 494.0
Eastern countries				
China, People's Republic of	640.0	713.0	744.4	..
Romania	260.0	265.2	269.1	..
U.S.S.R.	2 370.0	2 440.0	2 380.0	..
Other	225.4	225.2	256.2	..
Total	3 495.4	3 643.4	3 649.7	3 600.0
World total	16 451.8	17 529.4	18 117.1	18 029.0

Sources: Energy, Mines and Resources Canada; World Bureau of Metal Statistics.
e Estimated; .. Not available.

TABLE 8. WORLD CONSUMPTION OF ALUMINUM

	1987	1988	1989	1990e
		(000 tonnes)		
Europe				
Belgium/Luxembourg	284.7	302.3	302.1	328.7
France	615.6	660.6	685.5	722.1
Germany, Federal Republic of	1 185.7	1 232.6	1 290.0	1 306.0
Italy	548.0	581.0	607.0	579.2
Spain	254.7	268.0	273.4	280.2
United Kingdom	383.6	427.4	454.7	448.3
Yugoslavia	196.0	217.0	229.0	173.5
Other	778.5	833.1	880.7	862.0
Total	4 246.8	4 522.0	4 722.4	4 700.0
Africa				
Total	230.6	236.1	250.5	222.0
Asia				
India	326.0	327.0	420.0	420.0
Japan	1 696.8	2 132.2	2 203.9	2 320.5
Other	1 003.7	1 094.7	1 149.0	1 009.5
Total	3 026.5	3 544.9	3 772.9	3 750.0
Americas				
Canada	371.0	431.2	447.1	459.1
United States	4 539.0	4 598.1	4 359.6	4 340.7
Brazil	430.3	324.2	350.0	418.4
Other	403.5	376.6	391.4	441.8
Total	5 743.8	5 730.1	5 548.1	5 660.0
Oceania				
Total	355.9	358.5	354.7	283.0
Eastern countries				
Germany, Democratic Republic of	230.0	240.0	234.9	..
Hungary	197.9	175.4	162.2	..
U.S.S.R.	1 800.0	1 810.0	1 715.0	..
China, People's Republic of	660.0	630.0	700.0	..
Other	464.7	514.7	574.0	..
Total	3 352.6	3 370.1	3 386.1	3 380.0
World total	16 956.2	17 761.7	18 034.7	17 995.0

Sources: Energy, Mines and Resources Canada; World Bureau of Metal Statistics.
e Estimated; .. Not available.

Figure 1

LONDON METAL EXCHANGE ALUMINUM PRICES

HIGHEST GRADE SOLD

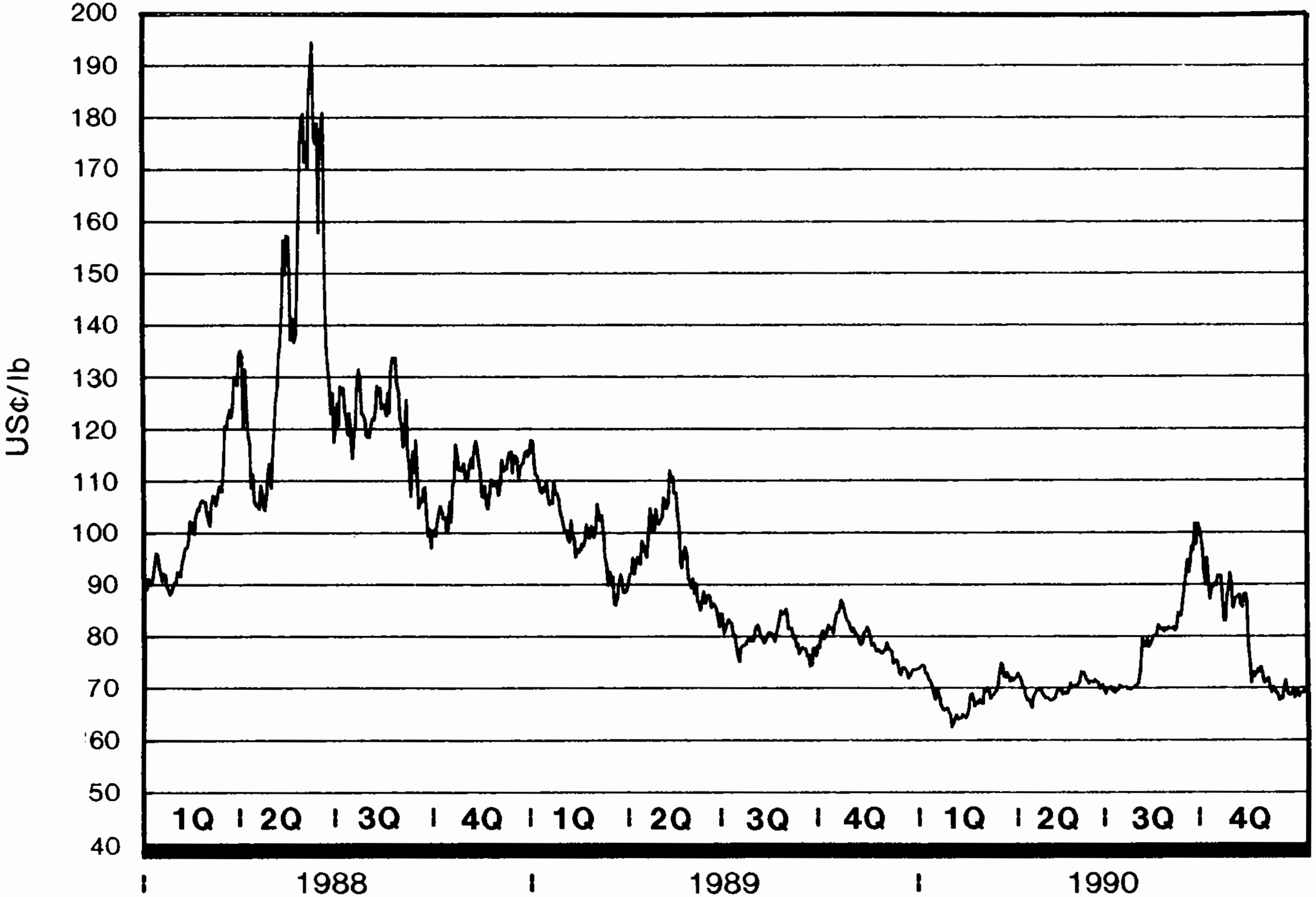
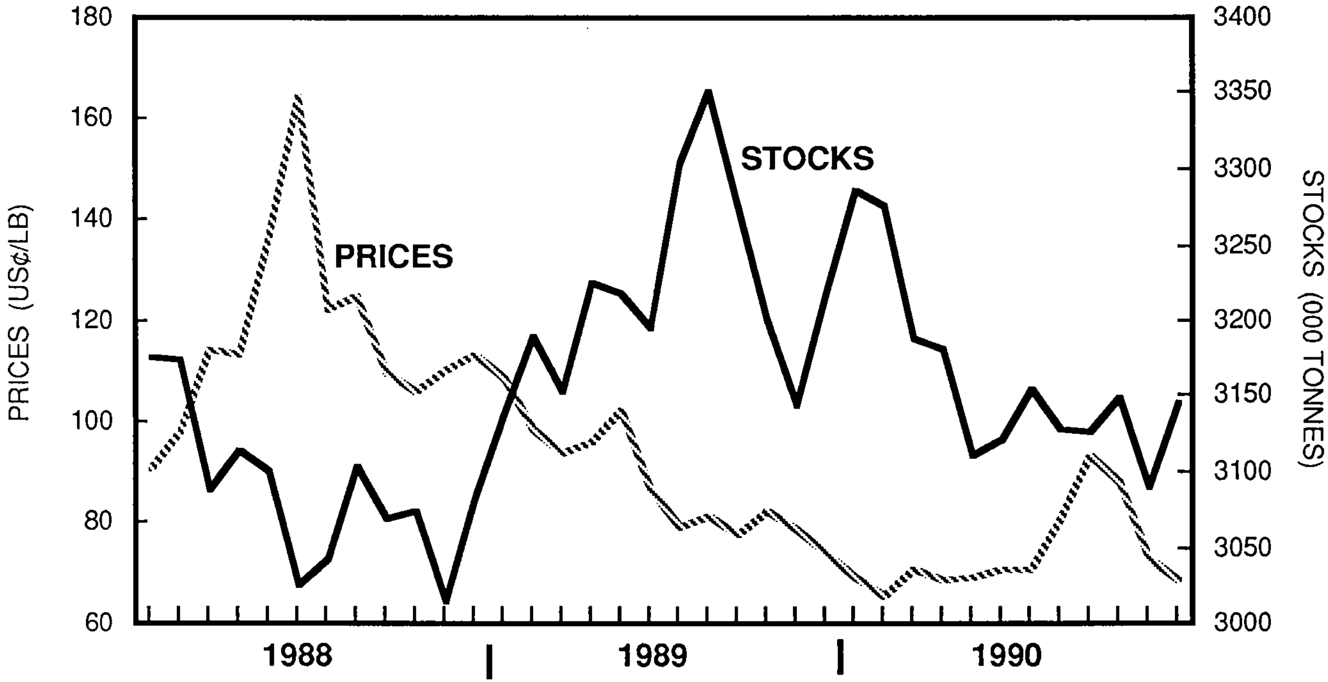


Figure 2

ALUMINUM PRICES AND STOCKS

(LME PRICES AND IPAI STOCKS)



MID-MONTH STOCKS AND AVERAGE MONTHLY PRICES.

Asbestos

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In 1990, Canadian asbestos production decreased 3.8% over 1989 due largely to the transition to the underground operation at Cassiar, British Columbia and, therefore, the unavailability of sufficient mill feed, a decrease in demand for short fibre, and reduced sales. Canadian mines operated at close to 100% of current capacity; average prices increased by only 1%. Total shipments for 1990, however, are estimated to be 665 300 tonnes (t), valued at $256.1 million, compared to revised figures for 1989 with shipments totalling 701 227 t, valued at $267.34 million. The 5.1% decrease in shipments primarily reflected the decline in demand for short fibre, as well as the impact of the transition at the Cassiar asbestos mine. The U.S. Bureau of Mines estimates imports of Canadian asbestos at 44 402 t for 1990 compared to 53 572 t in 1989, with the decrease continuing to be due to the general negative impact of the Environmental Protection Agency's (EPA) 1989 final asbestos rule and the first phase being implemented as of September 1, 1990.

Canadian export volumes for 1990 are forecast to be about 627 000 t, which represents a decrease of 11% from the previous year although the value of the exports is expected to decrease only by about 8%. Exports in the January to September 1990 period totalled 471 493 t, valued at $302.4 million, compared to 532 451 t, valued at $333.7 million for the same period in 1989.

Employment in asbestos mining/milling has remained stable throughout the year in the three provinces involved (British Columbia, Quebec and Newfoundland). There were no strikes and no major shutdowns, although minor shutdowns for inventory adjustment were experienced.

CANADIAN DEVELOPMENTS

With no major labour disruptions in 1990, Canadian developments involved LAB Chrysotile, Inc., Princeton Mining Corporation (Princeton) and Baie Verte Mines Inc. In order to avoid closure of the British Canadian mine owned by Asbestos Corporation Limited and operated by LAB Chrysotile Inc., development work on the mine began in the summer of 1990 to ensure its operation until 1997.

Early in 1990, Baie Verte Mines Inc. split into two separate entities: Baie Verte Mines Inc. (BVM), which controls the dry open-pit operation; and Baie Verte Mines Reprocessing Inc. (BVMRI), which owned the new wet-process plant and technology. In March 1990, the President of both BVM and BVMRI instigated a reverse takeover bid by Princeton in order to obtain additional finances to complete the wet-process mill for commercial operation. Although the takeover bid was dropped by mutual agreement, Princeton loaned BVMRI $4 million, to be repaid by June 30, 1990. As the loan was not repaid, Princeton placed BVMRI into "receiver-managership" on July 20, 1990, an action intended to ensure that monies were not misspent rather than the more usual context relating to bankruptcy. A public auction for BVMRI was held in Toronto on August 21, 1990, and Princeton paid $100 000 for 55% of BVMRI shares; the remaining 45% of the shares are still held by Cliff Resources Corporation.

On the operations side, BVM pit workers received permanent layoff notices from BVM in late fall, although ore may continue to be recovered from the pit until February or March 1991. Princeton is operating the wet-process mill on a commercial scale which is expected to extend the asbestos operations by 15-20 years depending on market conditions.

Princeton, which became the parent of Cassiar Mining Corporation (Cassiar) following a corporate restructuring last year, operated its mill during the year from stockpiled ore from the open pit which closed in 1989, as well as from the new underground McDame orebody. Although development of the McDame orebody continues, essentially on schedule, it produced a daily mill ore feed rate of 1500-2000 t at the end of 1990. Cassiar's wet-process operation is currently on hold due to problems relating to tailings disposal. Cassiar's decline in shipments was due to the transition from the open-pit operation to McDame and the unavailability of sufficient feed to maintain the mill's usual output.

J M Asbestos Inc., which last year had been hardest hit by the U.S. EPA's final asbestos rule, had a stable year with its marketing efforts resulting in sales sufficient to offset the declining U.S. imports.

In January 1990, the Quebec government, through its Worker Health and Safety Commission, amended its regulation reducing exposure to chrysotile asbestos from 2 f/cm^3 to 1 f/cm^3 (fibre per cubic centimetre).

INTERNATIONAL AND REGULATORY DEVELOPMENTS

Of ongoing interest in many quarters is the status of the legal appeal of the U.S. EPA's final asbestos rule (the rule bans and phases out 96% of current asbestos uses in the United States by 1997). The appeal was scheduled for the Fifth Circuit Appeals Court (New Orleans), and appeal briefs were filed between April 2 and November 5, 1990. An oral hearing has been scheduled for February 5, 1991. It is expected that the Court will take from four to six months to render its decision. Two companies which had filed appeal notices with the Court, Caterpillar and the Institute of Scrap Recyclers, sought exemptions from the EPA and mutually agreeable settlements were reached.

With respect to the buildings issue, on November 29, 1990, President Bush signed major asbestos legislation extending training and certification requirements to asbestos removal workers from public and commercial buildings bringing those into line with provisions for workers removing asbestos from schools. The EPA is now required to increase its training requirements for workers beyond the previously stipulated 24 hours and should include more hands-on activities.

On another front, the European Communities (EC) completed review and amendment of its asbestos workplace directive in December 1990. The limit for concentration of asbestos fibres in the air at the place of work was reduced as follows: for chrysotile (white) asbestos, from 1 f/cm^3 to 0.6 f/cm^3; for amosite (brown) asbestos, from 0.5 f/cm^3 to 0.3 f/cm^3; with crocidolite (blue) asbestos levels remaining at 0.3 f/cm^3. In addition, the action level was reduced from 0.25 f/cm^3 to 0.20 f/cm^3. These stricter regulations are still achievable by industry and serve to increase worker protection.

The Balangero asbestos mine in northern Italy, purchased by competing interests, was closed in early 1990. Greece currently has the only operating asbestos mine in the EC.

SCIENTIFIC DEVELOPMENTS

The asbestos in buildings issue peaked in 1990, largely due to a January article in the New England Journal of Medicine by Dr. B.T. Mossman (et al). The article stated that: "...even with damaged asbestos containing materials, the levels of airborne asbestos are magnitudes lower than concentrations in the unregulated workplace in the past and approximately 1/100 of the permissible exposure of 0.2 f/cc in the U.S. workplace. Before the enforcement of occupational standards, workplace concentrations of 100+ f/cc were not uncommon. In contrast, surveys of asbestos in schools and public buildings show that the mean airborne concentrations are several thousand-fold lower (0.00024 f/cc in schools with the outdoor air measuring 0.00039 f/cc)." Of further interest, the U.S. EPA issued a new booklet entitled "Managing Asbestos in Place," which now relegates removal as a last operation.

OTHER FIBRES

Non-asbestos fibrous materials, many of which are used as asbestos substitutes, are coming under increasing scrutiny in the workplace. However, no significant scientific or regulatory developments occurred in 1990, although investigations are ongoing in many countries and international organizations.

OUTLOOK

It is anticipated that demand for grades 3 and 4 fibre used in inexpensive, asbestos cement building materials such as roofing tiles, siding, asbestos sheet and asbestos cement pipe, will continue to remain strong through the next year due to worldwide housing needs. The demand for shorter fibres is expected to weaken. Canadian production is expected to remain stable as the depletion of open-pit ore reserves at Baie Verte will likely be offset by a marginal increase of fibre from wet-processing. The general market situation is expected to remain stable, although uncertain, until the regulatory situation in the United States has been clarified by the Appeal Court's decision with respect to the EPA's asbestos rule.

Note: Information contained in this review was current as of mid-January 1991.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2524.00.10	Crude asbestos	Free	Free	Free	Free
2524.00.90	Other asbestos	8%	5%	Free	Free
6811.10	Corrugated sheets of asbestos-cement, of cellulose fibre-cement or the like	8%	5%	3.2%	Free
6811.20	Sheets n.e.s., panels/tiles etc. of asbestos-cement, cellulose fibre-cement, etc.	8%	5%	3.2%	Free
6811.30	Tubes, pipes and tube or pipe fittings of asbestos-cement, of cellulose fibre-cement, etc.	8%	5%	3.2%	0.1¢/kg
6811.90	Articles n.e.s. of asbestos-cement, of cellulose fibre-cement, or the like	8%	5%	3.2%	Free
6812.10	Fabricated asbestos fibres; mixtures with a basis of asbestos or with a basis of asbestos and magnesium carbonate	8%	5%	3.2%	Free
6812.20	Asbestos yarn and thread	12.5%	12.5%	5%	Free
6812.30	Asbestos cords and string, whether or not plaited	12.5%	12.5%	5%	Free
6812.40	Asbestos woven or knitted fabric	8%	5%	8%	Free
6812.50	Asbestos clothing, clothing accessories, footwear and headgear	25%	25%	10%	1.8%-7.5%
6812.60	Asbestos paper, millboard and felt	8%	5%	3.2%	Free
6812.70	Compressed asbestos fibre jointing, in sheets or rolls	8%	5%	3.2%	Free
6812.90.10	Asbestos belting	17.5%	7.5%	7%	Free
6812.90.90	Other asbestos fabricated products n.e.s.	8%	5%	3.2%	Free
6813.10.10	Asbestos brake linings and pads for motor vehicles of heading No. 87.02, 87.03, 87.04 or 87.05	11.3%	Free	7.9%	Free
6813.10.90	Other asbestos brake linings and pads	8%	5%	5.6%	Free
6813.90.10	Asbestos clutch facings for motor vehicles of heading No. 87.02, 87.03, 87.04 or 87.05	11.3%	7.5%	7.9%	Free
6813.90.90	Other asbestos friction material and articles n.e.s.	9.2%	2.5%	6.4%	Free

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States effective January 1, 1990.
n.e.s. Not elsewhere specified.

Asbestos

TABLE 1. CANADA, ASBESTOS PRODUCTION AND TRADE, 1989 AND 1990

Item No.		1989		1990p	
		(tonnes)	($000)	(tonnes)	($000)
Production	**(shipments)[1]**				
	By type				
	Crude, groups 1, 2 and other milled	–	–	. .	. .
	Group 3, spinning	13 907	11 990	. .	. .
	Group 4, shingle	243 273	130 009	. .	. .
	Group 5, paper	143 616	56 646	. .	. .
	Group 6, stucco	182 103	49 224	. .	. .
	Group 7, refuse	118 328	19 472	. .	. .
	Total	701 227	267 341	665 000	256 111
	By province				
	Quebec	529 713	184 199	503 000	177 135
	British Columbia	109 180	58 268	96 000	52 639
	Newfoundland	62 334	24 874	66 000	26 337
	Total	701 227	267 341	665 000	256 111
Exports				(Jan.-Sept.)	
2524.00.10	Crude asbestos				
	EC countries (12)[1]	498	298	17	6
	Japan	2 835	1 025	750	249
	Taiwan	–	–	97	148
	United States	5 841	382	74	14
	India	5 071	2 481	–	–
	Other countries	2 953	1 579	–	–
	Total	17 198	5 765	938	419
2524.00.21	Asbestos milled fibres, group 3 grades				
	EC countries (12)[1]				
	Spain	1 011	1 212	1 838	2 304
	United Kingdom	1 742	2 229	1 114	1 525
	West Germany	176	243	302	448
	Italy	367	461	263	337
	France	102	123	160	249
	Portugal	160	245	160	245
	Belgium	1 035	1 289	–	–
	EC countries subtotal	4 593	5 802	3 837	5 108
	India	164	222	1 095	1 410
	Brazil	907	1 212	407	780
	Japan	756	947	534	733
	Sri Lanka	–	–	786	633
	South Korea	574	503	444	618
	Mexico	1 011	1 643	360	573
	People's Republic of China	621	839	321	432
	Bulgaria	210	273	140	182
	United States	451	545	635	179
	Venezuela	–	–	100	140
	Turkey	1 525	1 982	53	68
	Other countries	2 947	3 745	226	316
	Total	13 759	17 713	8 938	11 172
2524.00.22	Asbestos milled fibres, groups 4 and 5 grades				
	EC countries (12)[1]				
	Italy	33 751	28 072	27 531	23 015
	France	26 788	20 807	16 916	13 871
	Spain	18 323	17 019	7 850	7 543
	Belgium	6 749	6 130	6 168	5 865
	West Germany	11 998	11 228	6 453	5 620
	United Kingdom	7 263	6 401	5 563	5 040
	Netherlands	4 557	4 780	3 250	3 174
	Other EC countries	8 203	8 245	6 141	6 191
	EC countries subtotal	117 632	102 682	79 872	70 319

TABLE 1 (cont'd)

Item No.		1989 (tonnes)	1989 ($000)	Jan.-Sept. 1990p (tonnes)	Jan.-Sept. 1990p ($000)
Exports (cont'd)					
	Japan	30 095	23 766	27 296	22 286
	Thailand	25 592	15 135	25 906	19 162
	India	25 232	21 570	24 461	19 106
	Iran	12 142	12 659	18 412	18 319
	Algeria	12 650	9 969	10 120	8 771
	Malaysia	17 220	14 400	10 855	8 728
	Mexico	5 183	4 920	4 897	4 622
	Colombia	7 608	5 520	4 805	4 481
	Indonesia	4 540	2 969	6 596	4 459
	Sri Lanka	5 970	5 407	4 286	4 092
	United States	13 311	11 152	2 168	700
	Other countries	86 767	73 358	39 316	34 062
	Total	363 942	303 507	258 990	219 107
2524.00.29	Asbestos shorts, groups 6, 7, 8 and 9 grades				
	EC (12)[1]				
	France	4 807	2 088	7 715	2 644
	Italy	9 026	3 217	5 659	1 930
	Spain	5 591	2 266	4 966	1 779
	Belgium	6 603	3 134	4 627	1 597
	United Kingdom	7 103	2 541	3 979	1 532
	West Germany	9 297	4 739	3 571	1 107
	Other EC countries	7 019	3 592	4 377	1 786
	EC countries subtotal	49 446	21 577	34 894	12 375
	Japan	51 144	18 329	35 100	11 794
	Thailand	31 737	13 617	25 653	10 990
	United States	45 285	11 650	30 538	9 219
	South Korea	43 804	14 533	21 183	7 327
	Mexico	11 885	3 961	9 357	3 313
	India	13 130	4 820	9 054	2 908
	Taiwan	14 171	4 548	5 890	1 899
	Algeria	2 150	1 010	2 630	1 335
	Indonesia	5 030	2 228	3 638	1 284
	Turkey	6 509	2 899	2 884	1 247
	Other countries	38 624	18 271	21 806	8 005
	Total	312 915	117 443	202 627	71 696
Grand total crude, milled fibres and shorts		707 814	444 428	471 493	302 394
6811.10	Corrugated sheets of asbestos-cement, of cellulose fibre-cement, or the like				
	United States	..	1	..	574
	Total	..	1	..	574
6811.20	Sheets, n.e.s., panels/tiles, etc. of asbestos-cement, cellulose fibre-cement, etc.				
	United States	..	345	..	253
	Total	..	345	..	253
6811.30	Tubes, pipes and tube or pipe fittings of asbestos-cement, of cellulose fibre-cement, etc.				
	Norway	–	–	..	12
	Dominica	..	26	–	–
	Total	..	26	..	12
6811.90	Articles n.e.s. of asbestos-cement, of cellulose fibre-cement, or the like				
	United States	..	479	..	52
	Trinidad-Tobago	..	12	–	–
	Total	..	492	..	52

TABLE 1 (cont'd)

Item No.		1989 (tonnes)	1989 ($000)	Jan.-Sept. 1990p (tonnes)	Jan.-Sept. 1990p ($000)
Exports (cont'd)					
6812.10	Fabricated asbestos fibres; mixtures with a basis of asbestos or with a basis of asbestos and magnesium carbonate				
	United States	. .	1 208	. .	2 280
	Australia	–	–	. .	96
	Japan	. .	92	–	–
	Other countries	. .	317	–	–
	Total	. .	1 617	. .	2 376
6812.20	Asbestos yarn and thread				
	United States	148	1 733	72	313
	Other countries	263	674	53	211
	Total	411	2 407	125	524
6812.30	Asbestos cords and string, whether or not plaited				
	United States	. .	102	. .	6
	Other countries	. .	40	. .	5
	Total	. .	142	. .	11
6812.40	Asbestos woven or knitted fabric				
	United States	282	627	28	280
	United Kingdom	73	447	42	254
	Other countries	4	63	12	57
	Total	359	1 137	82	591
6812.50	Asbestos clothing, clothing accessories, footwear and headgear				
	Belgium	–	–	. .	122
	India	–	–	. .	13
	Other countries	. .	165	. .	34
	Total	. .	165	. .	169
6812.60	Asbestos paper, millboard and felt				
	United States	. .	2 101	. .	101
	Australia	. .	221	. .	91
	Other countries	. .	417	. .	97
	Total	. .	2 739	. .	289
6812.70	Compressed asbestos fibre jointing, in sheets or rolls				
	United States	285	861	. .	859
	Thailand	857	485	–	–
	Total	1 142	1 347	. .	859
6812.90.10	Asbestos building materials				
	Thailand	. .	45	. .	208
	Indonesia	–	–	. .	191
	Other countries	. .	1 662	. .	309
	Total	. .	1 707	. .	708
6812.90.90	Other asbestos fabricated products n.e.s.				
	U.S.S.R.	. .	828	. .	172
	United Arab Emirates	. .	69	. .	71
	United States	. .	616	. .	39
	Other countries	. .	827	. .	94
	Total	. .	2 340	. .	376
6813.10	Asbestos brake linings and pads				
	United States	. .	9 810	. .	23 816
	Other countries	. .	571	. .	186
	Total	. .	10 381	. .	24 002

TABLE 1 (cont'd)

Item No.		1989		Jan.-Sept. 1990p	
		(tonnes)	($000)	(tonnes)	($000)
Exports (cont'd)					
6813.90	Asbestos friction material and articles n.e.s.				
	United States	. .	16	. .	149
	Other countries	. .	116	. .	27
	Total	. .	132	. .	176
Total exports, asbestos manufactured		. .	24 978	. .	30 972
Imports					
2524.00.10	Crude asbestos	285	416	106	149
2524.00.90	Other asbestos	889	361	645	287
6811.10	Corrugated sheets of asbestos-cement, of cellulose fibre-cement, or the like	. .	176	. .	36
6811.20	Sheets n.e.s., panels/tiles, etc. of asbestos-cement, cellulose-fibre cement, etc.	. .	959	. .	665
6811.30	Tubes, pipes and tube or pipe fittings of asbestos-cement, cellulose fibre-cement, etc.	. .	1 924	. .	601
6811.90	Articles n.e.s., of asbestos-cement, cellulose fibre-cement or the like	. .	598	. .	255
6812.10	Fabricated asbestos fibres; mixtures with a basis of asbestos or with a basis of asbestos and magnesium carbonate	. .	405	. .	290
6812.20	Asbestos yarn and thread	16	196	12	52
6812.30	Asbestos cords and string, whether or not plaited	. .	51	. .	37
6812.40	Asbestos woven or knitted fabric	46	593	29	357
6812.50	Asbestos clothing, clothing accessories, footwear and headgear	. .	342	. .	93
6812.60	Asbestos paper, millboard and felt	. .	1 123	. .	420
6812.70	Compressed asbestos fibre jointing, in sheets or rolls	206	1 545	46	619
6812.90.10	Asbestos belting	. .	13	. .	11
6812.90.90	Other asbestos fabricated products n.e.s.	. .	4 200	. .	2 533
6813.10	Asbestos brake linings and pads		30 560		25 899
6813.90	Asbestos friction material and articles n.e.s.		4 101		2 654

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] EC includes Belgium, Denmark, France, West Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain and United Kingdom.
p Preliminary; . . Not available or not applicable; – Nil; n.e.s. Not elsewhere specified.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADIAN ASBESTOS PRODUCERS, 1989

Producers	Mine Location	Normal Mill Capacity Ore/day	Fibre/year	Remarks
		(tonnes)		
Baie Verte Mines Inc.	Baie Verte, Nfld.	6 600	80 000	Open-pit; wet-processing facility under development.
LAB Chrysotile, Inc.[1]				Partnership owned 55% LAQ and 45% Société nationale de l'amiante (SNA)
- Lac d'Amiante du Québec, Ltée (LAQ)	Black Lake, Que.	9 000	160 000	Open-pit. Since September LAQ is owned by Jean Dupéré (President of LAB) and Connell Bros. Company, Ltd. of the United States.
- Asbestos Corporation Limited				(SNA) Quebec Crown corporation.
British Canadian mine	Black Lake, Que.	7 000	70 000	Open-pit.
- Bell Asbestos Mines, Ltd.	Thetford Mines, Que.	2 700	70 000	(SNA) Quebec Crown corporation. Underground. Mine was reopened January 1989.
J M Asbestos Inc. Jeffrey mine	Asbestos, Que.	15 000	300 000	Open-pit (effective capacity reduced by one-half since 1982).
Cassiar Mining Corporation	Cassiar, B.C.	5 000	100 000	Open-pit; some wet-milling production; development work for underground McDame orebody progressing.
Total of four producers at year-end			780 000	

[1] A partnership involving three operating companies.

TABLE 3. CANADA, ASBESTOS PRODUCTION AND EXPORTS, 1983-90

	Crude	Milled	Shorts	Total
		(tonnes)		
Production[1]				
1983	–	448 953	408 551	857 504
1984	–	442 503	394 151	836 654
1985	–	397 729	352 461	750 190
1986	–	332 092	330 289	662 381
1987	–	365 144	299 402	664 546
1988	14	399 550	310 793	710 357
1989	–	400 796	300 431	701 227
1990p	. .	. .	. .	665 000
Exports				
1983	931	384 068	368 912	753 911
1984	45	430 407	366 206	796 658
1985	44	395 158	326 311	721 513
1986	127	375 948	341 609	717 684
1987	1 696	353 321	293 808	648 825
1988	11 288	381 561	292 236	685 085
1989	17 198	377 701	312 915	707 814
1990[2]	938	267 928	202 627	471 493

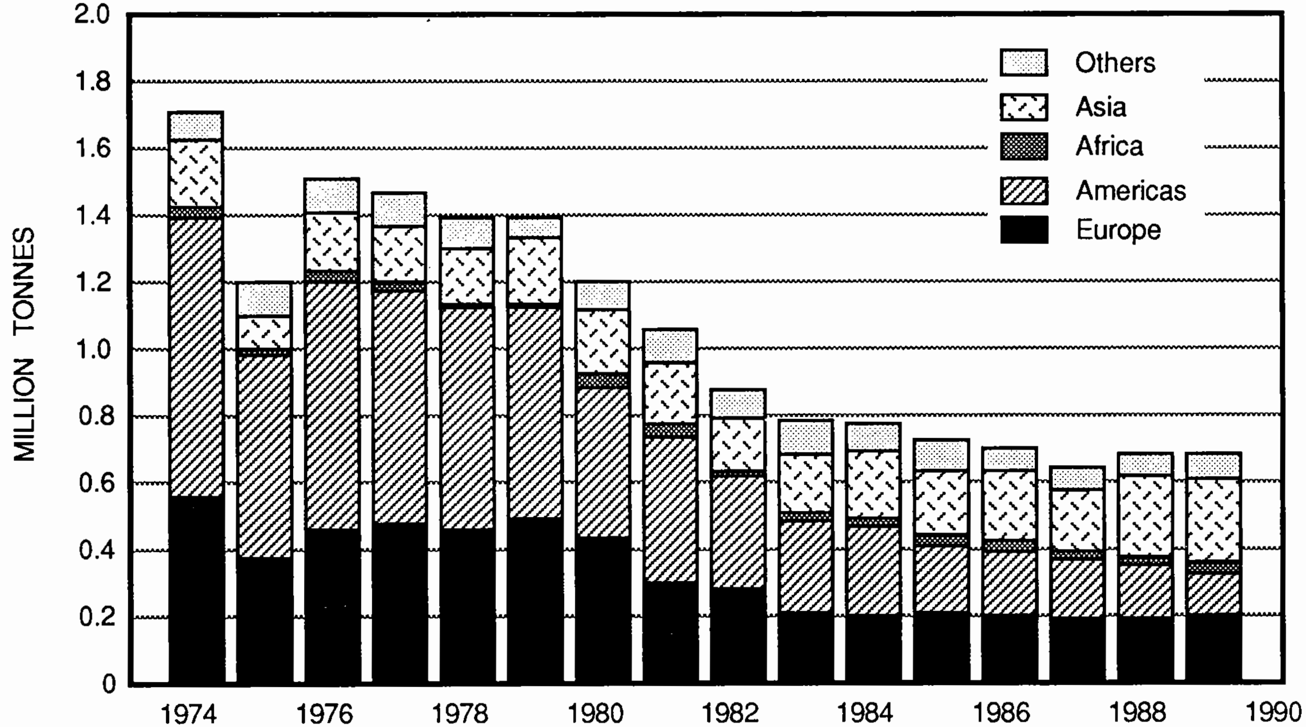
Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Producers' shipments. [2] January-September.
p Preliminary; – Nil; . . Not available.

TABLE 4. ASBESTOS: WORLD PRODUCTION BY COUNTRY, 1990

Country	Tonnes[e]
U.S.S.R.	2 568 000
Canada	705 000
Brazil	200 000
Zimbabwe	188 000
China	165 000
Republic of South Africa	154 000
United States	20 000
Greece	80 000
India	32 000
Indonesia	25 000
Swaziland	20 000
Colombia	13 000
Yugoslavia	20 000
Japan	4 000
Korea	3 000
Turkey	1 500
Argentina	1 000
Bulgaria	500
Egypt	400
Total	4 183 650

Sources: U.S. Bureau of Mines; Energy, Mines and Resources Canada.
[e] Estimated.

CANADIAN ASBESTOS EXPORTS
1974-90



Cadmium

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Cadmium is a relatively rare element in the earth's crust occurring most commonly as the sulphide minerals greenockite and hawleyite which are associated with zinc sulphide ores, particularly sphalerite. Cadmium metal is recovered principally as a by-product of zinc smelting and refining, and reserves at any time are a function of zinc reserves. Therefore, as Canada is the world's largest producer of zinc, Canada's position as a dominant source of cadmium seems assured.

CANADIAN PRODUCTION

Canada remains the fourth largest source of refined cadmium in the world after the U.S.S.R., Japan and the United States, although it is expected that with increased zinc production in 1991, Canada will become the world's second largest source. In 1990, Canadian mine output (the theoretical assay recoverable) was 1 836 942 kg, down 3.9% from 1 910 929 kg in 1989. Canadian production in 1990, that is, the actual recovery from smelters was 1 643 185 kg valued at $14 387 728 compared to 1 710 527 kg in 1989 valued at $28 026 985. The 3.9% decline in production was due to two zinc mine strikes combined with an economic slowdown in North America and the United Kingdom. The dramatic 48.7% drop in value was due to a combination of the impacts of "hedge" buying which took place between 1987 and 1989 when prices were fluctuating widely, a decrease in demand due to the negative impacts of increasing regulation, and the economic slowdown in North America.

WORLD PRODUCTION

According to the U.S. Bureau of Mines, world refinery production of cadmium is estimated to be 21 800 t for 1990, only a 5% increase from 1989. Production/consumption of cadmium in the traditionally, centrally planned economies represents approximately 22% (4300 t) of the world's production.

PROPERTIES AND USES

Cadmium is a soft, ductile, silver-white electropositive metal. Cadmium dissolves readily in mineral acids and is precipitated from solution by carbonate, hydroxide and sulphide ions. Cadmium has five main areas of application: nickel-cadmium (Ni-Cd) batteries (approaching 50%), coatings (20%), pigments (18%), stabilizers in plastics and synthetic products (6%), and alloys (6%).

Ni-Cd batteries are one of the most reliable of the rechargeable battery systems with advantages such as long life, high reliability and minimal maintenance requirements. Ni-Cd batteries have been largely responsible for the steadily rising demand for cadmium, almost 5%-10%/y. Although commonly associated with small electronic applications, large cell batteries are widely used for standby and emergency power in hospitals, telephone exchanges and computer installations where an uninterrupted power supply is essential.

Cadmium coatings are widely used to provide corrosion protection to components made of iron and steel. Cadmium coatings may be applied by electroplating, mechanical plating or vacuum and ion deposition. The high ductility of cadmium is an advantage where the plated parts are to be formed. The good soldering characteristics of cadmium plate are advantageous in electrical applications. Cadmium coatings are sometimes preferred to zinc coatings as cadmium coatings are more ductile, can be applied more uniformly in recesses of intricately shaped parts, have a more aesthetic appearance, and give increased protection with the same thickness of a zinc coating. Cadmium coatings are preferred in the electrical, electronic, automotive and aerospace industries.

Cadmium pigments, giving good uniform colour and resistance to both chemical attack and light degradation, are used to impart bright, clear colours, commonly reds and yellows, to plastics and ceramics.

Cadmium-barium stabilizers are used to retard the degradation of polyvinylchloride (PVC) on exposure to heat and sunshine.

Cadmium-containing alloys have two primary uses: those where cadmium helps produce low melting point alloys (e.g. cadmium-lead-tin-bismuth alloys for soldering at 70°C for parts sensitive to heat); and those in which the cadmium improves mechanical properties (e.g. alloyed with zinc which is to be rolled or extruded).

HEALTH AND SAFETY ISSUES

Cadmium is considered toxic because it is easily ingested through food, water and air but cannot be excreted. In mammals, cadmium is a cumulative toxicant concentrating in the liver, kidney, pancreas and thyroid. It can also form organic compounds which could lead to mutagenic or teratogenic effects. Cadmium acts synergistically with other metals, increasing its toxicity, particularly with copper and zinc.

The cadmium industry has, over the years, taken increasing measures to reduce risks to workers. Cadmium production and processing are subject to very strict controls in Canada, the European Communities (EC) and the United States. The general public is exposed to very little cadmium although small amounts can be absorbed from food. As cigarettes contain small amounts of cadmium, smoking can also increase an individual's intake.

REGULATORY DEVELOPMENTS

Because of its toxicity, cadmium is the subject of extensive legislation aimed at protecting workers and restricting the amounts of metal which can enter into the environment.

In Canada, cadmium is regulated under the Canada Labour Code and each province has specific exposure limits under its occupational health and safety legislation. Canada's Guidelines for Drinking Water Quality state that the maximum acceptable concentration of cadmium is 0.005 mg/litre.

In February 1990, the U.S. Occupational Safety and Health Administration (OSHA) issued its proposed rule on occupational exposure to cadmium. OSHA proposed "two 8-hour, time-weighted average permissible exposure limits (TWA PEL) of 5 and 1 micrograms (μg) of cadmium per cubic metre of air. In addition, OSHA proposed to set an action level of 2.5 $\mu g/m^3$ for a TWA PEL of 5 $\mu g/m^3$ and an action level of 0.5 $\mu g/m^3$ for a TWA PEL of 1 $\mu g/m^3$." OSHA's proposed rule is under review as only very few applications could achieve the proposed exposure levels. The review is expected to be finalized in October 1991 after which it will need to go to the Office of Management and Budget for approval. OSHA expects the rule to be implemented in early 1992.

The EC has many directives/regulations on cadmium dating back to 1974. In 1979, Sweden initiated a ban on certain cadmium-containing products, but as substitutes are not readily available, this action met with only limited application. In fact, today, Sweden is a major manufacturer in Europe of Ni-Cd batteries. More recently, the EC has drafted a directive on "Cadmium-Pigments, Stabilizers and Plating" and is proposing to prohibit cadmium in certain, but not all, plastics. Where there is no substitute, and where defense, safety and other applications of cadmium are essential, its use is permitted under strict workplace and environmental controls.

PRICES

Cadmium producer prices peaked at US$6.91/lb in 1988 due to a rising demand against a shortfall in supply. In 1989, prices fell 9% to an average price of US$6.28/lb and, in 1990, the average price fell to US$3.38/lb due to the combined effects of previous "hedge" buying, the economic slowdown in North America, and constraints on demand due to increasing regulation.

OUTLOOK

Although by-product metals demand or price are always difficult to forecast, it is expected that growth will only occur in the Ni-Cd battery market, although perhaps at a decreased rate as many companies are expending considerable R&D funds to develop cadmium-free rechargeable batteries. Demand for cadmium in other areas is decreasing as many users are searching for unregulated substitutes. In short, the prospects for cadmium are not good.

Note: Information contained in this review was current as of mid-January 1991.

TARIFFS

		Canada			United States	EEC	Japan[1]
Item No.	Description	MFN	GPT	USA	Canada	MFN	MFN
2617.90.00.30	Cadmium ores and concentrates	Free	Free	Free	Free	Free	Free
2825.90.90.10	Cadmium oxide	Free	Free	Free	2.2%	11%	5.8%
2830.30	Cadmium sulphide	Free	Free	Free	1.8%	6.9%	3.7%
8107.10.10	Unwrought cadmium, not alloyed; powders, not alloyed	Free	Free	Free	Free	4%	5.1%
8107.10.20	Unwrought cadmium, alloyed; waste and scrap; powders, alloyed	10.2%	6.5%	4%	Free	4%	5.1%
8107.90	Cadmium and articles thereof, n.e.s.	10.2%	6.5%	4%	3.3%	6%	6.5%

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States effective January 1, 1990; Official Journal of the European Communities, Vol. 33, No. L247, 1990, "Conventional" column; Custom Tariff Schedules of Japan, 1990.

[1] GATT rate is shown, lower tariff rates may apply circumstantially.

n.e.s. Not elsewhere specified.

TABLE 1. CANADA, CADMIUM PRODUCTION AND TRADE, 1989 AND 1990 AND CONSUMPTION, 1987-89

Item No.		1989		1990p	
		(kilograms)	($000)	(kilograms)	($000)
Production (all forms)[1]					
	Ontario	824 162	13 504	846 000	7 408
	British Columbia	327 264	5 364	285 000	2 495
	Northwest Territories	268 869	4 405	273 000	2 392
	Manitoba	125 463	2 056	104 000	907
	Newfoundland	63 187	1 035	49 000	429
	Quebec	44 878	735	37 000	324
	Nova Scotia	3 000	49	28 000	247
	New Brunswick	50 000	819	21 000	184
	Saskatchewan	3 200	52	...	2
	Yukon	504	8	–	–
	Total	1 710 527	28 027	1 643 000	14 388
	Refined[2]	1 619 798	..	1 436 600	..
Imports				**(Jan.-Sept.)**	
2825.90.90.10	Cadmium oxide				
	Belgium	29 400	509	22 649	309
	United States	15 796	261	11 200	228
	United Kingdom	2 400	51	808	17
	Total	47 596	821	34 657	554
2830.30	Cadmium sulphide				
	United States	82 549	55	28 933	19
	Total	82 549	55	28 933	19
8107.10.10	Unwrought cadmium, not alloyed; powders, not alloyed				
	United States	4 240	73	22 066	226
	West Germany	22	1	57	2
	Total	4 262	74	22 123	228
8107.10.20.10	Unwrought cadmium, alloyed; powders, alloyed				
	United States	1 925	27	48	1
	Total	1 925	27	48	1
8107.10.20.20	Cadmium waste and scrap				
	Zaire	–	–	811	8
	Total	–	–	811	8
8107.90	Cadmium and articles thereof, n.e.s.				
	United States	34 512	652	12 641	199
	Other countries	21 703	443	–	–
	Total	56 215	1 095	12 641	199
Exports					
2830.30	Cadmium sulphide				
	United States	–	–	–	–
	Total	–	–	–	–
8107.10	Unwrought cadmium; waste and scrap; powders				
	United States	797 429	10 514	521 297	5 154
	Japan	314 343	5 709	213 762	2 232
	France	104 748	1 242	36 334	481
	Other countries	167 795	2 540	31 925	210
	Total	1 384 315	20 005	803 318	8 077
8107.90	Cadmium and articles thereof, n.e.s.				
	France	–	–	5	2
	United States	18 819	416	–	–
	United Kingdom	4	20	–	–
	Other countries	30 006	24	–	–
	Total	48 829	460	5	2

TABLE 1 (cont'd)

Item No.	1987	1988	1989p
		(kilograms)	
Consumption			
Cadmium metal[3]			
Plating	12 490	15 426	16 261
Solders, other alloys and other uses[4]	6 429	4 562	10 665
Total	18 919	19 988	26 926

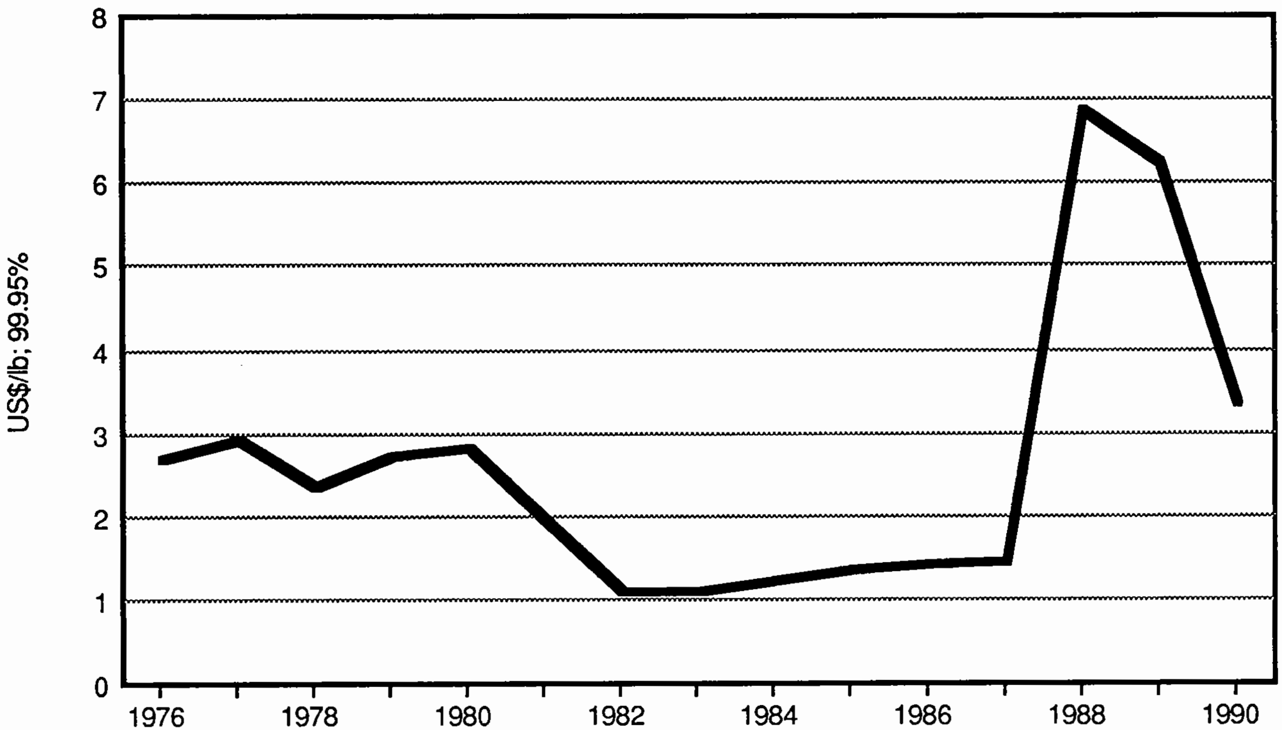
Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Production of refined cadmium from domestic ores, plus recoverable cadmium content of exported ores and concentrates.
[2] Refined metal from all sources and cadmium sponge. [3] Available data reported by consumers. [4] Chemicals and pigments.
p Preliminary; – Nil; n.e.s. Not elsewhere specified; .. Not available; ... Amount too small to be expressed.

TABLE 2. CANADA, CADMIUM PRODUCTION AND EXPORTS, 1975 AND 1980-90

	Production		Exports
	All Forms[1]	Refined[2]	Cadmium Metal
		(kilograms)	
1975	1 191 674	1 142 508	637 797
1980	1 033 000	1 302 955	1 095 825
1981	833 788	1 293 265	1 452 904
1982	886 055	1 162 390	769 505
1983	1 107 000	1 296 000	1 365 111
1984	1 605 300	1 756 707	1 369 422
1985	1 716 731	1 696 192	1 477 415
1986	1 483 907	1 551 732	1 382 807
1987	1 481 496	1 571 444r	1 156 555
1988	1 663 978	1 693 708	1 142 716
1989	1 710 527	1 619 798	1 433 144
1990p	1 643 000	1 436 600	803 323a

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Production of refined cadmium from domestic ores plus recoverable cadmium content of exported ores and concentrates. [2] Refined metal and cadmium sponge from all sources.
a For 1990, first nine months only; p Preliminary; r Revised.

PRODUCER PRICE: CADMIUM
1976-90



Source: Metals Week.

Cement

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In 1990, construction activity in Canada dropped in the residential sector and slowed in the non-residential building and engineering construction sectors. The rate of decline in housing starts accelerated in September when starts dropped to their lowest level in five years. Total cement shipments were 11.3 Mt valued at nearly $865 million, a decrease of more than 10% compared to 1989, based on preliminary figures. Production capacity in Canada remained the same at about 14.5 Mt/y.

Economic growth and construction activity began to slow near the end of 1989 following the general economic recovery after the 1982-84 period of recession. However, the commercial and institutional building sectors, along with engineering construction expenditures–with oil and gas accounting for up to one third–continued to be relatively stronger following the broad upturn that began in 1988.

THE CANADIAN INDUSTRY

The Canadian cement industry is diversified and vertically integrated into the closely related construction materials and products fields. Many cement manufacturers also supply ready-mix concrete, stone, aggregates, and concrete products such as slabs, bricks and pre-stressed concrete units. The industry is about 80% foreign controlled and it is strongly regionalized with capacity situated near growth areas in Canada and, in some cases, the United States. Recently, major international companies have purchased Canadian-based cement operations. These include S.A. Cimenteries CBR (CBR) of Belgium's purchase of Genstar Cement Limited (now renamed Inland Cement Limited), and the Société des Ciments Français' acquisition of Lake Ontario Cement Limited (now called Essroc Canada Inc.). The CBR plants in the "inland" western provinces continue to operate under the name Inland Cement Limited. In British Columbia, CBR's cement operations conduct business under the name of Tilbury Cement Limited, with production facilities in Delta and distribution centres throughout the province.

Essroc Canada Inc. is well integrated into the concrete products field. In 1989, its predecessor completed the takeover of Miron Inc., which currently has no clinker-producing capacity but is a major importer of cement and operates ready-mix plants in Quebec and Ontario.

Clinker-producing and finish-grinding capacities for cement are listed in Table 2, the former being the best measure of a plant's cement-manufacturing capacity given that clinker can be stockpiled or purchased from outside sources. For this reason, plant-grinding capacities may be significantly greater than their capabilities for producing primary stage clinker which is dependent on the necessary raw materials.

Two plants in the **Atlantic region** , which obtain raw materials on-site or nearby, account for about 4% of total Canadian clinker-producing capacity. North Star Cement Limited is now capable of producing specialty cements as well as Normal Portland cement at its Corner Brook, Newfoundland plant. The Lafarge Canada Inc. plant at Havelock, New Brunswick, with grinding capacity of 315 000 t/y, was retired in 1988. Previously, clinker was provided on a demand basis from the company's Brookfield, Nova Scotia plant.

In the **Quebec region**, four clinker-producing plants account for about 24% of Canadian output in a region which in 1989 consumed about 2.2 Mt of Portland cement, or 24% of total Canadian consumption.

Portland cement consumption in the **Ontario region,** where more than 40% of the nation's clinker-producing capacity is situated, decreased more than 18% in 1990. Lafarge

Canada Inc. has brought into production about 3 Mt of new cement capacity over the past 13 years. Emphasis continued on co-processing–or converting waste into fuel–and building new terminals to increase storage and consolidate markets. Limestone for Lafarge's Bath, Ontario plant is quarried on-site and silica is supplied from Potsdam sandstone at Pittsburgh, about 65 km east of Bath. Iron oxide and gypsum are purchased from Hamilton and Nova Scotia, respectively. The Woodstock plant obtains limestone on-site, silica from Falconbridge Limited, iron oxide from Stelco Inc. and gypsum from southern Ontario.

At Picton, Essroc Canada Inc. operates one of the largest cement plants in North America. In addition to the company's usual markets, the four-kiln plant supplies cement and clinker to an associated company, ESSROC Materials Inc., in the states of New York and Michigan.

St. Lawrence Cement Inc. suspended plans to build a $200 million, 900 000 t/y cement plant at Hudson, New York. The company continued work on its Resource Recovery/Refuse Derived Fuel (RDF) project. Following an acceptable assessment by environmental authorities, plans are to replace up to 20% of the company's coal consumption with RDF produced from local non-hazardous municipal wastes. Expanding aggregate operations and reserves of raw material remain major objectives. Gypsum is purchased from Nova Scotia or from southern Ontario mines.

St. Marys Cement Company continued with its $160 million plant expansion to at least double production capacity at Bowmanville. A state-of-the-art, dry-process system will replace two wet-process kilns and production of limestone on-site will be increased accordingly.

Two companies, Lafarge Canada Inc. and CBR's Inland/Tilbury operations, operate a total of four clinker-producing plants in the **Prairie region** and three in the **Pacific region**. This broad **Western region** accounts for about 27% of clinker-producing capacity, roughly in proportion to its share of total Canadian consumption.

A limestone quarry at Mafeking, Manitoba, near the Manitoba-Saskatchewan border, supplies limestone to Inland's Regina plant, while the Winnipeg plant is supplied from Steep Rock, Manitoba.

Raw materials for Lafarge's Exshaw plant are mainly from on-site sources, whereas gypsum and iron oxide are provided by Westroc Industries Limited and Cominco Ltd., respectively. Lafarge's Vancouver plant at Richmond, as well as Tilbury's plant, utilizes limestone from Texada Island. The company's Kamloops plant is supplied from reserves nearby.

WORLD DEVELOPMENTS

During the 1980s, the cement industry underwent marked changes in ownership, production and sourcing. In many regions, the commodity has been transformed from a domestically manufactured and marketed product to one having international status, interest and trade.

World cement production in 1989 was 1121 Mt, according to the U.S. Bureau of Mines. China ranked number one, leading all countries with 207 Mt, followed by the U.S.S.R. at 140 Mt and the United States at 72 Mt.

In August, the U.S. International Trade Commission (USITC) ruled that Mexican exports of grey Portland cement and cement clinker to the United States were materially injuring the U.S. cement industry. The action was filed by cement producers in the southern states; resulting anti-dumping duties against the Mexican producers range from nearly 58% to less than 4%.

Later in the year, the U.S. Department of Commerce issued a preliminary determination that grey Portland cement and clinker from Japan was being dumped in the United States. U.S. importers will be required to post bonds for the products equal to the estimated dumping margins and are at risk for paying duties on future imports. A final determination concerning material injury is expected in March 1991.

Most countries are capable of supplying their own raw material requirements for cement manufacture when a plant is warranted. Normally, market range is strictly limited by transportation costs; however, large additional sales may warrant secondary distribution terminals. Few countries rely entirely on imports for their cement needs. However, in recent years multinational companies with widespread production and distribution networks have become much more important in world markets. An outstanding recent example of this is the partial consolidation of the American, Canadian and Mexican cement industries to effect very broad regional marketing. An estimated 70% of the U.S. industry is now controlled by European and Pacific Rim cement producers.

CONSUMPTION AND TRADE

Portland cement is produced by burning, usually in a rotary kiln, an accurately proportioned, finely ground mixture of limestone, silica, alumina and iron oxide. The three most commonly used types of cement are Normal Portland, High-Early-Strength Portland and Sulphate-Resisting Portland, produced by most Canadian cement manufacturers. Concrete has become a readily adaptable material capable of being poured on-site for large engineering projects, or used in the form of delicate precast panels or as heavy, pre-stressed columns and beams in building construction.

Consumption of cement or concrete is about evenly distributed between the residential, non-residential and public-related construction sectors of the economy.

The trend continues toward an interconnected North American cement market. Low-cost marine transportation has influenced trade considerably with imports now providing about 20% of consumption in the United States.

Exports of Canadian cement and clinker are mainly to bordering states, particularly New York, Vermont, Michigan, Minnesota and Washington. Canadian cement production efficiencies and a relatively strong American dollar continue to make Canadian cement and clinker competitive in their own right.

TECHNOLOGY

Objectives continue to be directed toward using cheaper fuels, improving methods for defining optimum particle sizes based on grinding, and using waste materials in kilns because pyro-processing accounts for more than 80% of total energy needs. Of this amount, clinker accounts for about 85% and cement for about 15%. Waste fuels were used as a primary or secondary fuel at six plants in 1989, according to the Canadian Portland Cement Association. Energy conservation programs adopted by the cement industry have reduced the energy consumption per unit of production by about 22% between 1974 and 1989. In 1989, the Canadian cement industry consumed 4986 megajoules per tonne of production on average, of which 4412 megajoules were derived from fossil fuels.

During recent years, the fuel mix has changed considerably away from natural gas and petroleum products toward coal/coke. In 1989, more than 60% of plants reported using coal or coke and about 30% used natural gas as a primary source of fuel. Dry-process plants accounted for about 80% of total Canadian cement production in 1989.

Research in the private sector is conducted on behalf of all cement producers by the Portland Cement Association (PCA), a non-profit research group sponsored by the cement industry. In the case of Lafarge, the new Montreal-based facility is mandated "to develop new manufacturing processes and improve cement and concrete products tailored to the Canadian and U.S. markets."

The federal government recently awarded the Network of Centres of Excellence in High-Performance Concrete $6.4 million in funding for the next four years. This network links materials experts, designers and specialists from seven universities and two consulting firms.

Ongoing research relating to supplementary cementing materials, and sponsored through the Canada Centre for Mineral and Energy Technology (CANMET), led to the successful use of blast-furnace slag for making a slag cement. Reiss Lime Company of

Canada, Limited now produces this type of cement from a grinding plant at Spragge, Ontario, using granulated slag from The Algoma Steel Corporation, Limited's plant at Sault Ste. Marie. Capacity is 200 000 t/y of slag cement for complete or partial replacement of Portland cement, depending on needs. The primary use at present is in mine backfill; however, construction-related uses are also being investigated.

CANMET, along with the National Research Council's Institute for Research in Construction, was a major sponsor of the International Workshop on Fly Ash in Concrete. The purpose of the workshop, held in Calgary, Alberta, was to acquaint engineers, concrete producers and municipal authorities with new developments. Special emphasis was placed on the development of high-volume fly-ash (ASTM Class F) concretes for structural use; fibre-reinforced, high-volume fly-ash concrete as a capping material for mine tailings; roller-compacted concrete; and also on the durability of concrete made with ASTM Class F and Class C fly ashes.

Moderate Portland cement and Low-Heat-of-Hydration Portland cement, designed for concrete poured in large masses such as in dam construction, are manufactured by several companies in Canada. Masonry cement (generic name) includes such proprietary product names as Mortar Cement, Mortar Mix (unsanded), Mason's Cement, Brick Cement and Masonry Cement. The latter product, produced by Portland cement manufacturers, is a mixture of Portland cement, finely ground high-calcium limestone (35%-65% by weight) and a plasticizer. The aforementioned products do not necessarily consist of Portland cement and limestone, but may include mixtures of Portland cement and hydrated lime and/or other plasticizers.

Portland cement used in Canada should conform to the specifications of CAN/CSA-A5-M88, published by the Canadian Standards Association (CSA). This standard covers the five main types of Portland cement. Masonry cement produced in Canada should conform to the specifications of CAN/CSA-A8-M88. Blended hydraulic cements are covered by CAN/CSA-A362-M88. The cement types manufactured in Canada but not covered by the CSA standards generally meet the appropriate specifications of the American Society for Testing and Materials (ASTM).

OUTLOOK

The recession that began in the second quarter of 1990 deepened and the inflation-adjusted gross domestic product fell to an annual rate of decline of 1.0% in the third quarter. Interest rates remained relatively high and the demand for housing recorded the largest percentage of declines. Business investment in plant and equipment also turned downward, marking a sharp reversal from the optimism concerning earlier investment intentions. Housing starts were 222 562 in 1988, 215 382 in 1989, and then fell to about 182 000 in 1990. The outlook for new housing and office building construction remains uncertain; however, general construction activity outside of central Canada is expected to improve. Activity associated with the petroleum industry, roads, natural gas pipelines and forestry projects in the West, along with Hibernia-related construction in Newfoundland, is expected to improve the outlook for 1991/92.

The construction industry as a whole has expressed concern that Canada's large infrastructure network deserves attention now, rather than delaying until major renovation and upkeep projects are needed. Such a program would permit the construction industry, and the dependent portion of the mining industry, to plan five to ten years ahead with overall benefits in efficiency.

Conservation of energy and raw materials is an important concern and a factor influencing developments in the industry. Objectives to reduce costs will focus on the use of cheaper fuels, technological advances and more use of waste materials to heat kilns. Also, the use of blended cements, as well as the utilization of slag, ash and other by-products, is expected to grow.

Note: Information contained in this review was current as of mid-January 1991.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2523.10	Cement clinker	Free	Free	Free	Free
	Portland cement				
2523.21	White cement whether or not artificially coloured	81.59¢/t	54.25¢/t	Free	Free
2523.29	Other	Free	Free	Free	Free
2523.30	Aluminous cement	Free	Free	Free	Free
2523.90	Other hydraulic cements	Free	Free	Free	Free
68.10	Articles of cement, of concrete or of artificial stone, whether or not reinforced				
	Tiles, flagstones, bricks and similar articles				
6810.11	Building blocks and bricks	5%	Free	2%	2.9%
6810.19	Other				
6810.19.10	Floor and wall tiles	8%	Free	3.2%	4.2%-12.6%
6810.19.50	Other	8%	Free	3.2%	2.9%
6810.20	Pipes	9.8%	6.5%	3.9%	2.9%
6810.91	Prefabricated structural components for building or civil engineering	6.8%-8%	Free-4.5%	2.7%-3.2%	2.9%

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States effective January 1, 1990.
n.e.s. Not elsewhere specified.

Cement

TABLE 1. CANADA, CEMENT PRODUCTION AND TRADE, 1988-90

Item No.		1988		1989		1990p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Production[1] (all forms)							
Ontario		5 523 944	436 269	5 778 817	444 408	5 157 552	401 793
Quebec		3 253 764	189 364	3 170 906	186 457	2 845 000	165 547
Alberta		x	x	x	x	x	x
British Columbia		x	x	x	x	x	x
Manitoba		x	x	x	x	x	x
Nova Scotia		x	x	x	x	x	x
Saskatchewan		x	x	x	x	x	x
Newfoundland		x	x	x	x	x	x
New Brunswick		x	x	x	x	x	x
Total		12 349 873	971 293	12 590 637	960 000	11 252 043	864 929
Imports						(Jan.-Sept.)	
2523.10	Cement clinker						
	Japan	42 800	1 512	–	–	25 000	1 140
	United States	3 581r	159r	38 589	2 239	15 441	919
	Venezuela	–	–	–	–	27 340	808
	Colombia	–	–	27 500	1 512	20 634	631
	Other countries	178 738r	6 238r	68 087	3 106	–	–
	Total	225 119r	7 911r	134 176	6 858	88 416	3 500
2523.21	Portland cement, white whether or not artificially coloured						
	United States	5 593	621	6 514	1 149	5 900	1 092
	Other countries	2 925	454	8 790	503	341	49
	Total	8 519	1 075	15 305	1 653	6 243	1 142
2523.29	Portland cement, n.e.s.						
	United States	305 022r	18 296r	330 759	18 900	256 765	15 529
	Turkey	–r	–r	–	–	72 070	3 211
	Other countries	98 453r	4 136	108 669	4 752	7 517	524
	Total	403 478r	22 435r	439 428	23 656	336 352	19 265
2523.30	Aluminous cement						
	United States	21 540r	6 115r	12 986	4 731	13 011	5 376
	Other countries	252r	70r	40	28	5	2
	Total	21 792r	6 185r	13 026	4 760	13 016	5 378
2523.90	Hydraulic cement, n.e.s.						
	United States	34 169r	4 188r	58 601	5 511	14 520	2 401
	Turkey	–	–	–	–	24 300	1 065
	Other countries	309r	47r	3 338	307	2 222	224
	Total	34 480r	4 239r	61 941	5 823	41 042	3 694
6810.11	Building blocks and bricks of cement, concrete or artificial stone						
	United States	. .	8 834r	. .	4 915	. .	2 330
	United Kingdom	–	–	. .	56	. .	66
	Other countries	. .	2	. .	226	–	–
	Total	. .	8 837r	. .	5 199	. .	2 397
6810.19	Tiles, flagstones and similar articles of cement/concrete or artificial stone						
	United States	. .	2 804r	. .	5 233	. .	4 845
	Italy	. .	1 858r	. .	4 616	. .	2 178
	Other countries	. .	320r	. .	357	. .	600
	Total	. .	4 986r	. .	10 210	. .	7 628
6810.20	Pipes of cement or concrete						
	United States	. .	18r	. .	22	. .	77
	Total	. .	18r	. .	22	. .	77
6810.91	Prefabricated structural components of buildings, etc. of cement/concrete, etc.						
	United States	. .	713r	. .	1 528	. .	2 390
	Other countries	. .	87	. .	140	. .	84
	Total	. .	801r	. .	1 670	. .	2 475
6810.99	Articles of cement, of concrete or of artificial stone, n.e.s.						
	United States	. .	2 999r	. .	3 076	. .	2 892
	United Kingdom	. .	160r	. .	446	. .	238
	Other countries	. .	139r	. .	285	. .	511
	Total	. .	3 303r	. .	3 813	. .	3 647
Exports							
2523.10	Cement clinker						
	United States	331 796	11 565	178 491	6 432	270 751	10 489
	Total	331 796	11 565	178 491	6 432	270 751	10 489

TABLE 1 (cont'd)

Item No.		1988		1989		Jan.-Sept. 1990p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Exports (cont'd)							
2523.21	Portland cement, white whether or not artificially coloured						
	United States	76 234	9 353	34 440	3 503	86 021	9 916
	Other countries	2 408	283	526	413	26	2
	Total	78 642	9 637	34 966	3 918	86 047	9 919
2523.29	Portland cement, n.e.s.						
	United States	3 164 438r	116 963r	2 194 947	99 870	1 687 720	94 403
	Other countries	6 312r	556r	18 338	2 636	2 763	310
	Total	3 170 750r	117 527r	2 213 285	102 515	1 690 438	94 716
2523.30	Aluminous cement						
	United States	499	125	42 531	24	–	–
	Other countries	9	7	2	1	–	–
	Total	508	133	42 533	26	–	–
2523.90	Hydraulic cement, n.e.s.						
	United States	86 526	6 131	54 300	2 314	60 319	4 972
	Other countries	725	231	11 510	149	235	61
	Total	87 251	6 368	65 810	2 468	60 554	5 036
6810.11	Building blocks and bricks of cement, concrete or artificial stone						
	United States	. .	3 441	. .	2 663	. .	2 968
	Other countries	. .	140	. .	209	. .	39
	Total	. .	3 585	. .	2 875	. .	3 008
6810.19	Tiles, flagstones and similar articles of cement/concrete or artificial stone						
	United States	. .	5 770	. .	1 654	. .	2 450
	Other countries	. .	833	. .	64	–	–
	Total	. .	6 608	. .	1 719	. .	2 450
6810.20	Pipes of cement or concrete						
	United States	. .	747	. .	59	. .	54
	Other countries	. .	1 631	–	–	–	–
	Total	. .	2 379	. .	59	. .	54
6810.91	Prefabricated structural components of buildings, etc. of cement/concrete, etc.						
	United States	. .	45 082	. .	39 952	. .	25 493
	Other countries	. .	3 195	. .	2 359	. .	6 043
	Total	. .	48 280	. .	42 315	. .	31 539
6810.99	Articles of cement, of concrete or of artificial stone, n.e.s.						
	United States	. .	4 444	. .	4 891	. .	7 472
	Other countries	. .	125	. .	87	. .	3
	Total	. .	4 573	. .	4 981	. .	7 476

Sources: Energy, Mines and Resources Canada; Statistics Canada.
1 Producers' shipments plus quantities used by producers.
p Preliminary; r Revised; . . Not available; n.e.s. Not elsewhere specified; – Nil; x Confidential.
Note: Totals may not add due to rounding.

TABLE 2. CEMENT PLANTS, APPROXIMATE ANNUAL GRINDING CAPACITY, END OF 1989

Company	Plant	Wet (W) Dry (D) Preheater (x) Precalciner (c)	Fuel (Coal, Oil, Gas)	No. of Kilns	Grinding Capacity	Clinker Capacity
					(000 t/y)	
Atlantic						
Lafarge Canada Inc.	Brookfield, N.S.	D	C,O	2	485	458
North Star Cement Limited	Corner Brook, Nfld.	Dx	O	1	275	152
Atlantic Region Total				3	760	610
Quebec						
Lafarge Canada Inc.	Montreal East				600	–
Lafarge Canada Inc.	St. Constant	D	C,O,G	2	955	901
Ciment Québec Inc.	St. Basile	W,Dc	O,G	3	830	1 074
St. Lawrence Cement Inc.	Beauport	W	C	2	675	624
(Independent Cement Inc.)	Joliette	D	C,O	4	1 075	991
Quebec Region Total				11	4 135	3 590
Ontario						
Lafarge Canada Inc.	Woodstock	W	C,G	2	535	504
	Bath	Dx	C,G	1	1 000	943
Federal White Cement Ltd.	Woodstock	D	C,O,G	1	145	142
Lake Ontario Cement Limited	Picton	D,Dx	C,G	4	927	1 495
St. Lawrence Cement Inc.	Mississauga	W,Dc	C,O,G	3	1 640	1 864
St. Marys Cement Company	Bowmanville	W	C	2	910	600
	St. Marys	Dx	C,G	1	800	737
Ontario Region Total				14	5 957	6 285
Prairies						
Lafarge Canada Inc.	Fort Whyte, Man.			–	400	–
	Exshaw, Alta.	D,Dc	G	3	1 184	1 184
Inland Cement Limited- (S.A. Cimenteries CBR)	Winnipeg, Man.	W	G	1	370	350
	Regina, Sask.	D	O,G	1	215	200
	Edmonton, Alta.	Dc	G	1	780	726
Prairies Region Total				6	2 949	2 460
British Columbia						
Lafarge Canada Inc.	Kamloops	D	C,G	1	190	180
	Richmond	W	C,G	2	555	485
Tilbury Cement Limited- (S.A. Cimenteries CBR)	Tilbury Inland	Dx	C,G	1	1 000	884
B.C. Region Total				4	1 745	1 549
Canada Total (9 companies)				38	15 546	14 494

Source: Market and Economic Research Department, Portland Cement Association.
– Nil.

TABLE 3. CANADA, CEMENT PLANTS, KILNS AND CAPACITY UTILIZATION, 1978-90

	Clinker-Producing Plants	Sites	Approximate Cement Grinding Capacity[1]	Portland and Masonry Cement Production[2]	Clinker Exports	Approximate Total Production[3]	Capacity Utilization
			(t/y)	(t)	(t)	(t)	(%)
1978	24	51	15 985 000	10 558 279	1 077 274	11 635 553	72
1979	24	51	15 985 000	11 765 248	1 530 537	13 295 785	83
1980	23	47	16 363 000	10 274 000	726 087	11 000 087	67
1981	23	48	16 771 000	10 145 000	524 006	10 669 006	64
1982	23	48	16 771 000	8 418 000	290 329	8 708 329	50
1983	23	49	17 900 000	7 870 878	404 793	8 275 671	46
1984	23	49	17 900 000	9 387 466	440 297	9 827 763	55
1985	23	49	17 900 000	10 192 442	676 596	10 869 038	61
1986	23	49	17 900 000	10 611 223	324 000	10 935 223	61
1987	20	40	16 600 000	12 603 164	767 338	13 370 502	81
1988	20	40	15 506 000	12 349 873	331 796	12 681 669	82
1989[r]	20	38	15 546 000	12 590 637	178 491	12 769 128	82
1990[p]	20	38	15 546 000	11 252 043	460 075	11 712 118	82

Sources: Statistics Canada; U.S. Bureau of Mines; Portland Cement Association (PCA).
[1] Includes plants that grind only. [2] Producers' shipments and amounts used by producers. [3] Cement shipments plus clinker exports.
[p] Preliminary; [r] Revised.

TABLE 4. CANADA, HOUSE CONSTRUCTION, BY PROVINCE, 1989 AND 1990

	Starts			Completions			Under Construction		
	1989	1990	% Diff.	1989	1990	% Diff.	1989	1990	% Diff.
Newfoundland	3 536	3 245	–8.2	3 783	3 127	–17.3	3 168	3 201	1.0
Prince Edward Island	815	762	–6.5	927	683	–26.3	380	463	21.8
Nova Scotia	5 359	5 560	3.8	4 904	5 477	12.0	3 364	3 376	0.4
New Brunswick	3 681	2 683	–27.1	3 383	2 959	–12.5	1 638	1 359	–17.0
Total (Atlantic Provinces)	13 391	12 250	–8.5	12 997	12 246	–5.8	8 550	8 402	–1.7
Quebec	49 058	48 070	–2.0	50 855	52 630	3.5	19 527	14 719	–24.6
Ontario	93 337	62 649	–32.9	99 817	80 562	–19.3	66 695	47 808	–28.3
Manitoba	4 084	3 297	–19.3	6 461	4 028	–37.7	2 032	1 316	–35.2
Saskatchewan	1 906	1 417	–25.7	2 743	1 575	–42.6	979	809	–17.4
Alberta	14 712	17 227	17.1	12 763	17 467	36.9	6 297	5 973	–5.1
Total (Prairie Provinces)	20 702	21 941	6.0	21 967	23 070	5.0	9 308	8 098	–13.0
British Columbia	38 894	36 720	–5.6	31 735	37 655	18.7	23 483	21 645	–17.8
Total Canada	215 382	181 630	–15.7	217 371	206 163	–5.2	127 563	100 672	–21.1

Source: Canada Mortgage and Housing Corporation.

TABLE 5. CANADA, VALUE OF CONSTRUCTION BY TYPE[1], 1988-90

	1988	1989	1990
		($ millions)	
Building Construction[2]			
Residential	38 936	43 122	44 963
Industrial	3 842	4 264	4 001
Commercial	14 116	16 154	16 175
Institutional	4 540	4 954	5 441
Other building	2 452	2 781	3 315
Total	63 885	71 276	73 895
Engineering Construction[2]			
Marine	504	523	677
Highways, airport runways	5 721	6 327	6 469
Waterworks, sewage systems	2 477	2 742	3 069
Dams, irrigation	398	492	560
Electric power	4 198	5 290	6 249
Railway, telephones	3 090	3 294	3 376
Gas and oil facilities	7 288	6 006	7 597
Other engineering	3 311	4 116	4 097
Total	26 986	28 790	32 093
Total construction	90 871	100 065	105 987

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Actual expenditures 1988; preliminary 1989; intentions 1990. [2] Includes total value of new and repair work purchased.

TABLE 6. CANADA, VALUE OF CONSTRUCTION BY PROVINCE,[1] 1988-90

	1988			1989			1990		
	Building Construction[2]	Engineering Construction[2]	Total	Building Construction[2]	Engineering Construction[2]	Total	Building Construction[2]	Engineering Construction[2]	Total
					($ millions)				
Newfoundland	919	627	1 546	1 024	578	1 602	1 063	739	1 802
Nova Scotia	1 698	716	2 415	1 836	748	2 585	1 852	875	2 727
New Brunswick	1 352	459	1 811	1 509	539	2 048	1 476	685	2 160
Prince Edward Island	261	91	352	254	96	350	263	105	368
Quebec	15 834	4 731	20 565	16 450	5 547	21 996	16 297	6 565	22 862
Ontario	27 528	7 203	34 731	31 667	7 741	39 408	32 065	8 108	40 173
Manitoba	2 076	1 062	3 138	2 209	1 198	3 407	2 353	1 390	3 742
Saskatchewan	1 958	1 803	3 761	1 954	1 617	3 572	2 152	2 003	4 156
Alberta	4 984	6 803	11 787	5 253	6 541	11 795	5 848	7 485	13 333
British Columbia, Yukon and Northwest Territories	7 274	3 490	10 764	9 119	4 184	13 303	10 526	4 138	14 664
Canada	63 885	26 986	90 871	71 276	28 790	100 065	73 895	32 093	105 987

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Actual expenditures 1988, preliminary actual 1989, intentions 1990. [2] Includes total value of new and repair work purchased.
Note: Totals may not add due to rounding.

Coal

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The year 1990 was difficult for the Canadian coal industry. Preliminary statistics indicate that production, consumption, exports and imports will be down compared with 1989. Total coal production for 1990 decreased by 2 million tonnes (Mt) to 68.4 Mt compared with 1989. This represented a drop of 2% in the volume of output and was mainly attributable to reduced demand for thermal (or steam) coal in Nova Scotia, Ontario and Saskatchewan. Canadian coal consumption was down by nearly 5 Mt to 49 Mt due to decreased consumption by utilities and the steel industry. The fall in imports also reflected the weakness in demand in the Ontario electricity and steel sectors. Exports decreased by nearly 2 Mt primarily reflecting lower metallurgical exports to Japan.

During the 1980s elements of the coal production side of the industry experienced financial difficulties as a result of nearly a decade of declining prices. Average rates of return for British Columbia exporters have been unacceptably low for much of this period and structural adjustments are under way reflecting this fact. On the other hand, the domestic production and consumption segment of the Canadian coal industry is expanding with one coal mine under development, and one coal-fired power station commissioned and four others under construction in 1990. Major international events such as the Gulf crisis, with its subsequent oil price increase, and the political events in Europe, had little impact on the Canadian coal industry either in terms of prices or markets.

DOMESTIC CONSUMPTION AND MARKETS

Domestic coal consumption in Canada primarily reflects the demand for coal by provincial utilities.

Nova Scotia was one of the provinces that registered an increase in coal consumption in 1990, due to an increase in its use of coal for the generation of electricity. Statistics indicate that thermal coal consumption grew by approximately 4% to 2.3 Mt. In spite of this, provincial coal production declined due to a three-week labour dispute at the Cape Breton Development Corporation mines which normally account for 95% of the annual provincial output.

Coal currently accounts for about 75% of the electricity generated in Nova Scotia and will provide even more upon completion of the two coal-fired stations currently under construction. The 150 MW Trenton VI unit will come on stream in mid-1991, while the 165 MW Point Aconi plant is scheduled to commence operations in early 1993. These stations will use nearly another 1 Mt of coal, some of which will come from existing coal mines, and some of which will come from the new Westray coal mine when it begins production in late 1991 or early 1992. This underground mine located near Stellarton, in Pictou County, will be capable of producing more than 1 Mt of coal and will employ nearly 250 miners at full capacity. This mine will enable Nova Scotia to use a combination of lower sulphur coal and advanced combustion technology in its new power units to reduce sulphur dioxide and nitrogen oxide emissions.

Thermal coal consumption decreased by 200 000 t in New Brunswick to 500 000 t in 1990 reflecting both reduced demand for electricity due to a slowdown in the industrial sector, and unusual increases in the generation of electricity from hydro sources. Consumption will increase throughout this decade, however, especially after the completion of a 400 MW unit near Belledune in 1993.

Coal demand tends to remain fairly constant from year to year in Quebec due to the nature of its industrial consumers. The three quarters of a million tonnes of coal used annually in this province is consumed by companies in the industrial-commercial sector.

Coal

Demand in 1988 and 1989 totalled 748 000 t and 753 000 t respectively, and 1990 figures are forecast to be in this same range. Quebec traditionally obtains about 100 000 t of its requirements from Nova Scotia, with the remainder coming from the United States.

Ontario remained the second largest coal-consuming province although it also experienced a decline in coal use in 1990. Much of this decline was accounted for by a 2.3 Mt decrease in thermal coal demand from Ontario Hydro due to a combination of factors, including lower electricity demand and increases in electricity availability from nuclear, hydro and out-of-province sources. Coal consumption totalled 10.5 Mt (down from 12.8 Mt in 1989) for power generation; 4.7 Mt (down from 5.9 Mt) for the steel industry; and 700 000 t for industrial purposes in 1990. Coal demand was down for the steel industry due to a lengthy labour dispute. Overall coal consumption in Ontario will total 16 Mt in 1990, down from 19.5 Mt in 1989.

Although Ontario is a major consumer of coal and has considerable deposits of coal in certain areas, it imports all of its coal requirements. In 1990 approximately 40% of the coal consumed by Ontario Hydro originated from western Canada, while all other coal was imported from the United States.

Manitoba coal consumption remained near the 1989 level of 500 000 t in 1990, divided 60/40 between utility and industrial demand. Virtually all of the coal used in Manitoba is lignite coal imported from Saskatchewan.

Saskatchewan is a producer, consumer and exporter of lignite coal. Production in 1990 is expected to be down by 12% to 9.5 Mt compared with 1989. The main factor underlying this was a decrease in demand of more than 1 Mt by the provincial utility, due to lower energy demand and increased electricity output from hydro sources. Final consumption in this sector fell to a four-year low of 7.6 Mt while exports of lignite coal to other Canadian markets were also down in 1990. Demand for Saskatchewan's lignite coal will grow in the 1990s by at least 1.5 Mt to supply the new 300-MW Shand power station which is scheduled to enter service in July 1992.

Alberta continues to be Canada's largest coal-producing and consuming province. However, for the first time in several years, Alberta coal production and consumption stabilized. Production is marginally down reflecting decreases in both domestic and export demand. Approximately two thirds of Alberta's coal production is sub-bituminous coal produced for mine-mouth power stations, with the remainder of bituminous coal for Canadian and export markets. Most of the future growth in coal output in Alberta will occur in the sub-bituminous market based on the development of new coal-fired power stations. The 375-MW Sheerness II station was officially commissioned in November 1990, with the next addition, the 400-MW Genesee II unit, scheduled to come on stream sometime in 1994 or later depending on energy demand. These two units will increase demand for sub-bituminous coal by over 3 Mt/y by the mid-1990s.

Although British Columbia consumes very small amounts of coal, in terms of value, it is Canada's most important producer. Production in 1990 kept pace with 1989 at approximately 24.8 Mt, valued at $1 billion. This represents 36% of the volume and 56% of the value of Canadian production. The value of British Columbia coal is proportionally greater than its share of national production because most of its coal is sold into the higher priced metallurgical coal market. British Columbia coal is sold into Asian-Pacific, European and Latin American markets.

EXPORTS

While preliminary statistics suggest that world coal trade increased in 1990, it was a troublesome year for exporters who were still recovering from the difficult period of the 1980s. Due to six consecutive years of price decreases in that decade, many exporters were making unacceptably low returns on their investment. While 1988 and 1989 saw some small price increases, at least for metallurgical exporters, most, if not all, of these increases were eaten up by exchange rate fluctuations. As a result, a private sector review of the British Columbia coal industry documented that the industry recorded a loss of $4 million in 1989, making it the worst year in the last eight. However, year-end price negotiations between the Japanese steel industry and some Canadian exporters, who were hoping for another price increase for fiscal year 1991 or at least for a price roll-over, ended much sooner than expected on an ominous note.

Three Canadian exporters had to accept a US$1 price reduction on their metallurgical coal following the lead of a major Australian exporter. When exchange fluctuations are taken into account this translates into a C$2 reduction from 1989 prices. The surplus of coal available in some markets, along with evolving quality changes in coal requirements and the forecasted recession, were cited as the critical factors underlying the price decrease. The implications for world coal trade from another year of lower revenues could be serious for several metallurgical coal exporters.

The concerns of thermal or steam coal exporters are very similar. While demand for this coal is widely forecast to grow throughout the 1990s, low prices may constrain new sources of supply. This market faces the additional challenge of the growing concern over global warming.

OUTLOOK

The Canadian coal industry faces important challenges in the 1990s. Coal demand is forecast to grow internationally, but primarily in the thermal, or steam, coal market. Traditionally, only 10% of Canadian coal exports are thermal coals, and many exporters in Canada and elsewhere are not making acceptable returns on the sale of this type of coal at today's prices.

These financial and related market difficulties are precipitating structural adjustments within the Canadian coal industry. The first became evident in 1989 when one coal mine changed hands. This process continued in 1990 when two mines, the Line Creek mine of Shell Canada Limited and the Byron Creek mine of Esso Resources Canada Limited, were put up for sale.

Another major development in 1990 involved the Quintette mine in northeastern British Columbia, owned by Denison Mines Limited and Japanese and French interests. In May 1990, an arbitration decision set a new price for the coal sold from this mine to its Japanese steel industry customers. This decision precipitated a reorganization of Quintette Coal Limited, which was still under way at the end of 1990.

In spite of these challenges, Canada remains a major coal exporter, with an enviable record as one the most secure and reliable coal suppliers in the world. The Canadian coal industry has the capacity to produce and export more coal to meet the growing energy and raw material needs of countries in all parts of the world. Its good quality metallurgical coals and low sulphur thermal coals should help meet domestic and international demands well into the twenty-first century.

Note: Information contained in this review was current as of mid-January 1991.

TABLE 1. SUMMARY OF COAL SUPPLY BY TYPE AND VALUES, 1986-90

	1986		1987		1988		1989		1990p	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
DOMESTIC[1]										
Bituminous										
Nova Scotia	2 955	178 000	2 925	179 000	3 545	216 000	3 512	200 000	3 350	199 000
New Brunswick	485	28 000	533	33 000	542	34 000	520	34 000	550	37 000
Albertta	7 619	297 000	7 202	239 000	9 558	299 000	9 907	314 000	9 280	299 000
British Columbia	21 140	974 000	21 990	948 000	24 941	974 000	24 840	948 000	24 790	1 049 000
Total	32 199	1 477 000	32 650	1 399 000	38 586	1 523 000	38 779	1 496 000	37 970	1 584 000
Sub-bituminous										
Alberta	17 331	143 000	18 537	150 000	19 910	160 000	20 918	156 000	21 000	187 000
Lignite										
Saskatchewan	8 281	101 000	10 020	92 000	12 148	122 000	10 816	100 000	9 480	100 000
Total	57 811	1 721 000	61 207	1 641 000	70 664	1 805 000	70 513	1 752 000	68 450	1 871 000
IMPORTED[2]										
Bituminous and anthracite briquettes	13 125	999 000	14 719	899 000	17 248	974 000	14 660	808 000	13 700	608 000
Total	70 936	2 720 000	75 926	2 540 000	87 892	2 779 000	85 173	2 560 000	82 150	2 479 000

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] F.o.b. mines. [2] Value at United States port of exit.
p Preliminary figures or estimates.

TABLE 2. PRODUCERS' DISPOSITION OF CANADIAN COAL, 1989

Destination	Deliveries From: Nova Scotia	New Brunswick	Saskatchewan	Alberta	British Columbia	Canada
	(kilotonnes)					
Newfoundland	–	–	–	–	–	–
Prince Edward Island	7	–	–	–	–	7
Nova Scotia	2 154	–	–	–	–	2 154
New Brunswick	–	520	–	–	–	520
Quebec	87	–	–	–	–	87
Ontario	–	–	1 563	2 165	954	4 682
Manitoba	–	–	475	1	43	519
Saskatchewan	–	–	8 767	1	33	8 801
Alberta	–	–	–	21 444	1	21 445
British Columbia	–	–	–	10	256	266
Total Canada	2 248	520	10 805	23 621	1 287	38 481
Shipments for export	1 264	–	10	7 204	23 554	32 032
Total	3 512	520	10 815	30 825	24 841	70 513

Sources: Statistics Canada; Energy, Mines and Resources Canada.
– Nil.

TABLE 3. SUMMARY OF COAL SUPPLY-DEMAND, 1979-90

Year	Canada Production				Imports				
	Bituminous	Sub-bituminous	Lignite	Total	Anthracite	Bituminous	Total Available	Domestic Consumption	Exports
	(million tonnes)								
1979	18.4	9.6	5.0	33.0	0.2	17.3	50.5	34.8	13.7
1980	20.2	10.5	6.0	36.7	0.3	15.5	52.5	37.3	15.3
1981	21.7	11.6	6.8	40.1	0.4	14.4	54.9	38.4	15.7
1982	22.3	13.0	9.5	42.8	0.3	15.5	58.6	41.5	16.0
1983	22.5	14.5	7.8	44.8	0.3	14.4	59.5	43.6	17.0
1984	32.1	15.4	9.9	57.4	0.2	18.1	75.7	48.6	25.1
1985	34.2	16.8	9.7	60.7	0.3	14.6	75.6	48.7	27.4
1986	32.2	17.3	8.3	57.8	0.4	12.7	70.1	44.6	25.9
1987	32.7	18.5	10.0	61.2	0.4	14.3	75.9	50.1	26.7
1988	38.6	18.9	12.1	70.6	0.4	16.8	87.8	54.4	31.7
1989	38.8	20.9	10.8	70.5	0.4	14.3	85.2	53.9	32.7
1990p	38.0	21.0	9.5	68.5	0.4	13.3	82.2	49.1	33.0

Sources: Statistics Canada; Energy, Mines and Resources Canada.
p Preliminary.

TABLE 4. COAL USED BY THERMAL POWER STATIONS IN CANADA, BY PROVINCES, 1971-90

	Nova Scotia	New Brunswick	Ontario	Manitoba	Saskat-chewan	Alberta	Total Canada
				(000 tonnes)			
1971	689	271	8 560	446	1 996	3 653	15 615
1972	663	281	7 599	410	2 145	4 113	15 211
1973	585	193	6 615	386	2 806	4 474	15 059
1974	606	292	6 721	132	2 902	4 771	15 424
1975	571	248	6 834	323	3 251	5 345	16 572
1976	730	207	7 612	979	3 521	5 996	19 045
1977	572	198	8 795	1 113	4 304	7 461	22 443
1978	771	151	9 097	341	4 585	8 029	22 914
1979	644	198	9 901	73	4 956	9 181	24 956
1980	1 052	315	10 779	240	4 972	10 424	27 782
1981	1 126	515	11 460	332	4 935	11 445	29 813
1982	1 300	548	12 484	184	5 897	13 242	33 656
1983	1 400	564	13 025	109	6 625	14 492	36 216
1984	2 974	610	13 413	163	7 925	16 123	40 208
1985	2 235	521	10 985	253	8 290	18 112	40 396
1986	2 137	469	9 172	111	6 786	17 719	36 394
1987	2 077	526	12 016	457	7 672	19 077	41 825
1988	2 266	678	13 079	780	8 637	20 538	45 978
1989	2 141	705	12 809	327	8 534	21 410	45 926
1990p	2 230	500	10 555	345	6 499	21 499	42 439

Sources: Statistics Canada; Energy, Mines and Resources Canada.
p Preliminary.

TABLE 5. SUMMARY OF COAL DEMAND, 1985-90

	1985	1986	1987	1988	1989	1990p
			(000 tonnes)			
Thermal Electric						
Canadian	32 563	30 035	33 932	37 452	37 449	35 880
Imported	7 833	6 359	7 893	8 527	8 477	7 550
Total	40 396	36 394	41 825	45 978	45 926	43 430
Metallurgical						
Canadian	52	243	290	16	–	–
Imported	6 210	5 891	6 019	6 247	5 917	4 715
Total	6 262	6 134	6 309	6 263	5 917	4 715
General Industry						
Canadian	582	655	594	672	608	600
Imported	1 416	1 375	1 416	1 477	1 430	1 400
Total	1 998	2 030	2 010	2 149	2 038	2 000
Exports						
Canadian	25 138	27 378	25 943	26 740	32 744	31 000
Total						
Canadian	60 575	56 876	61 556	69 871	70 801	67 480
Imported	15 459	13 625	15 328	16 251	15 824	13 665
Total	76 034	70 501	76 884	86 122	86 625	81 145

Sources: Statistics Canada; Energy, Mines and Resources Canada.
p Preliminary; – Nil.

TABLE 6. EXPORTS OF CANADIAN COAL BY TYPE AND DESTINATION, 1990

Country	Metallurgical	Thermal	Total
		(kilotonnes)	
Japan	16 569	1 933	18 502
South Korea	3 948	1 205	5 153
Brazil	1 108	98	1 206
United States	973	204	1 177
Taiwan	1 059	–	1 059
United Kingdom	645	18	663
Portugal	519	–	519
Denmark	–	479	479
France	379	18	397
Netherlands	369	–	369
Chile	223	129	352
China	300	–	300
Pakistan	208	–	208
Italy	159	–	159
West Germany	72	64	136
Iran	129	–	129
Sweden	102	–	102
Turkey	51	–	51
Finland	41	–	41
Belgium	6	–	6
Total	26 860	4 149	31 009

Source: Statistics Canada/Energy, Mines and Resources Canada joint survey, Coal.
– Nil.

TABLE 7. CANADA, COAL PRODUCTION, IMPORTS, EXPORTS AND CONSUMPTION, 1985-90

	Production	Imports	Exports	Domestic Consumption
		(000 tonnes)		
1985	60 738	14 867	27 378	48 656
1986	57 811	13 125	25 943	44 558
1987	61 209	14 719	26 740	50 144
1988	70 644	17 248	31 732	54 390
1989	70 513	14 660	32 744	53 881
1990	68 356	14 204	31 009	49 039

Sources: Statistics Canada; Energy, Mines and Resources Canada.

TABLE 8. CANADA, COKE PRODUCTION AND TRADE, 1979-89

	Production		Imports		Exports	
	Coal	Petroleum	Coal	Petroleum	Coal	Petroleum
			(tonnes)			
1979	5 775 141	1 105 433	520 534	980 657	189 555	125 416
1980	5 249 744	1 156 444	626 923	908 322	79 927	150 200
1981	4 659 007	1 098 397	653 645	935 929	67 642	200 149
1982	3 999 117	1 083 129	453 915	650 810	14 392	104 897
1983	4 120 002	986 730	576 649	759 954	1 601	65 323
1984	4 900 478	1 072 983	660 257	886 734	10 654	55 300
1985	4 683 770	1 099 808	369 224	866 530	21 944	45 968
1986	4 552 532	765 867	432 730	941 314	9 126	46 554
1987	4 636 629	1 039 556	599 015	964 949	70 094	53 118
1988	4 663 441	1 010 152	568 063	1 347 152	19 685	48 840
1989p	4 414 418	1 185 589	537 009	737 248	54 131	35 560

Sources: Statistics Canada; Energy, Mines and Resources Canada.
p Preliminary figures or estimates.

Copper

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During 1990, Canadian producers benefited from the continuing strength of international copper markets. Domestic copper production in 1990 made a strong recovery with mine shipments (recoverable copper) estimated at 780 000 t compared to 704 000 t in 1989. The estimated value of mine shipments in 1990 was $2.49 billion versus $2.39 billion in 1989. On the other hand, estimated refined production declined slightly to 504 000 t from 515 216 t in 1989.

CANADIAN DEVELOPMENTS

The focus of activity for the Canadian copper industry during 1990 was in exploration. On the basis of recent exploration results, the future for the industry appears very encouraging.

British Columbia

During 1990, a preliminary feasibility study was completed which concluded that a copper smelter and refinery complex in British Columbia would be economically viable. The report, which was prepared by a B.C. business group with the help of a $100 000 contribution from the federal and B.C. provincial governments, proposes the construction of a $500 million facility at Kitimat due to its tidewater location, existing infrastructure and availability of low-cost power. The smelter would process both Canadian and offshore concentrates. At present, the bulk of the copper concentrates produced in British Columbia is exported to Japan.

In the extreme northwest corner of British Columbia, Geddes Resources Limited continued work on its Windy Craggy deposit which hosts reserves of at least 165 Mt in the North and South zones, grading 1.9% copper and 0.8% cobalt, along with recoverable gold and silver. In October 1990, the company confirmed the existence of the new Ridge zone which should significantly increase total reserves.

As a requirement for B.C.'s Mine Development Review Process, Geddes submitted a Stage 1 Environmental and Socioeconomic Impact Assessment for the project in January 1990. On the basis of a project review conducted by provincial and federal agencies, the provincial Mine Development Steering Committee rejected the company's initial mine plan since it did not adequately address the potential for acid rock drainage or provide acceptable measures for the prevention of acid generation.

In a revised mining plan submitted at the end of 1990, the company announced its intention to reduce the amount of potentially acid-generating waste by more than 50% to less than 100 Mt. This will be accomplished by reducing the amount of ore produced from open-pit operations and a corresponding increase in production from underground mining activity. The company also plans to store all potentially acid-generating waste at an underwater site. This will require the construction of an artificial lake and a water management system that accommodates ground water, surface run-off and mine and mill process water.

In order to maintain an acceptable rate of return for the project in view of the additional expenditures required for environmental protection, the company has increased its planned rate of mining from 20 000 t/d to 30 000 t/d. At this production rate, the mine should have an average annual output of 140 000 t of contained copper during the first 14 years of operation.

Also in northwestern British Columbia, exploration is continuing on the Tulsequah Chief property of Cominco Ltd. (60%) and Redfern Resources Ltd., located 100 km south of Atlin while, further south, Consolidated Rhodes Resources Inc. is continuing work on the Copper Canyon project in the Galore Creek area on which the company can earn a 50% interest in the property from Canamax

Resources Inc. In addition, promising copper values have been reported in conjunction with gold exploration activity in the Iskut River region.

During 1990, there was significant exploration activity near the Island Copper mine of BHP-Utah Mines Ltd. near Port Hardy on Vancouver Island. This included work by Moraga Resources Ltd. on the Expo property, on which the company can earn a 45% interest from BHP-Utah, and also on the Red Dog property on which the company can earn an interest from Crew Natural Resources Ltd. Preliminary reserves at the former property have been estimated at over 400 Mt grading 0.26% copper plus 0.34 g/t gold, while the Red Dog deposit is estimated to have reserves of more than 50 Mt grading 0.32% copper and 0.37 g/t gold.

Exploration work continued during 1990 on the Mt. Milligan copper-gold property in north-central British Columbia. In August, Placer Dome Inc. announced that it had concluded an agreement with BP Resources Canada Limited for the purchase of BP's 30% interest in the Mt. Milligan property. In October, Placer gained control of virtually all of the remaining ownership of the project with the purchase of 97% of the outstanding shares of Continental Gold Corp. The property, which could be brought into production as early as 1993, contains estimated reserves of 400 Mt grading 0.2% copper and 0.48 g/t gold.

In the area around Mt. Milligan, exploration work is continuing at several other copper prospects including the Webb property of Moondust Ventures Inc. and Grand America Minerals Ltd., as well as the Mitzi joint venture of Alban Explorations Ltd. and Noranda Exploration Company, Limited.

In November, it was announced that Nippon Mining Company Limited and Sumitomo Corp. had agreed to finance the reopening of the Goldstream copper-zinc mine near Revelstoke. The Goldstream property, which is owned by Bethlehem Resources Corporation and Goldnev Resources Inc., contains reserves of 1.86 Mt grading 4.81% copper and 3.06% zinc, plus silver. Annual output at the Goldstream mine is expected to total 16 000 t of contained copper and 3000 t of contained zinc. The mine, which was originally developed by Noranda Inc., was operated briefly in 1984 until low metal prices and low zinc recoveries forced its closure.

Elsewhere in British Columbia, Imperial Metals Corporation completed a feasibility study in July on its Mount Polly copper-gold property near Williams Lake. Development costs, for a mining operation with a capacity of 13 700 t/d, have been estimated at $131.5 million. Total mining reserves have been calculated at 54 Mt grading 0.38% copper and 0.55 g/t gold. Exploration is also continuing at the Kutcho Creek orebody located 100 km east of Dease Lake. Work on the main Kutcho Creek lens is being undertaken by Homestake Mining (Canada) Limited and American Reserve Mining Corporation as well as Sumac Mines Ltd., a subsidiary of Sumitomo Metal Mining Canada Ltd. Preliminary open-pit reserves at the site total 13.9 Mt grading 1.75% copper, 4.47% zinc, 28 g/t silver and 0.34 g/t gold.

It had been planned that Brenda Mines Ltd. would close its copper-molybdenum mine near Peachland on June 29, 1990, after more than 20 years of discontinuous production, due to the depletion of ore reserves. However, in April, a rock slide on the western wall of the open pit forced the closure of the mine on June 8.

In June, Gibraltar Mines Limited temporarily suspended milling operations at its mine near Williams Lake when heavy rains caused concerns that there would be an overflow of the mine's acid mine drainage containment system. In August, workers at Westmin Resources Limited's Myra Falls operations near Campbell River staged a short wildcat strike to protest alleged safety problems at the operation.

In January 1991, Princeton Mining Corporation announced that it would implement a revised mining plan at its Similco mine near Princeton in order to lower operating costs. The revised plan, which will reduce the overall open-pit mining rate from about 60 000 t/d ore and waste to about 40 000 t/d and result in the elimination of 47 jobs, is largely directed at a reduction of waste stripping.

Saskatchewan

Cameco Corporation commenced feasibility studies on its Hanson Lake project situated 65 km west of Flin Flon, Manitoba. Late in the year, shareholders of Trimin Resources Inc. approved the sale of the company's 33% interest in the project to Billiton Metals Canada Inc. The Hanson Lake deposit has an estimated reserve of 9.8 Mt grading 0.95% copper, 5.76% zinc, 0.42% lead, 0.51 g/t gold and 25 g/t silver.

Manitoba

In November 1990, Hudson Bay Mining and Smelting Co., Limited (HBMS) announced the discovery of a new high-grade zone of zinc-copper mineralization beneath the current workings of the Trout Lake mine which the company jointly owns with Granges Inc. and Manitoba Mineral Resources Ltd. While further work is required to delineate the actual size of the discovery, the addition to reserves should be sufficient to extend the life of the mine by several years. HBMS also completed a new ore-handling system at the Trout Lake mine. This includes a new 4.9-m diameter circular shaft, 652 m deep, which will allow about 300 t/h of material to be hoisted to the surface.

Ontario

During 1990, Falconbridge Limited continued work on the development of its No. 3 mine at Kidd Creek near Timmins. This development, which consists of an internal shaft from the 4600-ft level, will allow the company to access ore to the 6000-ft level and also permit continued exploration at depth. While the mine has considerable remaining reserves, mine output is expected to decline through the 1990s due principally to the diminishing width of the orebody at greater depth.

A significant new copper-zinc discovery was made by Minnova Inc. 1.5 km southwest of the main shaft of its Winston Lake mine near Schreiber. Referred to as the Deep Pick zone, the massive sulphide deposit is about three times deeper than the Winston Lake orebody.

Quebec

In May, production at Westminer Canada Limited's copper-gold mines near Chibougamau was suspended when the company implemented a lockout of its workforce. An agreement between management and labour was finally reached in October at which time production at the Portage mine resumed. Operations at the Copper Rand mine resumed at the end of November.

The legal dispute between Aur Resources Inc. and Louvem Mines Inc. over the ownership of the Louvicourt massive sulphide property near Val-d'Or was settled in September. Under the terms of the agreement, Aur increased its ownership in the property to 55% from 50%, while Louvem's share fell to 45%. The agreement also provided Noranda Inc. with first right of refusal for the purchase of a minimum of 50% of Aur's share of concentrates from the mine during the first eight years of production.

The settlement has enabled the partners to proceed with a $4.6 million exploration program which will include the sinking of a 915-m shaft as well as further infill drilling on the deposit, environmental and engineering studies and metallurgical testwork. The Louvicourt mine, which could begin production in 1993, is expected to cost between $150 million and $200 million to develop. The mine is expected to produce between 4000 and 4500 t/d of ore. Geological reserves at Louvicourt are estimated at 37 Mt grading 3.6% copper, 1.59% zinc, 21.3 g/t silver and 0.9 g/t gold.

At the Mobrun mine near Rouyn-Noranda owned by Audrey Resources Inc. and Minnova Inc., work continued on the 1100 (B) lens. In addition, a new discovery, the C lens, was located about 150 ft south of the 1100 lens at a depth of about 2000 ft. A feasibility study completed in November estimated capital costs of $90 million for a 3000 t/d operation through a new shaft, or $40 million to mine the orebodies at 2000 t/d through the existing Mobrun workings. The project's ore reserves are 25 Mt grading 0.75% copper, 3.53% zinc, 30.8 g/t silver and 1.1 g/t gold.

Near Joutel, Breakwater Resources Ltd. brought its 500 t/d Estrades polymetallic massive sulphide mine into production at a capital cost of $15 million. Ore from the underground mine is custom milled at Noranda's Matagami mill. Proven reserves at Estrades are 941 400 t grading 10.7% zinc, 0.94% copper, 0.92% lead, 182 g/t silver and 5.6 g/t gold.

Exploration by partners VSM Exploration Inc. and Serem Quebec Inc. on the Grevet project near Lebel-sur-Quévillon continued throughout the year. Reserves at the III and IV zones were increased and a new high-grade zone, the 97 zone, was discovered. The preliminary estimated reserve for the III and IV zones is currently 10.2 Mt grading 8.27% zinc, 0.44% copper and 34.8 g/t silver.

In May, the Mines Gaspé division of Noranda Inc. announced that it would develop its new E-29 orebody at its Murdochville mine. The deposit, which contains reserves of about 2.4 Mt grading 2.69% copper, is expected to extend the life of the mine by three years. It was also reported that the company was undertaking a feasibility study for an expansion and modernization of its 65 000 t/y Gaspé smelter.

Exploration undertaken by Windy Mountain Explorations Ltd. during 1990 increased preliminary reserves on its MacLeod Lake copper property, north of Chibougamau, to 37.5 Mt grading 0.44% copper and 0.05% molybdenum. Additional drilling is planned for 1991.

New Brunswick

A strike by the 1100 workers at Brunswick Mining and Smelting Corporation Limited's Brunswick mine at Bathurst, which began on July 1, 1990, was unresolved at year-end. During the strike, management staff maintained production at the mine at 25% of capacity. The Brunswick mine normally produces between 6000 t/y and 10 000 t/y of copper in concentrates.

Marshall Minerals Corp. announced its intention to sell its wholly owned Restigouche deposit west of Bathurst. The property contains proven reserves of 998 000 t grading 7.72% zinc, 0.32% copper, 5.99% lead, 124 g/t silver and 1.2 g/t gold.

During 1990, NovaGold Resources Inc. and partner Costigan Gold Corporation intersected high-grade copper-zinc mineralization on their Sewell Brook property near Plaster Rock.

Newfoundland

In April, BP Canada Inc. announced a new base-metal discovery at Daniel's Pond, located 20 km south of Buchans. The discovery is 20 km west of the BP/Noranda Duck Pond deposit where drill indicated reserves are 4.3 Mt grading 3.58% copper, 1.05% lead, 6.73% zinc, 68.3 g/t silver and 1.0 g/t gold.

Yukon

Thermal Exploration Company and Western Copper Holdings Limited continued work on their Williams Creek deposit, located 130 miles north of Whitehorse. The deposit contains preliminary reserves of almost 15 Mt grading 1.15% copper. At the Marg property of NDU Resources Ltd. and Cameco Corporation, estimated reserves were increased to 2.85 Mt grading 1.62% copper, 2.25% lead, 4.17% zinc, 55.9 g/t silver and 0.9 g/t gold on the basis of a drilling program completed in 1990.

WORLD OVERVIEW

Western World mine production of copper is estimated to have increased slightly in 1990 to 7.18 Mt from 7.15 Mt in 1989. The production of refined copper, which includes metal derived from both primary and secondary material, was estimated at 8.50 Mt, compared to 8.38 Mt in 1989.

Despite the addition of new capacity in Chile during 1990, production problems and falling ore grades at existing operations reduced overall output to 1.588 Mt compared to 1.609 Mt in 1989. Government-owned Corporacion Nacional del Cobre de Chile (Codelco-Chile) announced that its copper output in 1990 was 1.15 Mt, down from 1.17 Mt in 1989. This decline was due primarily to a rockburst in July at its El Teniente mine. In January 1991, Codelco-Chile reported that repair work would not be completed until May.

Faced with declining ore grades at its Chuquicamata mine, Codelco-Chile is continuing with an exploration program to identify nearby orebodies that would maintain output at or near existing levels. In addition, the company is also considering the leaching of oxide ores in the Chuqui Norte deposit and the heap leaching of low-grade sulphide ores. In December, the company reported that it had discovered a new copper deposit near Chuquicamata. The deposit, which has been named Mina Mansa, contains reserves of at least 190 Mt grading 1.2% copper.

In late December, the first copper concentrate was shipped from the new US$850 million La Escondida complex, a full six months ahead of schedule. The mine, which will produce 320 000 t/y of copper in concentrates, is owned by The Broken Hill Proprietary Company Limited (B.H.P.) (57.5%), RTZ Corporation PLC (30%), a Japanese consortium (10%) and International Finance Corp. (2.5%). About half of the annual output will be exported to Japan.

Other projects in Chile include the 20 000 t/y Los Pelambres mine being developed by Midland Montagu (40%), Lucky-Goldstar International Corp. and Antofagasta Holdings Group (20%), which is scheduled to come on stream in late 1991. In addition, the Lince project of Compania Minera Carolina de Michilla S.A. (25%), Chemical Bank of New York (60%) and Outokumpu Resources Inc. is expected to come on stream in early 1992. This solvent extraction-electrowin technology (SX-EW) operation is expected to produce approximately 20 000 t/y of copper. Elsewhere in Chile, Disputada de Las Condes Mining Co. Inc., a subsidiary of Exxon Minerals Chile Inc., is proceeding with an expansion of its Los Bronces operation which will increase production of copper in concentrates to 130 000 t/y, while Cominco Ltd. is proceeding with its 75 000 t/y Quebrada Blanca SX-EW project that is expected to begin production in the third quarter of 1993. Other properties that will likely be developed include the Zaldivar deposit of Outokumpu Oy and the La Candelaria property of Phelps Dodge Corporation.

Exxon Corporation was forced to close its 44 000 t/y Chagres smelter during the month of September to avoid exceeding air quality standards imposed by the Chilean government. The company is currently examining the feasibility of increasing the capacity of the smelter to 120 000 t/y. This project would also include the installation of pollution control equipment. In September, it was also reported that Codelco-Chile would replace two of the three reverberatory furnaces at Chuquicamata in order to deal with environmental problems.

In December, B.H.P. and RTZ Corporation PLC, two of the six companies involved in a consortium examining the feasibility of constructing a new US$450 million copper smelter near La Escondida in northern Chile, were reported to have decided against proceeding with the project. However, Codelco-Chile, one of the other consortium members, stated that it, along with the state smelting company, Empresa Nacional de Mineria (ENAMI), would continue to support the construction of the smelter.

Copper production during 1990 in Peru fell to 318 000 t, a decline of almost 13%, due to labour problems. These problems included a 10-day strike at Empresa Minera del Centro del Peru S.A. (Centromin Peru SA) in January, a 53-day strike at Southern Peru Copper Corporation (SPCC) which began in March, a 26-day work stoppage at Empresa Minera Especial Tintaya S.A. (Ematinsa) which also began in March, a second strike at Centromin Peru SA in May which lasted 8 days, a 5-week walk-out at the operations of Minero Peru Comercial SA (MINPECO) which began on August 17, and another 4-day work stoppage at Centromin in October. With the threat of continuing labour unrest at the beginning of 1991, it appears unlikely that the situation will improve in the short term.

In August, the Government of Mexico announced that it would sell the state-run Cananea SA copper complex for US$475 million to Mexicana de Cananea S.A. de C.V., a joint venture between Mexicana de Cobre S.A. and Acec-Union Minière SA of Belgium. The new owners plan to increase the capacity of the mine from about 150 000 t/y to 250 000 t/y, of which 100 000 t/y will be copper cathode from SX-EW operations.

During 1990, copper mine production in the United States was estimated to have increased to 1.60 Mt compared to 1.50 Mt in

1989. All five of the major U.S. copper producers, Phelps Dodge Corporation, Magma Copper Company, Cyprus Minerals Company, ASARCO Incorporated and Kennecott Corporation, a subsidiary of RTZ Corporation PLC, are planning expansions using both conventional milling-pyrometallurgy and SX-EW technologies. In January, Kennecott announced a US$227 million expansion project for its Bingham Canyon mine that will increase copper production at the company's Utah operations from 215 000 t/y to 245 000 t/y by 1992.

In October, the Texas Water Commission granted a discharge permit to Texas Copper Corporation, a subsidiary of Mitsubishi Materials Corporation, for its new US$200 million copper smelter to be built at Texas City, Texas. Assuming that no significant delays are experienced in obtaining all of the required permits for the project, construction of the 180 000 t/y smelter could begin in 1991.

ASARCO announced in 1990 that it was increasing the size of a previously announced expansion to its Ray mine in Arizona. This upgrade, which will increase mine output by almost 60 000 t/y to about 165 000 t/y of contained copper by 1992, is expected to cost US$194 million. However, in September, the company announced that a part of the project, the construction of a new mill, would be put on hold until the issue relating to the optimum location of a mine tailings disposal site had been resolved. Although the company experienced a 22-day strike at the Ray mine in July, production was largely maintained by supervisory personnel. Also in July, ASARCO announced that it would construct a new $54 million SX-EW plant at its Silver Bell operation in Arizona. The project, which is expected to be completed in 1993, is expected to yield about 16 000 t/y of copper cathode. The company also announced during 1990 that it would spend $81 million to modernize and expand its El Paso, Texas smelter. The project, which will increase capacity by about 20 000 t/y of copper, is expected to be completed by the end of 1991.

Cyprus Minerals Company announced in November that it would use the "Isasmelt" process for an expansion and modernization program at its Miami, Arizona smelter. The project, which will cost US$92.5 million, is expected to increase throughput capacity to 600 000 t/y of concentrate. In August, Cyprus completed a mill expansion at its Baghdad mine that will increase concentrate production to about 90 000 t/y of contained metal.

In January 1991, Phelps Dodge Corporation announced that its Phelps Dodge Morenci subsidiary and its joint venture partner, Sumitomo Metal Mining Arizona Inc., had discovered a new ore deposit containing 135 Mt grading 0.7% copper. The Coronado deposit is expected to extend the life of the Morenci operation to 23 years. During 1990, Phelps Dodge continued work on a US$112 million expansion to its electrowinning cathode facility at Morenci. Completion of the project, which will increase capacity by 65 000 t/y, is expected in mid-1991.

Elsewhere in the United States, Flambeau Mining Co., a subsidiary of Kennecott Corporation, announced that it would develop its Flambeau orebody in Wisconsin. The operation, which will produce about 27 000 t/y of copper over a six-year period, is expected to come on stream in late 1992. Ore from the mine, which has an average grade of 10.5% copper, will be shipped by rail to an existing mill. Magma Copper announced that it would reopen its Superior underground mine in 1991. This mine, which was closed in 1982, is expected to produce between 10 000 t/y and 15 000 t/y of copper in concentrates. Michigan Copper Company Ltd. reopened its 5000 t/y Centennial mine at Calumet, Michigan while South Atlantic Ventures plans to begin production at its 5000 t/y Oracle Ridge mine in Arizona in the first quarter of 1991. In addition, Arimetco International Inc. began production at its 5000 t/y SX-EW operation located at the Johnson Camp mine in Arizona.

In May, the Thalanga base-metal mine in Australia was commissioned. The operation, which is owned by Pancontinental Mining Ltd., Outokumpu Oy and Agip Australia Pty. Ltd., is expected to produce about 10 000 t/y of copper in concentrates. Elsewhere in Australia, Southern Copper Ltd. (formerly The Electrolytic Refining & Smelting Co. of Australia Ltd.) announced that labour problems had delayed the start-up of its Port Kembla smelter in New South Wales. The plant, which has been expanded to a capacity of 80 000 t/y, through the installation of a Noranda continuous reactor, is now expected to begin production in February 1991. A modernization of Southern's copper refinery is expected to be completed in early 1991.

At the end of 1990, it was reported that B.H.P. had agreed to partially fund the commercialization of a new process that produces high-grade granular copper without the use of traditional smelting. The process, which is known as the "Intec Hydromet System (IHS)," uses counter-current leaching followed by purification and electrowinning. During trials, the new technique has achieved significant cost savings over traditional processing methods.

In Papua New Guinea, the Bougainville open-pit mine remained closed in 1990 due to continuing political unrest. Although an agreement between the government and secessionist rebels on the island of Bougainville was reached in January 1991, it was unclear whether there would be an early resumption of operations at the mine.

Copper production in the Philippines in 1990 was again expected to fall short of output levels achieved in 1988 due a number of natural disasters. These included an earthquake in June which forced the temporary closure of the Santos Tomas gold-copper mine of Philex Mining Corp., a mudslide in August which forced the temporary closure of the Toledo mine of Atlas Consolidated Mining and Development Corp., and a typhoon in November which affected production at Atlas's operations on the island of Cebu.

In January 1991, it was reported that the Government of the People's Republic of China had signed a letter of intent with Philcopper Gold Mining Co. Ltd. for the construction of a new copper smelter at Bacon in Benguet province. The Chinese investment in the project would total US$100 million.

With the addition of significant new reserves at its Grasberg mine, Freeport-McMoRan Copper & Gold Inc. announced that it would increase mine production at its Indonesian operations to a rate of 85 000 t/d. Reserves at the Grasberg mine are now estimated at 267 Mt grading 1.47% copper, 1.69 g/t gold and 2.64 g/t silver. In January 1991, the company announced that it was considering the construction of a copper smelter in Indonesia although it had not yet determined a specific timetable for the project.

In Taiwan, the state-owned Keelung smelter was closed in March due to environmental problems. The 50 000 t/y smelter, which remained closed for the remainder of the year, was reported to be up for sale at the end of 1990.

At the end of 1990 it was reported that the Saindak gold and copper development in Pakistan, a joint venture between Pakistan's Resources Development Corp. and The China Metallurgical Construction Corporation, could be shelved because of a lack of funds. The project, which was to include both mining and processing operations, was expected to produce up to 16 000 t/y of copper and 1600 kg/y of gold. In the People's Republic of China itself, it was reported that the China National Nonferrous Metals Corp. plans to increase production at the Dexing and Wushan copper mines in Jiangxi province. The expansion of the Dexing mine is expected to increase production from 45 000 t/y of copper in concentrates to 130 000 t/y by 1993.

In September, Zambia Consolidated Copper Mines Limited (ZCCM) reported the first shipment of copper through the port of Walvis Bay in Namibia. In view of the transportation problems which ZCCM has experienced in recent years regarding copper exports through Tanzania and Mozambique, the Namibian route could provide a reliable alternative for the future. In November, there were a number of work stoppages at ZCCM's operations in Zambia itself, although no significant loss of production was reported.

Copper output in Zaire continued to be adversely affected by a lack of investment in new capacity and the maintenance of existing mining infrastructure caused in part by the scarcity of foreign exchange. During 1990, the situation was aggravated by transportation and labour difficulties as well as mining problems. In September, a cave-in at the Kamoto mine of

Générale des Carrières et des Mines (Gécamines) was expected to result in the loss of between 5000 t and 10 000 t of output.

In the Republic of South Africa, Prieska Copper Mines (Pty) Ltd. announced that it would close its Prieska mine at the end of January 1991 due to high operating costs. The mine had only limited remaining reserves.

Outokumpu Oy signed a preliminary agreement in October with a consortium of seven Portuguese companies for the construction of a 200 000 t/y copper smelter in southern Portugal. The US$300 million smelter, which will utilize Outokumpu's flash smelting technology, is expected to come on stream in 1994. While the source of feed for the smelter has yet to be determined, it is assumed that the large Neves Corvo mine in Portugal will supply a major percentage of its requirements.

In November, Outokumpu announced that it had signed a letter of intent to establish a joint venture for the development of the Alexandrinsky and Podolsk deposits in the southern Urals of the U.S.S.R. The former deposit contains reserves of 4 Mt grading 4.4% copper and 5.5% zinc, while the latter contains 77 Mt grading 2.5% copper and 1.8% zinc.

In Europe, several new mines are expected to come on stream in the next few years, boosting copper output in the region. These include the Parys Mountain deposit of Anglesey Mining plc in north Wales with reserves of 6.4 Mt grading 2.3% copper, 2.6% lead and 5.3% zinc, plus gold and silver, and the deposit of Société Minière de Chessy near Lyon in France with mineable reserves of 4.1 Mt grading 7.8% zinc and 2.5% copper. In addition, Pirites Alentejans SARL plans to begin production at its Moinho mine in Portugal in April 1991. When fully on stream, this mine is expected to produce about 25 000 t/y of copper in concentrates.

In the United Kingdom, BICC Plc announced that it was closing its 65 000 t/y Prescot refinery in early 1991 due to a shortage of blister feed and high production costs.

At the end of 1990, seven nations, accounting for less than 30% of the world trade in copper, had accepted the terms of reference for a new International Copper Study Group (ICSG). This group includes the United States, Finland, Chile, Greece, Poland, Peru and the People's Republic of China. The approval of copper-consuming and -producing nations, accounting for at least 60% of the world trade in copper, has been regarded as the minimum required to permit the ICSG to come into effect.

CONSUMPTION AND USES

Canadian refined copper consumption in 1990 was estimated to have declined to approximately 184 000 t from the 219 000 t recorded in 1989. Western World consumption of refined copper in 1990 was estimated to have increased slightly to 8.85 Mt (this includes refined copper from both primary and secondary material) from 8.65 Mt in 1989. In addition, more than 3 Mt/y of copper scrap is used directly by consumers. Altogether, approximately 4.4 Mt, or slightly less than 40% of the copper consumed in the Western World, is estimated to be derived from recycled materials.

Copper's high electrical and thermal conductivity combined with its good tensile strength and mechanical properties, elevated melting point (1083°C), non-magnetic properties and resistance to corrosion make it and its alloys very attractive for electrical transmission, water tubing, castings and heat exchangers. Copper is the most efficient conductor of electrical power, signals and heat of all of the industrial metals (aluminum's electrical and thermal conductivity is only 72% and 76%, respectively, of copper's). In Canada, more than half of the refined copper consumed annually is used for electrical applications, mostly wire.

Detailed copper consumption statistics are not collected officially in Canada. The Canadian Copper and Brass Development Association (CCBDA), an association of producers and fabricators, collects certain statistics for its members. The CCBDA disseminates information to copper users and provides technical assistance to encourage and foster copper consumption in Canada. Besides the traditional uses, copper is consumed in Canada for retrofitting of fire suppression systems, natural gas tubing in residences, central vacuuming and roofing. Changes are being contemplated that would require fire suppression systems to be installed in all new residential dwellings; copper is the preferred material for such systems.

The United States has the best publicly available copper consumption data. Table 8 presents preliminary end-use data for 1988 and 1989 collected by the U.S. Copper Development Association Inc. (US CDA). These data clearly indicate the importance of building construction to copper consumption, with 41% of the total in 1989. Usage in houses is rising as dwelling size increases and more labour-saving and other electrical devices are incorporated. In 1990, the average new home in the United States was 186 m^2 (2000 sq ft) and contained an estimated 213 kg of copper. In comparison, about 166 kg of copper were used to construct the average 158 m^2 (1700 sq ft) house in 1983.

Electrical and electronic products accounted for about 24% of U.S. copper usage in 1989, followed by industrial machinery and equipment with 14%, transportation equipment with 11% and consumer and other products with 10%. The average North American automotive vehicle contained about 23 kg of contained copper in 1990, compared to 22 kg in 1986 and 17 kg in 1980. This change has largely been due to the increasing complexity of automotive electrical systems. A typical vehicle, which had about 500 electrical circuits in 1981 and about 750 circuits in 1986, could contain up to 1200 circuits by 1992.

NEW MARKETS

A number of promising new markets for copper could well provide significant growth opportunities for the industry by the end of the century. These include applications in roofing, fire suppression systems and natural gas systems inside houses and buildings, as well as solar power generation, data communication and the storage of spent nuclear fuel. While copper use in original-equipment automobile radiators has declined due to the market penetration of aluminum radiators, copper and brass radiators continue to predominate in the replacement market. In addition, the use of copper in an increased number of automotive electrical circuits is expected to more than offset declining non-electrical copper consumption in vehicles.

With a number of technological advances in the communications and telecommunication sectors in recent years, including the development of fibre optics, multiplexing and gauge reduction, copper utilization in telecommunications has declined. However, copper remains the preferred metal for electrical wiring applications in building construction. As houses increase in size and incorporate more labour-saving electrical devices, the use of copper in household wiring applications could increase by up to 40%.

TRADE

In 1989, about 1.8 Mt of copper in concentrates was exported by Western World countries. The United States was the largest exporter (360 500 t) followed by Canada (326 400 t), Chile (314 400 t) and Papua New Guinea (226 000 t). Blister and anode copper exports by Western nations totalled 652 200 t/y while refined copper exports were about 3.2 Mt/y. East-West trade is relatively small, with exports from Western countries totalling only 155 000 t of contained copper in 1989 while imports into Western countries totalled 240 000 t.

HEALTH AND THE ENVIRONMENT

Human and animal health depends on an adequate dietary intake of copper (as it does on many other trace metals). Copper combines with proteins to form many enzymes critical for life. One such important enzyme is superoxide dismutase which removes the superoxide radicals in the human body. Superoxide radicals are the "residues" of metabolic processes which otherwise could build up to toxic levels. Copper is also required to transport iron from absorption sites to the bone marrow where red blood cells are produced.

Many regulatory agencies have chosen 1 ppm as the maximum desirable concentration of copper in drinking water. It signifies more of an aesthetic than a health limit: water containing more than 1 ppm can stain laundry, and persons with a keen sense of taste may perceive a metallic flavour in the water.

Copper

Copper tube used for distribution of potable water supplies inhibits bacterial growth. In addition to the suppression of bacteria such as *Legionnella pneumonillia* in a water system, copper also discourages biofilm formation, under which bacteria can survive.

Like most metals, copper is found in small concentrations in nature. The mining of copper generates significant amounts of solid wastes in tailings ponds and, to a lesser extent, in rock dumps. Due to associated minerals such as pyrites in the ore, the wastes generate acid when exposed to oxygen in the air. Commonly, mine operators control acid generation by keeping the tailings areas below the water table and covering acid-generating waste with soil.

Most of the environmental concerns that arise from producing copper are associated with the sulphur dioxide emissions that result from copper smelting. In Canada, Noranda Inc. closed the reverberatory furnace at its Horne smelter in early 1989 and completed construction of a 350 000 t/y acid plant at year-end.

Under a 1985 Ontario government regulation, Inco Limited and Falconbridge Limited must reduce their emissions of sulphur dioxide to 265 000 t and 100 000 t, respectively, by 1994. In 1985, the limit was 685 000 t for Inco and 154 000 t for Falconbridge.

At Inco's Sudbury operations, work is under way on those projects which will be required to achieve compliance with the regulation. The major part of this program involves changes to the smelter, which include two oxygen flash furnaces, a new sulphuric acid plant, an additional oxygen plant plus some other plant modifications. Over the next two years, the company has reported that it will spend about $300 million on these environmental programs at Sudbury.

Falconbridge is spending $38 million on research, development and capital projects related to increasing pyrrhotite rejection and greater roasting to be able to conform to the regulation. While actual emissions of sulphur dioxide in 1990 were below the required 1994 level, the company was producing below capacity. The company is conducting research on methods to reduce emissions to 75 000 t/y, at capacity production, by 1998. Increased pyrrhotite rejection is the focus of the research.

HBMS intends to upgrade its Flin Flon smelting complex with an investment of $170 million. The project will reduce operating costs while allowing for a 25% reduction in sulphur dioxide emissions and a 50% reduction in airborne particulate emissions by 1994, as required by Manitoba legislation. The modernization of the copper smelter includes the replacement of concentrate roasting and calcine smelting processes with Noranda's continuous converter technology. While SO_2 emissions will not initially be captured at the copper smelter, the volume of off-gases will be reduced, making collection at some point in the future more practical and effective.

During 1990, the Canadian mineral industry raised concerns over draft export-import regulations under the Canadian Environmental Protection Act. These new regulations are required to give effect to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal which, while signed in March 1989, Canada has not as yet ratified.

While the proposed regulations would discourage the importation of hazardous waste material, these could also apply to recyclable metal scrap that contained some material that could be designated hazardous. The industry contends that such regulations could have a negative impact on those Canadian companies which depend on imported scrap for a portion of their feed requirements. As an example, 10% of the feed for Noranda's Horne smelter is composed of recyclable scrap, a large percentage of which is imported material.

STOCKS

Combined copper stocks on the London Metal Exchange (LME) and COMEX, which totalled almost 115 000 t at the beginning of 1990, declined through the first quarter to a low of about 58 000 t in mid-April. Stocks remained at relatively low levels until the end of July when inventory levels increased dramatically, climbing to over 200 000 t by mid-October. Combined stocks at the end of the year were about 198 000 t.

The American Bureau of Metal Statistics reported that total refined copper stocks held by U.S. refineries at the end of December totalled about 47 000 t compared to over 51 000 t at the end of 1989. The Bureau also reported that copper stocks at other Western World refineries totalled almost 257 000 t in November 1990 compared to about 208 000 t in November 1989.

PRICES

The price of copper increased from under US$1.00/lb on the LME in January 1990 to a high of $1.54 in September as a result of actual or threatened supply disruptions caused by a combination of labour and production problems around the world, as well as for purely technical and speculative reasons. With the slowdown of economic activity, particularly in North America, and an increase in LME and COMEX stocks, copper prices experienced some weakness in the fourth quarter of 1990. The average LME cash price in December was US$1.13. The average price of copper in 1990 on the LME was US$1.21/lb, compared to $1.29 in 1989.

The LME and COMEX predominate in establishing copper prices worldwide. Both trade in spot or "cash" metal as well as in futures contracts. Figure 1 shows daily LME cash prices from 1988-90 in US$/lb while Figure 2 shows monthly average LME prices from 1965-90. Canadian producers sell refined copper in the United States at COMEX plus a premium of about US3¢/lb, in Canada at the Canadian dollar equivalent of COMEX plus about 3.5¢/lb, and in Europe at LME plus £10 to £15/t (payment terms may differ between regions).

OUTLOOK

With the likelihood that the current economic slowdown in North America will continue into 1991 and that growth may slow in certain parts of Europe, it is expected that the demand for copper will ease somewhat in the first half of 1991. Although an economic recovery may begin to build in the second half of 1991, significant increases in copper supplies, principally as a result of the commissioning of the new Escondida project in Chile, will constrain the recovery of prices.

The slower demand and increased supply which is forecast for 1991 will drive up copper stocks, barring any major supply disruptions, and could push copper prices on the LME to below US90¢/lb by year-end. It is expected that the average copper price on the LME in 1991 will be about 95¢/lb. For the remainder of the 1990s, it is expected that copper prices will average between US68¢ and US95¢/lb (constant 1990 cents). This assumes that copper consumption will grow at an average annual rate of between 1.5% and 2% through the decade.

Copper prices in the upper end of this price range are likely to occur if a widely forecast shortage of smelting capacity develops in the mid-1990s. The principal reason for this impending shortage is related to the artificially low smelter charges in Japan, the result of a protective tariff on refined copper imports. This has discouraged the construction of smelting capacity elsewhere in the world, particularly in those copper-mining nations of the Pacific Rim. While this tariff protection may be eliminated or at least reduced in the next few years, the shortage could still develop in view of the significant and growing lead-time required for new smelter construction.

The severity and length of a possible smelter capacity shortage is also dependent to some degree on the amount of new low-cost SX-EW capacity that comes on stream in the 1990s. According to Commodities Research Unit Limited, the production of copper by electrowinning will increase from about 10.5% of total Western World refined output in 1989 to about 20% by the year 2000.

Although a significant number of promising new copper deposits have been discovered in Canada in recent years, Canadian mine production of copper is expected to decline in the early 1990s as the growth of new copper capacity is unable to match mine closures or the decline of capacity at existing operations. In the late 1990s, however, production is expected to recover when a number of large deposits, particularly in British Columbia, come on stream.

Note: Information contained in this review was current as of mid-January 1991.

Copper

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EEC MFN	Japan[1] MFN
2603.00	Copper ores and concentrates						
2603.00.00.10	Copper content	Free	Free	Free	Free	Free	Free
2825.50	Copper oxides and hydroxides	Free	Free	Free	2.3%-3.0%	3.2%	7.2%
28.33	Sulphates; alums; peroxosulphates						
	Sodium sulphates:						
2833.25	Of copper						
2833.25.10	Cupric sulphate	6.8%	Free	2.7%	0.8%	3.2%	5.8%
74.01	Copper mattes; cement copper (precipitated copper)						
7401.10	Copper mattes	Free	Free	Free	0.4¢/kg on copper content	Free	Free
74.03	Refined copper and copper alloys, unwrought						
	Refined copper						
7403.11	Cathodes and sections of cathodes	Free	Free	Free	0.6%	Free	21 yen/kg
7403.12	Wire-bars	4.0%	Free	1.6%	0.6%	Free	21 yen/kg
7403.13.00	Billets	Free	Free	Free	0.6%	Free	21 yen/kg
7403.19	Other						
7403.19.10	Ingots, ingot-bars and slabs	Free	Free	Free	0.6%	Free	21 yen/kg
7403.21	Copper-zinc base alloys (brass)						
7403.21.10	Ingots, ingot-bars, slabs and billets	4.0%	Free	1.6%	0.6%	Free	21 yen/kg
7403.22	Copper-tin base alloys (bronze)	10.3%	6.5%	4.1%	0.6%	Free	21 yen/kg
7404.00	Copper waste and scrap						
7404.00.10	Not alloyed	Free	Free	Free	Free	Free	Free
	Alloyed						
7404.00.21	Copper-zinc base alloys (brass)	4.0%	Free	Free	Free	Free	Free
7405.00	Master alloys of copper	10.3%	6.5%	4.1%	1.5%-3.6%	Free	6.0%
74.06							
7406.10	Powders of non-lamellar structure						
7406.10.10	Not alloyed	4.0%	Free	2.8%	4.3%	1.4%	7.2%
7406.20	Powders of lamellar structure; flakes						
7406.20.10	Not alloyed	4.0%	Free	2.8%	2.4%	6.2%	7.2%
74.07	Copper bars, rods and profiles						
7407.10	Of refined copper						
	Unworked						
7407.10.11	Bars and rods, of a maximum cross-sectional dimension not exceeding 12.7 mm	4.5%	3.0%	3.1%	0.8%-5.0%	6.0%	7.2%
	Of copper alloys						
7407.21	Of copper-zinc base alloys (brass)						
	Unworked						
7407.21.11	Bars and rods, of a maximum cross-sectional dimension not exceeding 12.7 mm	4.5%	3.0%	3.1%	1.5%-2.5%	6.0%	7.2%
7407.21.12	Bars and rods, of a maximum cross-sectional dimension exceeding 12.7 mm; profiles	4%	Free	2.8%	1.5%-2.5%	6.0%	7.2%
74.08	Copper wire						
	Of refined copper:						
7408.11	Of which the maximum cross-sectional dimension exceeds 6 mm						
	Not exceeding 12.7 mm:						
7408.11.11	Not coated or covered	4.5%	3.0%	3.1%	0.8%-3.2%	6.0%	7.2%
	Exceeding 12.7 mm						
7408.11.21	Not coated or covered	4.0%	Free	2.8%	0.8%-3.2%	6.0%	7.2%
74.09	Copper plates, sheets and strip, of a thickness exceeding 0.15 mm						
	Of refined copper						
7409.11	In coils						
7409.11.10	Unworked	4.0%	Free	2.8%	5.3%	6.0%	6.5%
7409.19	Other						
7409.19.10	Unworked	4.0%	Free	2.8%	3.7%	6.0%	6.5%
	Of copper-zinc base alloys (brass):						
7409.21	In coils						
7409.21.10	Unworked	4.0%	Free	2.8%	1.5%	6.0%	6.0%
7409.29	Other						
7409.29.10	Unworked	4.0%	Free	2.8%	1.5%	6.0%	6.0%
74.10	Copper foil (whether or not printed or backed with paper, paperboard, plastics or similar backing materials) of a thickness (excluding any backing) not exceeding 0.15 mm						
	Not backed:						
7410.11	Of refined copper						
7410.11.10	Unworked	4.0%	Free	2.8%	0.8%	6.5%	6.0%

TARIFFS (cont'd)

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EEC MFN	Japan[1] MFN
74.11	Copper tubes and pipes						
7411.10	Of refined copper						
7411.10.10	Unworked	4.0%	Free	2.8%	1.2%	6.0%	6.5%
	Of copper alloys:						
7411.21	Of copper-zinc base alloys (brass)						
7411.21.10	Unworked	4.0%	Free	2.8%	1.1%	6.0%	6.5%
74.12	Copper tube or pipe fittings (for example, couplings, elbows, sleeves)						
7412.10	Of refined copper	10.3%	6.5%	7.2%	8.9%	6.5%	5.8%
7412.20	Of copper alloys	10.3%	6.5%	7.2%	2.5%	6.5%	5.8%
7413.00	Stranded wire, cables, plaited bands and the like, of copper, not electrically insulated	10.3%	6.5%	7.2%	3.2%-4.5%	Free-6.5%	7.2%
74.15	Nails, tacks, drawing pins, staples (other than those of heading No. 83.05) and similar articles, of copper or of iron or steel with heads of copper; screws, bolts, nuts, screw hooks, rivets, cotters, cotter-pins, washers (including spring washers) and similar articles, of copper						
7415.10	Nails and tacks, drawing pins, staples and similar articles	10.3%	6.5%	7.2%	4.0%	6.5%	5.8%
	Other threaded articles:						
7415.31	Screws for wood	10.2%	6.5%	7.1%	4.4%	4.9%	5.8%

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States effective January 1, 1990; Official Journal of the European Communities, Vol. 33, No. L247, 1990, "Conventional" column; Custom Tariff Schedules of Japan, 1990.
[1] GATT rate is shown, lower tariff rates may apply circumstantially.

Copper

TABLE 1. CANADA, COPPER PRODUCTION AND TRADE, 1989 AND 1990p

	1989		1990p	
	(tonnes)	($000)	(tonnes)	($000)
Shipments[1]				
Nova Scotia	x	x	x	x
New Brunswick	7 802	26 456	6 475	20 719
Quebec	65 135	220 874	94 207	301 461
Ontario	271 914	922 068	277 067	886 609
Manitoba	50 484	171 191	55 641	178 051
Saskatchewan	x	x	x	x
British Columbia	308 348	1 045 617	345 685	1 106 184
Yukon	–	–	–	–
Northwest Territories	–	–	–	–
Total	704 432	2 388 748	779 566	2 494 596
Refinery output	515 216	. .	504 000	. .
Exports			**(Jan.-Sept.)**	
Copper ores and concentrates				
Copper content				
Japan	226 376	604 974	210 969	503 791
South Korea	29 758	82 116	30 759	70 057
Spain	30 625	82 967	17 605	45 231
Philippines	14 627	37 266	7 617	17 787
People's Republic of China	10 726	27 394	–	–
Other countries	20 843	52 537	27 580	46 094
Total	332 955	887 254	294 530	682 960
Other ores and concentrates				
Copper content				
United States	358	268	531	925
Belgium	30	50	24	51
Other countries	–	–	3	27
Total	388	318	558	1003
Copper oxides and hydroxides				
Total	–	–	–	–
Copper mattes				
Norway	16 720	42 673	10 688	26 460
Other countries	2 038	5 084	724	2 345
Total	18 758	47 757	11 412	28 805
Refined copper				
United States	177 192	590 833	141 810	426 409
United Kingdom	68 408	231 322	36 753	112 840
Netherlands	28 854	93 836	22 749	71 801
Italy	12 951	43 382	19 202	58 471
Sweden	11 385	38 197	7 033	21 673
West Germany	14 317	47 361	5 424	16 073
France	6 213	21 813	4 014	12 615
Japan	1 088	3 817	593	1 772
South Korea	755	2 858	–	–
Other countries	527	2 061	3 278	9 554
Total	321 690	1 075 480	240 856	731 208
Other copper alloys				
United States	2 940	11 337	122	240
Other countries	1 261	2 877	420	963
Total	4 201	14 214	542	1 203

TABLE 1 (cont'd)

	1989		Jan.-Sept. 1990p	
	(tonnes)	($000)	(tonnes)	($000)
Exports (cont'd)				
Copper waste and scrap				
United States	46 888	113 141	65 744	167 351
West Germany	5 407	11 614	3 445	7 853
South Korea	3 747	9 433	2 395	5 883
India	2 551	4 111	2 160	3 542
United Kingdom	2 057	4 438	125	166
Other countries	6 251	13 149	5 150	8 910
Total	66 901	155 886	79 019	193 705
Master alloys of copper				
United States	61	247	–	–
Norway	–	–	1	22
Total	61	247	1	22
Copper powders and flakes				
United States	342	1 894	50	334
Other countries	96	824	111	796
Total	438	2 718	161	1 130
Copper and copper alloy rods and profiles				
United States	7 977	34 957	3 134	13 599
Other countries	466	2 243	297	1 052
Total	8 443	37 200	3 431	14 651
Copper and copper alloy wire				
United States	652	2 140	211	1 065
Other countries	1 721	5 572	23	201
Total	2 373	7 712	234	1 266
Copper and copper alloy plates, sheets, strip and foil				
United States	14 323	51 218	6 795	29 744
Other countries	817	2 820	606	2 494
Total	15 140	54 038	7 401	32 238
Copper and copper alloy tubes and pipes				
United States	4 829	27 498	4 920	23 943
Other countries	910	4 345	1 234	5 674
Total	5 739	31 843	6 154	29 617
Copper and copper alloy tube and pipe fittings				
United States	..	7 704	..	4 152
Other countries	..	3 692	..	3 913
Total	..	11 396	..	8 065
Stranded wire, cables, plaited bands and the like, of copper, not electrically insulated				
United States	28	114	3	71
Other countries	41	191	1	7
Total	69	305	4	78
Cloth, fastener and other items of copper				
United States	..	20 851	..	5 598
Other countries	..	12 701	..	1 661
Total	..	33 552	..	7 259

TABLE 1 (cont'd)

	1989		Jan.-Sept. 1990p	
	(tonnes)	($000)	(tonnes)	($000)
Imports				
Copper ores and concentrates				
Copper content	47 429	109 450	15 385	34 679
Other ores and concentrates				
Copper content	1 831	3 682	34 062	38 300
Copper oxides and hydroxides	735	2 267	419	1 633
Sulphates; alums; peroxosulphates (persulphates)				
of copper	5 203	4 018	3 598	2 759
Copper mattes; cement copper (precipitated copper)				
Copper mattes	2 970	4 701	3 025	7 117
Refined copper and copper alloys, unwrought				
Refined copper	4 408	13 370	2 102	7 667
Other copper alloys	1 629	7 407	2 333	8 631
Copper waste and scrap	97 174	177 540	53 028	93 885
Master alloys of copper	64	246	38	164
Copper powders and flakes	1 154	5 680	1 056	4 502
Copper and copper alloy rods and profiles	24 235	80 741	21 285	70 311
Copper and copper alloy wire	22 868	92 531	6 648	28 916
Copper and copper alloy plates, sheets, strip and foil	13 133	60 775	13 532	55 973
Copper and copper alloy tubes and pipes	11 213	61 265	7 910	37 720
Copper and copper alloy tube and pipe fittings	4 775	36 993	3 004	24 177
Stranded wire, cables, plaited bands and the like, of copper, not electrically insulated	3 749	16 689	2 636	10 922
Cloth, fastener and other items of copper	1 135	47 611	876	31 670

Sources: Energy, Mines and Resources Canada; Statistics Canada.
1 Anode copper recovered in Canada from domestic concentrates plus exports of payable copper in concentrates and matte.
p Preliminary; .. Not available or not applicable; x Confidential; – Nil.
Note: Totals may not add due to rounding.

TABLE 2. CANADA, COPPER PRODUCTION, TRADE[1] AND CONSUMPTION, 1970, 1975, 1980 AND 1985-90

	Production		Exports			Imports	Consumption[3]
	Shipments[2]	Refinery Output	Concentrates and Matte	Refined	Total	Refined	Refined
	(tonnes)						
1970	610 279	493 261	161 377	265 264	426 641	13 192	229 026
1975	733 826	529 197	314 518	320 705	635 223	10 908	196 106
1980	716 363	505 238	286 076	335 022	621 098	13 466	208 590
1985	738 637	499 626	320 619	280 033	600 652	19 131	222 466
1986	698 527	493 445	341 390	306 822	648 212	20 901	225 586
1987	794 149	491 124	381 126	288 800	669 926	16 583	231 288
1988	758 478	528 723	348 404	268 680[r]	617 084[r]	4 659	236 280
1989	704 432	515 216	352 101	321 690	673 791	4 408	218 571
1990[p]	779 566	504 000	306 500[a]	240 856[a]	547 356[a]	2 594	184 480

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Beginning in 1988, Exports and Imports are based on the new Harmonized System and may not be in complete accordance with previous method of reporting. [2] Anode copper recovered in Canada from domestic concentrate plus exports of payable copper in concentrates and matte. [3] Producers' domestic shipments of refined copper plus imports of refined shapes.
[a] January to September 1990; [p] Preliminary; [r] Revised.

TABLE 3. WESTERN WORLD PRODUCTION OF RECOVERABLE COPPER IN CONCENTRATES, 1989 AND 1990

	1989	1990e
	(000 t)	
Chile	1 609	1 588
United States	1 498	1 600
Canada[1]	704	780
Zaire	441	440
Zambia[2]	510	520
Peru	364	318
Australia	295	265
Mexico	249	300
Philippines	193	190
Papua New Guinea	205	170
Other	1 085	1 011
Total	7 153	7 182

Sources: World Bureau of Metal Statistics; Energy, Mines and Resources Canada.
[1] Data are for shipments. [2] Includes SX-EW material from reprocessing of tailings.
[e] Estimated from nine months' data and other information.

TABLE 4. WESTERN WORLD PRODUCTION OF REFINED COPPER,[1] 1989 AND 1990

	1989	1990e
	(000 t)	
United States	1 954	2 000
Chile	1 071	1 185
Japan	990	1 008
Canada	515	504
Federal Republic of Germany	475	475
Zambia[2]	470	485
Belgium	397	397
Australia	255	247
Zaire	204	210
Brazil	153	166
Peru	224	171
Other	1 676	1 653
Total	8 384	8 501

Sources: World Bureau of Metal Statistics; Energy, Mines and Resources Canada.
[1] Includes primary, secondary and electrowon copper. [2] Includes some material from Zaire.
[e] Estimated from nine months' data and other information.

TABLE 5. WESTERN WORLD CONSUMPTION OF REFINED COPPER, 1989 AND 1990

	1989	1990e
	(000 t)	
United States	2 203	2 255
Japan	1 447	1 517
Federal Republic of Germany	855	877
Italy	458	486
France	459	505
Belgium	376	399
United Kingdom	325	319
South Korea	249	294
Canada	219	187
Taiwan	315	263
Brazil	180	188
Other	1 565	1 561
Total	8 651	8 851

Sources: World Bureau of Metal Statistics; Energy, Mines and Resources Canada.
e Estimates based on partial year's data and other information.

TABLE 6. COPPER AND COPPER-NICKEL SMELTERS IN CANADA, 1990

Company and Location	Product	Rated Annual Capacity	Blister or Anode Copper Produced in 1990 (1989)	Remarks
		(tonnes of concentrates)	(tonnes)	
Falconbridge Limited Falconbridge, Ontario	Copper nickel matte	570 000	31 720 (25 200)	Fluid bed roasters and electric furnaces; 1800 t/d sulphuric acid plant treats roaster gases. Matte from the smelter is refined in Norway.
Inco Limited Sudbury, Ontario	Molten "blister" copper, nickel sulphide and nickel sinter for the company's refineries; nickel oxide sinter for market, soluble nickel oxide for markets	1 500 000	114 864[a] (122 368)[a]	Oxygen flash-smelting of copper concentrate; converts for production of blister copper. Roasters, reverberatory furnaces for smelting of nickel-copper concentrate, converters for production of nickel-copper Bessemer matte. Production of matte followed by matte treatment, flotation, separation of copper and nickel sulphides, then by sintering to make sintered nickel products for refining and marketing. Electric furnace melting of copper sulphide and conversion to blister copper.
Falconbridge Limited Timmins, Ontario	Molten "blister" copper	440 000	117 000 (105 676)	Mitsubishi-type smelting, separation and converting furnaces, acid plant and oxygen plant to treat continuous copper concentrate feed stream to yield molten 99% pure copper which is transported by ladles and overhead cranes to two 350 t anode furnaces.
Noranda Inc., Horne smelter Noranda, Quebec	Copper anodes	700 000	168 000 (144 000)	One oxy-fuel fixed reverberatory furnace (currently closed), one continuous Noranda process reactor and five converters; oxygen for the reverberatory furnace and Noranda reactor is supplied by two plants with a combined total of 540 t/d. Continuous reactor modified to produce matte instead of metal. Acid plant became operational at end of 1989.
Noranda Inc., Gaspé smelter Murdochville, Quebec	Copper anodes	215 000	65 000 (66 000)	Green charge reverberatory furnace, two converters, rotary anode furnace and an acid plant. Treats Gaspé and custom concentrates.
Hudson Bay Mining and Smelting Co., Limited (HBMS) Flin Flon, Manitoba	Copper anodes	400 000	62 500 (57 700)	Five roasting furnaces, one reverberatory furnace and three converters. Company treats its own copper concentrate from mines at Flin Flon, Leaf Rapids and Snow Lake, as well as custom copper concentrates; zinc plant residues and stockpiled zinc-plant residues fed to reverberatory furnace.

Source: Data provided by each company.
[a] Production of anode not available; figures cited are for refinery output which includes a small tonnage of copper from Inco's Manitoba operations.

TABLE 7. COPPER REFINERIES IN CANADA, 1990

Company and Location	Rated Annual Capacity	Output in 1990 (1989)	Remarks
	(tonnes)		
Noranda Inc., Division CCR East Montreal, Quebec	350 000	298 477 (287 000)	Refines anodes from Noranda's Horne and Gaspé smelters, from the Flin Flon smelter and also from purchased scrap. Copper sulphate and nickel sulphate recovered by vacuum evaporation. Precious metals, selenium and tellurium recovered from slimes. Produces CCR brand electrolytic copper cathodes, cakes and billets. Tank-house modernization program under way.
Inco Limited Copper Cliff, Ontario	180 000	114 864 (122 368)	Casts and refines anodes from molten converter copper from the Copper Cliff smelter; also refines purchased scrap. Gold, silver, selenium and tellurium cake recovered from anode slimes, which are further processed at Port Colborne to recover platinum metals concentrates. Recovers and electrowins copper from Copper Cliff nickel refinery residue. Produces ORC brand electrolytic copper cathodes. Modernization completed in 1988.
Falconbridge Limited Timmins, Ontario	95 000	95 001 (94 992)	Molten copper from two 350 t anode furnaces is cast in a Hazelett continuous casting machine into continuous copper strip, then formed to 145 kg anodes in a blanking press. Spent and scrap anodes are remelted in a 40 t ASARCO shaft furnace. Cathodes formed in jumbo-sized electrolytic tanks in a highly automated tank-house. A decopperized precious metal slime is also marketed.
Gibraltar Mines Limited McLeese Lake, British Columbia	5 000	3 737 (4 009)	Dissolved copper-in-solution from heap leaching operations is treated in a solvent extraction plant and then electrowinned to produce copper cathode.

Source: All data provided by the companies.

TABLE 8. SUPPLY OF COPPER PRODUCTS AND THEIR CONSUMPTION IN END USE MARKETS, 1988 AND 1989

United States	1988		1989p	
	(000 t)	(% of total)	(000 t)	(% of total)
Supply				
Domestic mill products				
Building wire	508	15.8	516	16.5
Magnet wire	231	7.2	233	7.4
Communication wire	332	10.3	317	10.1
Other wire and cable	440	13.6	457	14.6
Strip, sheet, plate	428	13.3	395	12.6
Rod and bar	430	13.3	401	12.8
Tube and pipe	414	12.8	424	13.4
Mechanical wire	29	0.9	27	0.9
Foundry products	234	7.3	225	7.2
Powder products	20	0.6	19	0.6
Total	3 066	96.4	3 014	96.1
Imported mill products	159	4.9	122	3.9
Total supply	3 225	100.0	3 136	100.0
Uses				
Building construction	1 317	40.8	1 296	41.3
Electrical/electronic products	757	23.5	750	23.9
Industrial machinery/equipment	450	14.0	423	13.5
Transportation equipment	385	11.9	358	11.4
Consumer and general products	316	9.8	309	9.9
Total	3 225	100.0	3 136	100.0

Source: United States Copper Development Association Inc.
p Preliminary.
Note: Percentages may not add due to rounding.

TABLE 9. YEARLY AVERAGE COPPER PRICES[1]

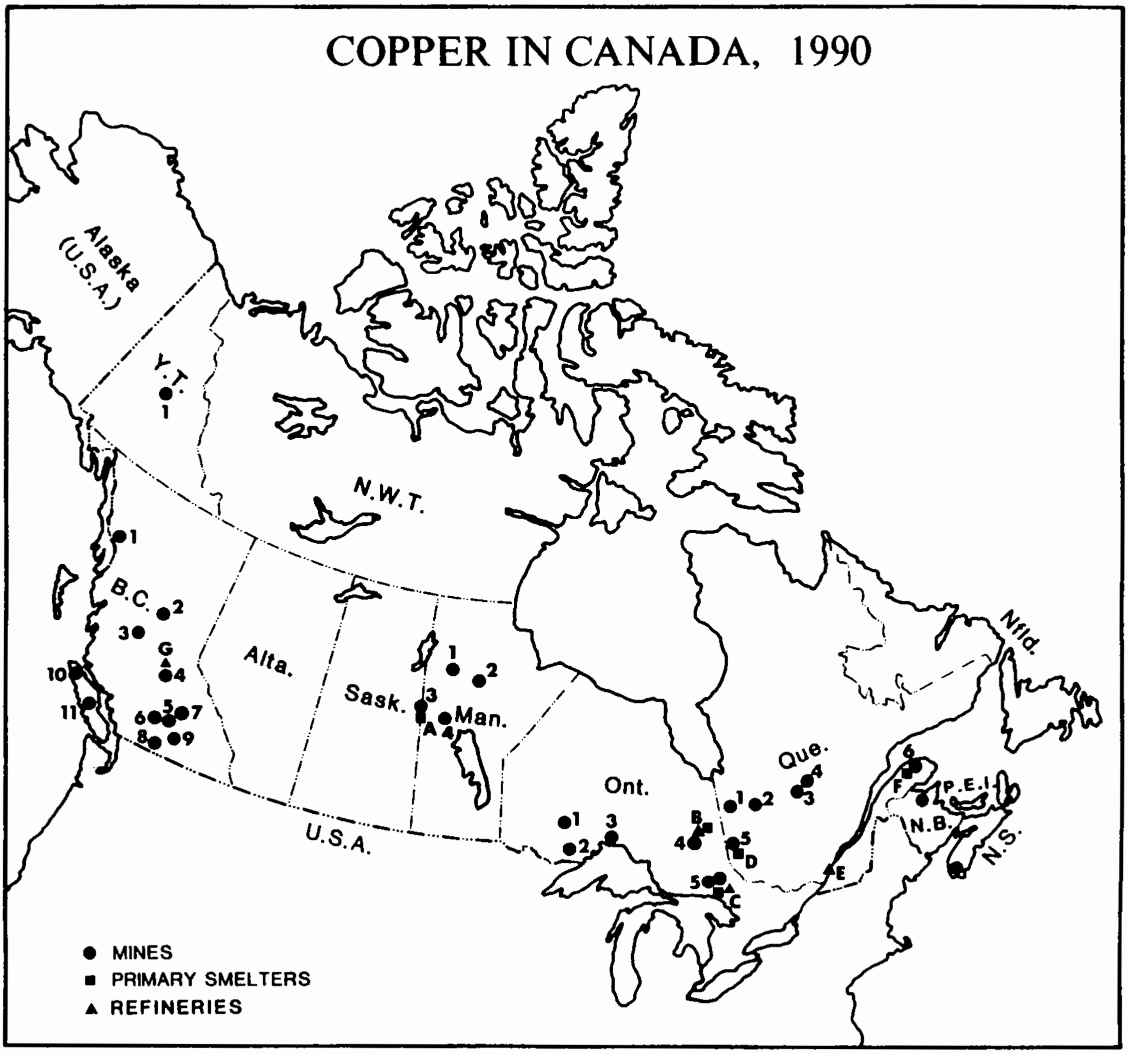
Year	LME
	(current US¢/lb)
1980	99.3
1981	79.5
1982	67.2
1983	72.2
1984	62.6
1985	64.9
1986	62.3
1987	80.1
1988	118.0
1989	129.0
1990	121.1

Source: Metals Week.
[1] Settlement price for highest grade of copper sold.

TABLE 10. MONTHLY AVERAGE COPPER PRICES, 1989 AND 1990

	LME[1]		COMEX[2]	
	1989	1990	1989	1990
	(current US¢/lb)			
January	154.2	107.3	152.2	104.4
February	140.6	107.1	134.2	107.3
March	148.2	119.1	142.9	124.2
April	141.4	121.8	138.3	122.4
May	124.4	124.4	120.7	120.3
June	115.3	117.2	109.5	112.9
July	113.4	125.6	107.2	121.9
August	125.5	134.1	121.7	130.5
September	130.7	137.5	132.0	130.5
October	130.0	124.4	125.5	126.4
November	117.5	117.3	111.5	115.8
December	109.6	112.7	103.4	112.4

Source: Metals Week.
[1] LME settlement price for Grade A copper. [2] COMEX First Position Settlement price.


COPPER IN CANADA, 1990
Alaska (U.S.A.)
Y.T.
N.W.T.
B.C.
Alta.
Sask.
Man.
Ont.
Que.
Nfld.
P.E.I.
N.B.
N.S.
U.S.A.
MINES
PRIMARY SMELTERS
REFINERIES

COPPER PRODUCERS IN 1990

(numbers and letters correspond to those on map "Copper in Canada 1990")

Yukon

1. Curragh Resources Inc. (Faro)

British Columbia

1. Skyline Gold Corporation (Iskut River)
2. Noranda Inc. (Bell mine)
3. Equity Silver Mines Limited
4. Gibraltar Mines Limited
5. Highland Valley Copper[1]
6. Teck Corporation (Afton)
7. Minnova Inc. (Samatosum)
8. Princeton Mining Corporation (Similco)
9. Brenda Mines Ltd., Peachland
10. BHP-Utah Mines Ltd.
11. Westmin Resources Limited

Saskatchewan

Hudson Bay Mining and Smelting Co., Limited (HBMS), (Flin Flon)

Manitoba

1. Hudson Bay Mining and Smelting Co., Limited (HBMS), (Ruttan mine)
2. Inco Limited (Thompson mine)
3. Hudson Bay Mining and Smelting Co., Limited (HBMS), Flin Flon area mines
   Hudson Bay Mining and Smelting Co./ Outokumpu Mines Ltd. Joint Venture (Namew Lake mine)
4. Hudson Bay Mining and Smelting Co., Limited (HBMS), Snow Lake area mines

Ontario

1. Noranda Inc., Lyon Lake Division
2. Noranda Inc., Geco Division
3. Minnova Inc. (Winston Lake mine)
4. Falconbridge Limited, Timmins
   Giant Yellowknife Mines Limited (Shumacher mill)
4. Falconbridge Limited (Sudbury area)
   Inco Limited (Sudbury area)

Quebec

1. Les Mines Selbaie
2. Noranda Inc., Mattagami Lake Division
3. Minnova Inc., Opemiska Division
4. Westminer Canada Limited
   Campbell Resources Inc.
5. Audrey Resources Inc. (Mobrun mine)
   Agnico-Eagle Mines Limited (La Ronde mine)
   Minnova Inc. (Ansil mine)
6. Noranda Inc., Division Mines Gaspé

New Brunswick

Brunswick Mining and Smelting Corporation Limited
Noranda Inc. (Heath Steele mine)
Breakwater Resources Ltd. (Caribou mine)

Nova Scotia

Rio Kemptville Limited

COPPER SMELTERS

A. Hudson Bay Mining and Smelting Co., Limited (HBMS), (Flin Flon)
B. Falconbridge Limited (Timmins)
C. Inco Limited (Sudbury area)
   Falconbridge Limited (Sudbury area)
D. Noranda Inc. (Noranda)
F. Noranda Inc. (Division Mines Gaspé)

COPPER REFINERIES

B. Falconbridge Limited (Timmins)
C. Inco Limited (Sudbury)
E. Noranda Inc. (Division CCR)
F. Gibraltar Mines Limited (SX-EW)

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[1] Highland Valley Copper is a partnership of Cominco Ltd., Teck Corporation and Rio Algom Limited.

An inventory of undeveloped Canadian copper deposits is available in the publication "Canadian Mineral Deposits Not Being Mined in 1990," Energy, Mines and Resources Canada. Report MR 223. ISBN 0-660-14371-3.

For detailed production and ore grade information, refer to the table of Nonferrous Mines following the last commodity chapter.

Figure 1

LONDON METAL EXCHANGE COPPER PRICES

HIGHEST GRADE SOLD

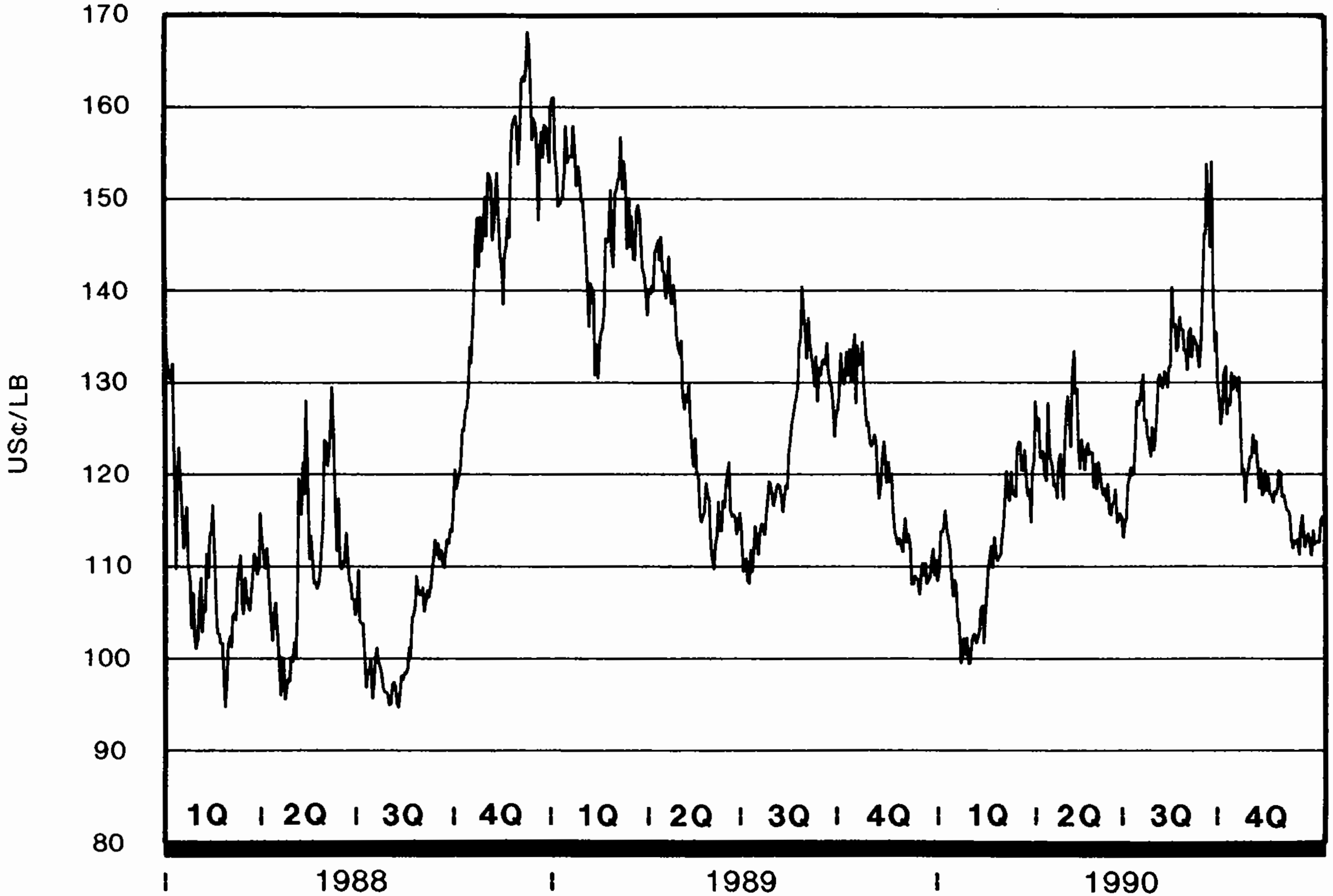


Figure 2

MONTHLY COPPER PRICES 1965–90

LME SETTLEMENT

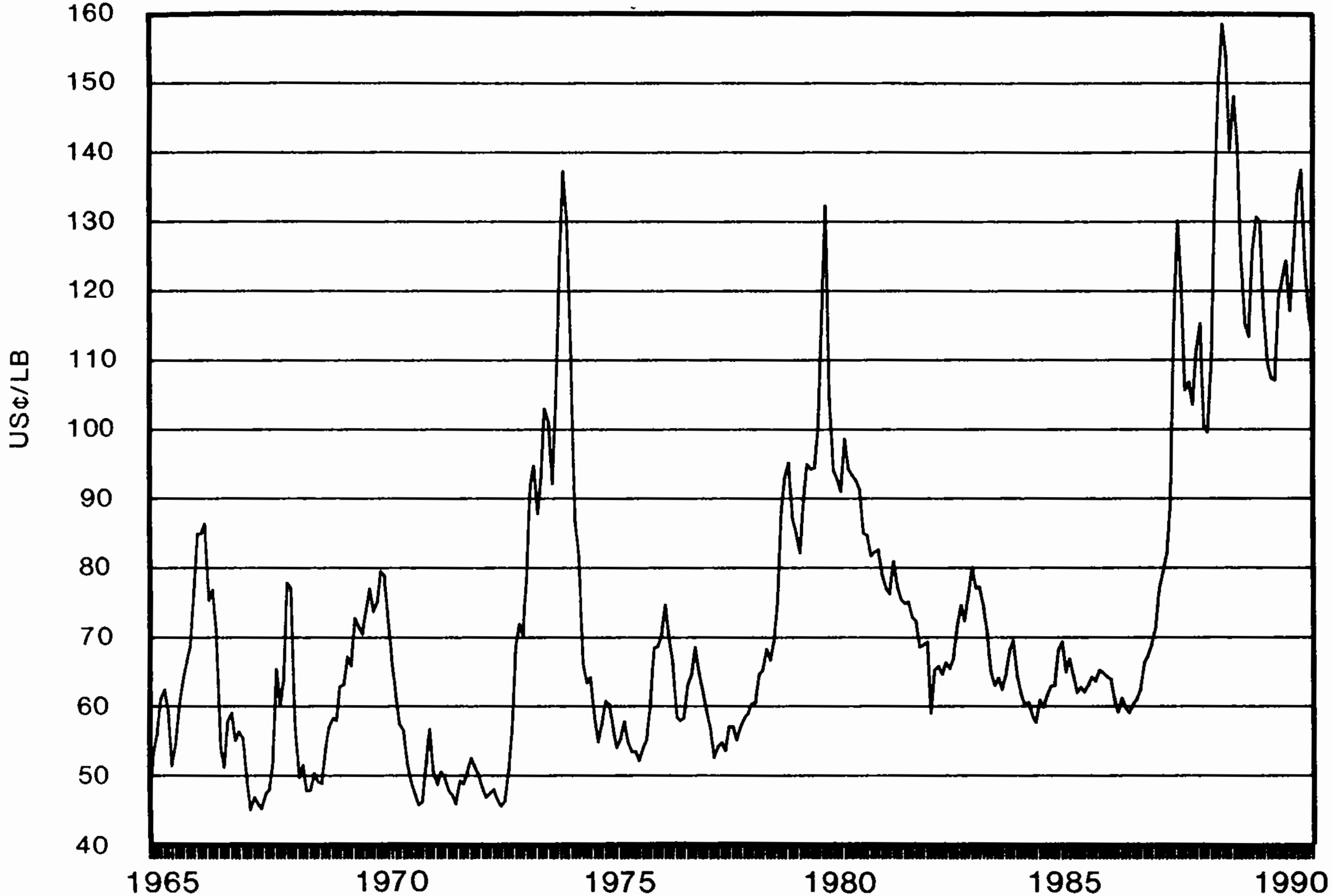
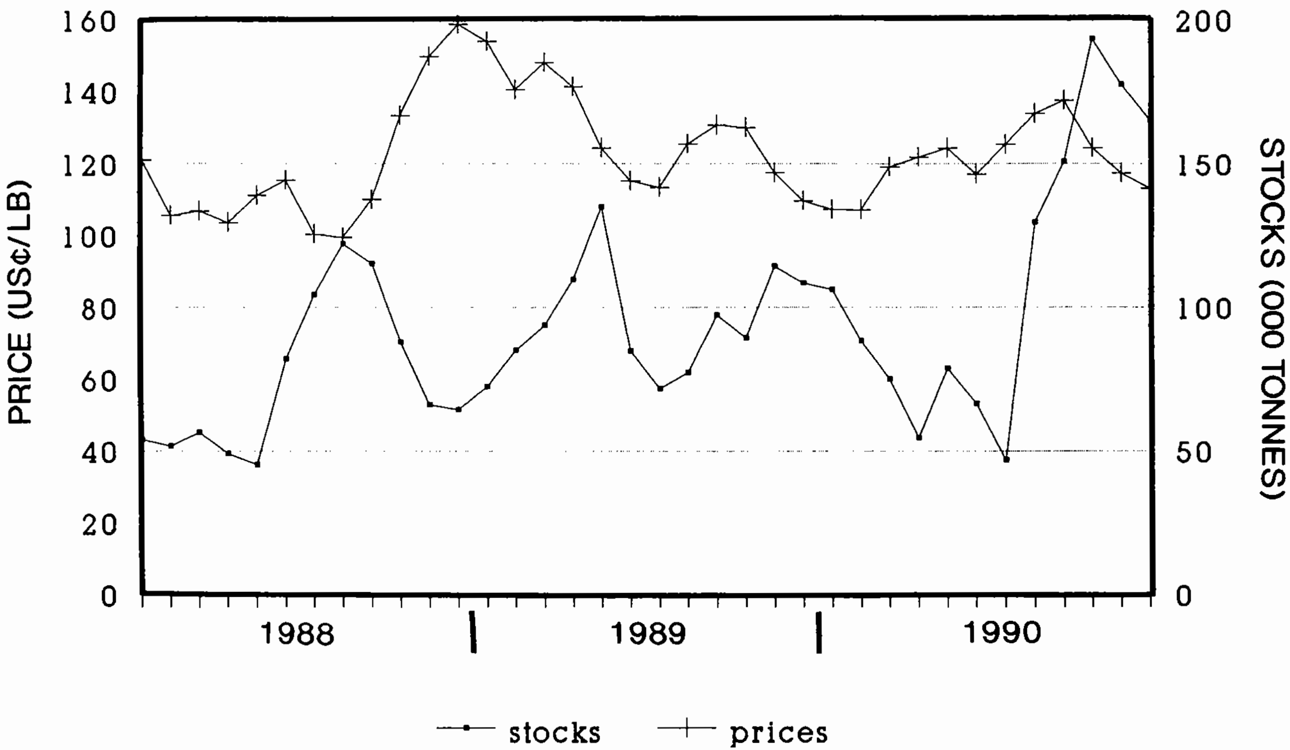


Figure 3

LME COPPER STOCKS AND PRICES

MID-MONTH STOCKS AND AVERAGE MONTHLY PRICES



Gold

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Canada's gold production has increased by more than five times in the last decade from 30 t in 1980 to 165 t in 1990. In 1990, Canada was the fifth largest gold producer behind South Africa, the United States, the U.S.S.R., and Australia.

In 1990, the average price of gold was $384/oz, compared to $381/oz in 1989 and $437/oz in 1988. Increased uncertainty in the Middle East brought prices to the $400/oz level by year-end. Other factors influencing the price of gold in 1990 were heavy sales by Middle East countries in the early part of the year, strong production levels by Western World producers, increased exports by socialist countries, and relatively high interest rates in most industrialized nations.

CANADIAN DEVELOPMENTS

There were 60 primary gold mines in Canada at the end of 1990, which accounted for about 80% of the 165 t of gold produced during the year. Production in 1989 was 159.5 t. Total employment in gold mines declined by 13.5%, from 12 645 jobs in 1989 to 10 937 in 1990.

The value of Canadian gold mine production, calculated on the basis of average cash gold prices, increased by 2.7% to $2.378 billion.

British Columbia

In 1990, British Columbia's gold production reached 16.1 t, compared to 15.6 t in 1989.

The Golden Bear gold mine, of Golden Bear Operating Company Limited and Homestake Mining (Canada) Limited, started production in early February. Design capacity of the operation is 360 t/d. The parent company of Homestake Mining (Canada) Limited, Homestake Mining Company of the United States, will take a writedown of about US$34 million in its Canadian subsidiary. The Golden Bear operation has experienced a series of cost overruns and technical problems. The company also had to cut back production by 50% due to problems in roasting the refractory oxide ore.

The Premier Gold mine of Westmin Resources Limited reactivated the former Silbak and Big Missouri mines' gold and silver operations. The mill is currently operating at a rate of 2300 t/d.

Skyline Gold Corporation (formerly Skyline Explorations Ltd.) suspended operations in September at the 270 t/d Johnny Mountain gold, copper and silver operation due to the company's inability to develop new economic reserves at current gold prices. Also, MinVen Gold Corporation closed its 180 t/d Blackdome mine due to declining ore grades.

There were a number of significant developments in British Columbia regarding exploration, where expenditures were expected to be similar to last year's total of $150 million. As a result, the outlook for gold production in British Columbia is quite positive. A number of exploration projects are expected to be put into production in the next few years.

Over $25 million were spent on the Eskay Creek gold-silver property of Prime Resources Group Inc. and Stikine Resources Ltd. Drilling on the property totalled 200 000 m and a 500-m adit was driven. Bulk sampling tests are presently being conducted to establish milling parameters for the operational stage. A feasibility study is planned and the property could be in commercial production by 1994. The project is estimated to contain 43.97 Mt of ore grading 26.4 g/t gold and 998.4 g/t silver. Prime Resources Group Inc. and Stikine Resources Ltd. each own 50% of the Eskay Creek property. Both are controlled by Corona Corporation.

Gold

In December, the British Columbia government refused to issue a mining lease to cover most of the Eskay Creek property until the ownership of the claims has been resolved. A group of companies are challenging the ownership of the property.

In early July, Cominco Ltd. formally announced the decision to proceed with the $65 million Snip gold-copper-silver project, held jointly with Prime Resources Group Inc. Production was scheduled to start in January 1991 at a rate of 300 t/d. The Snip project holds reserves of 936 000 t of ore with a gold content of 30 g/t of gold. Employment at the mine is expected to reach 150 persons.

To facilitate exploration in the Iskut River region, and to provide needed access to the developing Snip and Eskay Creek properties, the provincial government entered into a joint venture agreement with Cominco Ltd. and Prime Resources Group Inc. to proceed with planning and construction of a road link between the Stewart-Cassiar Highway and the two properties. Currently, the two properties are only accessible by air.

Control of the Mount Milligan porphyry gold-copper property deposit of Continental Gold Corp. was formally taken over by Placer Dome Inc. in the fall of 1989. By November 1990, a total of 758 holes had been drilled at this project, which entered the British Columbia government Mine Development Review Process in February 1990. Exploration work on the Mount Milligan property continues at a reduced rate pending a feasibility study and a production decision. The Mount Milligan deposit contains 400 Mt of reserves grading 0.2% copper and 0.48 g/t gold.

A feasibility study on the Mount Polley porphyry copper-gold deposit of Imperial Metals Corporation and Corona Corporation concluded that this proposed $131.5 million open-pit project would have a payback of 3.6 years. The project is undergoing the Mine Development Review Process and is awaiting financing. Reserves at Mount Polley are estimated at 48 Mt grading 0.38% copper and 0.55 g/t gold.

In the northwestern part of the province, Geddes Resources Limited continued with a $15.5 million program on the Windy Craggy copper-gold deposit. Current probable and possible reserves at the Windy Craggy deposit are about 210 Mt grading 1.59% copper, 0.18 g/t gold and 3.62 g/t silver.

The $22 million Q.R. gold project of QPX Minerals Inc. received approval in principle by the Mine Development Review Committee and is also awaiting a production decision. This project has estimated reserves of 1.2 Mt grading 5.2 g/t gold.

Yukon and Northwest Territories

Gold production in the Yukon and Northwest Territories increased to 15.1 t in 1990, up from 12.2 t in 1989.

The opening of the Colomac mine by NorthWest Gold Corp., a subsidiary of Northgate Exploration Limited, in the Indin Lake area is partly responsible for that increase. This mine is unique in the Territories in that it is a low-grade, high-volume open-pit operation. The first gold bar was poured in May 1990. Mechanical problems with the grinding circuit, due to the abrasive nature of the ore, have resulted in the mill throughput being about 70% of the 9100 t/d target. Gold recovery is also 20% less than predicted. NorthWest Gold wrote down the project by $151.3 million in November 1990, and is negotiating a restructuring of loan payments with its bankers on a $90 million debt and $20 million in additional working capital. Should negotiations prove to be unsuccessful, the company indicated its intentions to suspend operations at the mine. The total cost of bringing the Colomac mine into production, including exploration expenditures, was $230 million. The 1988 production decision was based on a feasibility study using a forecasted gold price of C$571/oz.

Giant Yellowknife Mines Limited closed its tailings reprocessing project in Yellowknife due to exhaustion of reserves.

Yukon placer gold production declined to 3.2 t, compared to 4.3 t in 1989. The number of active placer operations fell from 226 in 1990 to 194 in 1989.

Canamax Ltd.'s Ketza River gold mine closed in November after oxide reserves were exhausted. The 290 t/d operation employed 100 persons.

Saskatchewan

The Jasper mine began production on April 15, 1990, following an agreement between joint venture partners Cameco Corporation, Shore Gold Fund Inc., Golden Rule Resources Ltd., Goldsil Resources Ltd. and International Mahogany Corp., in which ownership was transferred to Cameco (80%) and Shore Gold Fund Inc. (20%). Mineable reserves of the deposit are 163 300 t containing 16.1 g/t gold. The mine is expected to yield some 2.6 t of gold during its anticipated two-year life.

The Jolu mine of Corona Corporation (30%), which operates the mine, and International Mahogany Corp. (70%), is expected to close in the middle of 1991 unless new reserves are found. An underground drilling program failed to delineate any new reserves. Current reserves are approximately 375 000 t grading 13.7 g/t gold.

Claude Resources Inc. has announced that it will proceed with a 360 t/d mine facility at the Seabee mine site, following the approval of its Environmental Impact Statement. Proven and probable reserves are estimated at 1 Mt grading 13.7 g/t gold. The mine development costs are projected to be $22 million and annual production is expected to be 1.5 t/y of gold.

Manitoba

Following the mine closures in the last few years, including the Tartan Lake mine by Granges Inc., the McLellan mine by LynnGold Resources Inc. and the Puffy Lake operation of Pioneer Metals Corporation, the entire gold production of Manitoba is a by-product of base-metal mines.

The Contact Lake property of Cameco, Uranerz Exploration and Mining Limited and Westward Explorations Ltd. has undergone a feasibility study for a planned 635 t/d operation. The project's estimated capital costs of $38 million are for a mine producing 2000 kg of gold annually.

Ontario

Ontario's gold production in 1990 totalled 79.7 t, an increase of 2.7% over the 1989 total. Three additional mines opened: the 360 t/d Kerr mine of GSR Mining Corporation and Deak Resources Corporation was brought back on stream in August; the Hoyle 2700 t/d gold-silver operation of Giant Yellowknife Mines Limited in Timmins, Ontario opened; and the Cheminis operation of Northfield Minerals Inc. started production at a rate of 350 t/d. Production at the Cheminis mine could eventually increase to as high as 1800 t/d.

The Kremzar mine was put under care and maintenance by Canamax Resources Inc. because of low gold prices.

The Magnacon mine of Flanagan McAdam Resources Inc., Muscocho Explorations Ltd. and Windarra Minerals Ltd. was also put on care and maintenance by its partners because of high costs and low gold prices. This mine started production in 1989.

The Timmins tailings operations of ERG Resources Inc. closed down because of lower-than-expected head grades and mill recovery. The operation started commercial production in 1989.

The Eagle River project of Hemlo Gold Mines Inc. and Central Crude Ltd., and the Cochenour-William project of Inco Gold Company, Wilanour Resources Limited and Pronto Explorations Limited, are currently undergoing a feasibility study.

The Musselwhite project of Placer Dome Inc., Inco Gold Company and Corona Corporation has been put on hold because the project is not feasible under current gold prices.

Employees of the Dome gold mine at Timmins reached an agreement after a six-month labour dispute with Placer Dome Inc. The company had threatened to close the mine, which has been in operation for 80 years, if the employees did not accept the final offer of the company. About half of the labour force was laid off prior to the strike as a result of the company's plans to reduce the mine's operating costs. On November 1, the company announced that the employees, represented by the United Steelworkers of America, had approved a new three-year contract.

Quebec

In 1990, Quebec's gold production increased from 37 t to 39.4 t and five new mines opened.

The Bousquet No. 2 mine of LAC Minerals Ltd. entered production in June 1990. The Bousquet No. 2 mine, which is situated less than one mile from the Bousquet No. 1 mine, has reserves of 1.3 Mt grading 8.9 g/t gold. The planned capacity of the Bousquet No. 2 mine is about 4.3 t/y.

Inco Limited and Consolidated TVX Mining Corporation officially merged their gold interests on January 7, 1991, to form a new company, TVX GOLD Inc., in which Inco will hold 62%. TVX GOLD Inc. will have an interest in six operating gold mines located in North and South America.

In April, TVX Gold Inc. and Golden Knight Resources Inc. opened the Golden Pond West mine, the second mine in the Casa Berardi camp. It has reserves of 3.6 Mt grading 8.0 g/t gold. The partners are expecting to increase the production capacity of the West Zone to 2.2 t in 1991.

The Silidor mine was officially opened by joint venture partners Noranda Minerals Inc. (55%), Cambior inc. (25%) and Nova-Cogesco Resources Inc. (20%) in September 1990. Noranda will be the operator. The Silidor mine will produce about 1.8 t/y of gold with grades averaging 5.4 g/t. The mine will not have a mill. Noranda will transport its share of the ore to the nearby Horne complex while Cambior and Nova-Cogesco will send their share of the output to Cambior's Yvan Vézina mill. Estimated life of the mine, at the planned rate of 400 000 t/y, is 12 years. In December 1990, Cambior bought Nova-Cogesco's 20% share in the project for $16.6 million, thereby raising its share to 45%.

Cambior inc. also announced the proposed opening of the Mouska mine in Bousquet Township for June 1991. For Cambior, it will be the company's third new mine in the past three years. It previously opened the Pierre Beauchemin mine near Rouyn-Noranda and the Lucien C. Béliveau mine (formerly the Pascalis project) near Val-d'Or.

Société Minière Sphinx Inc. announced positive results on its heap leaching test on the Duvay deposit, 10 miles north of Amos. The company began leaching 40 000 t from the property in May and by mid-August had poured its first bars of gold and silver. In 1989, the company had begun construction of a 100 000 t capacity heap leach pad and a 400 000 t/y Merrill-Crowe treatment plant.

Muscocho Explorations Ltd.'s 400 t/d Montauban mine and Campbell Resources Inc.'s 450 t/d S-3 mine in Chibougamau were closed because of exhaustion of reserves. Furthermore, Aurizon Mines Ltd. ceased mining operations at the Sleeping Giant mine because of low gold prices.

Other mines are threatened to close unless new reserves are found, such as the Camflo mine of American Barrick Resources Corporation which has reserves for only two more years. To extend the life of the 25-year-old operation, American Barrick and property neighbour Malartic Hygrade Gold Mines (Canada) Ltd. are spending $3.3 million on exploration on the Orion property.

Agnico-Eagle Mines Limited intersected promising gold mineralized zones from surface exploration of its Eagle West discovery, 800 m west of the company's Eagle shaft in the Joutel area.

The Douay property, jointly owned by Inco (42% and operator), Vior Inc. (37%) and Cambior (21%), has a total reserve of 600 000 t grading 9.2 g/t gold. The partners will undertake further exploration to increase reserves. The Douay project will become a joint venture between two partners, Inco (57%) and Vior Inc. (43%), following Cambior's decision to sell its participation.

Campbell Resources Inc.'s Joe Mann mine has found additional reserves of 1 Mt grading 9.4 g/t of gold. A decision to deepen the existing shaft by another 300 m at a cost of $10.5 million is under consideration.

New Brunswick

Following the closure of Gordex Minerals Limited's mine in 1989, the Murray Brook mine of NovaGold Resources Inc. is the only operating gold mine in New Brunswick. The Murray Brook mine, which uses an indoor vat leaching process, produces some 1300 t/d of ore grading 2 g/t gold and 39.5 g/t silver.

Nova Scotia

After completing bulk sampling tests at its Forest Hill and Beaver Dam deposits, Westminer Canada Limited concluded that the projects were not economically viable under current market conditions.

The Coxheath Gold Holdings Limited operations at Tangier were placed on hold while the company attempted to arrange further financing. Reported proven and developed reserves are 45 000 t at an average mineable grade of 20.5 g/t gold.

Newfoundland

Hope Brook Gold Inc., a subsidiary of BP Resources Canada Inc., has been operating a gold mine near Port aux Basques in Newfoundland since 1987. The mine has experienced a number of difficulties in meeting its original plans, and a new system for treatment of effluents was installed in 1990. Metallurgical recovery of 83% is lower than originally anticipated.

WORLD DEVELOPMENTS

South Africa

South Africa is still the world's largest gold producer, with output of 608 t in 1989 and an estimated 605 t in 1990. However, its share of Western World production fell from 70% in 1980 to 36.8% in 1989 and further in 1990 due to increased production elsewhere. Similarly, South Africa has moved from being the lowest cost gold producer in 1985 to the highest cost among the major producers. Cash costs in South Africa in 1985 were at approximately US$147/oz while costs at other major Western World producers averaged about $200/oz. However, in 1989, South Africa was considered to be the highest cost producer, with a cash cost of $276/oz while the average Western World cost was $250/oz. At a price of US$380/oz, about 20% of South African gold mine production is unprofitable. Gold production, valued at US$7.5 billion a year, accounts for some 38% of South Africa's export earnings. It is an important factor in the country's financial status, especially because foreign debt is estimated to be US$22 billion.

While South Africa's reserves are still the largest, its future mine production faces major difficulties because ore grades are falling, gold reserves are deep, and domestic inflation and, consequently, the costs of labour, are rising rapidly. Other problems facing the South African gold mining industry are low productivity and social tensions. According to the Chamber of Mines, a total of about 424 000 persons are employed in the gold mining industry in South Africa. Throughout its history, the Chamber of Mines has assumed responsibility for overall policy coordination, research, recruitment of labour and, until recently, marketing of the Krugerrand and promotion through its former subsidiary, the International Gold Corporation.

The South African Department of Minerals and Energy Affairs estimates that the effective exchange rate of the Rand in comparison to a basket of currencies has been declining at a rate of 10%/y during the 1980s. The Department of Minerals and Energy Affairs also indicated that the producer price index rose on average by 14.1% during the 1980s.

To increase the competitiveness of South African gold mines, the government has put forward some measures such as the devaluation of the Rand (R) and the subsidization of some mining operations and gold purchases by the Federal Reserve Bank.

In May, the South African government announced an R$220 million loan guarantee and subsidization of interests on the loan, and some infrastructure costs at East Rand Proprietary Mines Limited, a subsidiary of South Africa's Rand Mines Limited.

Anglo American Corporation of South Africa Ltd. and associate Vaal Reefs Exploration and Mining Company Limited announced the development of a new shaft at the Moab area, adjoining its existing pits in Klerksdorp and

160 km southwest of Johannesburg. It is estimated that the development of Moab would cost R$2.5 billion. Development of the Moab mine is expected to start by early 1991.

General Mining Union Corporation Limited (Gencor) formally opened its Weltevreden mine in the northwestern Orange Free State. The operation is designed to treat 360 000 t/y of ore grading 4.2 g/t gold. The first phase of development cost about R$210 million while the second phase, which should be in operation by 1995, is expected to cost R$265 million. This mine is expected to be in operation for a period of 25 years. Anglo American Corporation controls approximately 30% of the value of shares on the Johannesburg Stock Exchange. Its gold production is estimated at around 300 t.

Gold Fields of South Africa Ltd. reduced its workforce of 80 000 by 5000 as part of a cost-cutting exercise, prompted by low bullion prices. The biggest cut will be at Venterspost Gold Mining Co. which plans to reduce employment by 1000.

In order to increase the attractiveness of the Krugerrand gold coins, which have been facing sanctions by many industrialized countries, the authorities decided to trade it at a one-dollar premium to spot gold prices. Other gold coins are usually sold at prices ranging between 3% and 5% above the spot price.

Johannesburg Consolidated Investment Company, Limited (JCI) announced it would suspend its North Shaft. This mine closure will reduce production by 6 t/y and cut 4400 jobs. JCI plans to open a new mine in the South Deep Project Area, depending upon a recovery of gold prices. The property contains 116 t of mineable gold. Its ore reserves grade 9 g/t. The estimated cost to bring the property into production is R$2.17 billion.

United States

U.S. gold production almost quadrupled from 66 t in 1984 to an estimated 301 t in 1990, with nearly half of the increase coming from Nevada. According to industry sources, gold production in 1991 could reach 315 t. For the first time in nearly five decades, U.S. gold production will exceed that estimated for the U.S.S.R., thereby making the United States the second largest producer behind the Republic of South Africa. The state of Nevada was by far the dominant gold producer, surpassing other producing states such as California, South Dakota and Montana. Growth in Nevada was made possible by the application of a new low-cost method of treating low-grade ores, the heap leach process. This technique, combined with financing by gold loans and forward sales, considerably shortened the time between discovery of low-grade gold reserves and the beginning of commercial production.

Newmont Mining Corporation is the largest U.S. gold producer, with about 30 t from five mines in 1989. With its current US$400 million expansion program, production is expected to reach 49.7 t by 1991.

Australia

Australian gold production showed a spectacular increase similar to that in the United States, rising from 39.1 t in 1985 to an estimated 224 t in 1990. In 1988, Australia displaced Canada as the Western World's third largest gold-producing country. A contributing factor in the large production increase stems from the government's decision to end the tax-exempt status of income generated from gold mine operations by 1991. Accordingly, production was accelerated in recent years. A report issued by the Bureau of Mineral Resources, Geology & Geophysics (BMR), estimated that Australian gold production will decline to 180 t in 1991.

Enterprise Metals, a wholly-owned subsidiary of CRA Limited, announced that it will proceed with the development of the Peak Gold mine, near Cobar, in central New South Wales. The mine will start to produce by the fall of 1992 at a rate of 3000 kg/y of gold.

Pioneer Minerals Exploration announced its production start-up at its Plutonic gold mine in Western Australia. Gold production is expected to be at a rate of 3000 kg/y.

Placer Dome Inc. wrote down A$15 million of its investment in its 50%-owned Big Bell mine, and announced gold output from the newly opened Big Bell mine to be around 15 t/y between 1990 and 1994, down by 3 t/y from earlier forecasts. The reduction in gold production in the Western Australian project was caused by dilution difficulties. The company also indicated that Big Bell mine costs were at A$572/oz.

Melbourne-based BHP Gold Mines Ltd. has accepted Australia's Newmont Mining Corp.'s offer for its 55% gold subsidiary. The merged group will become Australia's largest pure gold company and be amongst the world's ten top producers with production in 1991 of around 23 t.

Papua New Guinea

Gold production in Papua New Guinea (PNG) has been stable during the last four years, but significant projects under way will double PNG production by 1992.

The huge Porgera gold mine in the Enga province was officially opened on October 20, 1990. The operation is based upon 50.8 Mt of mineable reserves grading 7.5 g/t. In its first six years, Porgera is expected to produce an average of 28 t/y. Placer Dome Inc., through its PNG subsidiary, will manage the US$1 billion Porgera project. Following agreements to build nine neutralizing ponds to treat waste and to provide training, employment and business opportunities to local people, the planned 39 months of construction began. Gold production began in September 1990 while full production is expected to be reached in the first half of 1991. Placer Dome Inc. has a 30% interest in the project. The other partners are Renison Goldfields Consolidated Ltd. (30%), M.I.M. Holdings Limited (30%) and the PNG government (10%). The PNG government is also expected to earn US$600 million in royalties over the 20-year life span of the project.

Trial mining at the Mount Kara alluvial/colluvial gold deposit in the Hidden Valley region started in December 1990. The project is 51% owned by CRA Minerals and 49% owned by Kare Puga Development, which in turn is owned by 6000 land owners. The Kara deposit could produce up to 4.5 t/y.

A production decision on the Lihir gold project, owned by RTZ Corporation PLC (80%) and Niugini Mining, a Battle Mountain Gold Co. subsidiary (20%), is expected in early 1991 with a production start-up scheduled for 1993. The operators plan to produce 8 t in the first year, rising to 25 t/y thereafter.

U.S.S.R.

The U.S.S.R. is now the world's third largest gold producer behind the Republic of South Africa and the United States, with production estimated to be 300 t in 1990. The U.S.S.R. markets a large share of its production in the Western World. Crude oil, natural gas and gold export earnings are keys in the U.S.S.R.'s commercial policy and balance of payments. With the current fast pace of political reform and slow progress on economic improvements, it is anticipated by many analysts that U.S.S.R. gold production and exports will be increased in order to earn additional foreign exchange. It is also thought that the U.S.S.R.'s gold reserves, estimated at 2000-3000 t, could play an important stabilizing factor in maintaining the international value of the rouble should it become a convertible currency.

Glavalmazzoloto controls all gold-mining enterprises, including ore and metallurgical plants, secondary processing factories, finished goods and jewellery-making facilities, and scientific research and auxiliary organizations supporting these activities. The U.S.S.R., with estimated gold reserves of 7200 t, could become an increasingly important investment alternative for foreign companies.

The Soviets started in late 1990 to mint a gold coin to commemorate Glasnost-Perestroika policies. The new coin will be available for the world market in one-ounce, half-an-ounce and one-quarter-of-an-ounce forms. Nearly 300 000 gold coins are expected to be produced totalling 4.5 t of gold.

China

China's gold export policy remained unchanged as it needs additional foreign currencies to offset payments on imports and repayment of foreign debt. China's external debt exceeded US$43 billion at the end of 1990 and repayment requirements are expected to reach an annual US$10 billion by 1992. China's annual gold production was estimated at between 90 t and 100 t for 1990. The New China News Agency reported China's official gold reserves at 394 t. The State Administration of Exchange Control (SAEC) indicated that China's gold reserves stood at nearly 400 t. Also according to the SAEC, some 34 new mine projects presently under exploration should be in production by 1992. It is reported that gold production has grown by 10%/y for the past 10 years.

China is minting 99.9% gold and silver Panda coins. The gold coins are available in five sizes, ranging from one ounce to one twentieth of an ounce. The Chinese normally mint between 6 t/y and 9 t/y of the Panda gold coins.

Brazil

Brazil's gold production was 96.9 t in 1989, while 1990 production is expected to be between 100 t and 110 t. About 80% of its production comes from the panning efforts of wildcat miners called "garimpeiros." In 1989, inflation remained a problem, which sustained strong domestic gold demand. Brazil is the world's sixth largest gold producer. The Central Bank does not release gold reserve figures, but it is estimated that Brazil's reserves totalled 130 t at the end of 1989.

The activities of the 1.2 million garimpeiros in the Amazon are strongly opposed by Indian tribes. Extraction of gold, tin and gems has serious effects on the environment. For instance, in filtering gold from ore, the garimpeiros use mercury to bind to the gold. The mercury is then burnt off, releasing toxic fumes. It is estimated that the Madeira river contains some 200 t of mercury. At the request of Indian bands, Brazilian government authorities attempted to evict garimpeiros from certain areas.

Following a drastic anti-inflation plan implemented in March by the President Collor administration, the price of gold plunged and many prospectors found mining no longer profitable, but gold prices paid to garimpeiros have since recovered, encouraging many wildcat prospectors to return.

Japan

The Hishikari gold-silver mine of Sumitomo Metal Mining Co., Ltd., located in the Kyushu Island, accounts for more than 50% of Japan's gold production. The 370 t/d mine, which had been in operation since 1985, annually produces between 6 t and 7 t of gold. It is reported to be the richest gold mine in the world, with average grades of 70 g/t gold and 35 g/t silver.

Sumitomo recently announced its intention to proceed with the production start-up of the Yamada zone in 1991, which contains reserves of about 50 t of gold. The company also started the development of the Sanjin deposit, which also hosts gold reserves of 50 t, bringing Hishikari mine's total reserves to some 250 t.

After completing the sale of 220 t of 20-gram gold commemorative coins of former Emperor Hirohito, the Japanese Mint is currently producing some 60 t of 30-gram gold commemorative coins for the new Emperor Hakihito. Hakihito gold coins will start selling in April 1991 for 100 000 yen.

CONSUMPTION AND USES

The industrial consumption of gold, sometimes referred to as fabrication demand, includes gold consumed in jewellery, electronics, dentistry and both fake and official coins, even though the latter type of coin is often used for investment purposes. Table 4 gives some historical perspective to world gold consumption in these uses.

In Canada, the largest use of gold is for official coins. The Royal Canadian Mint produces two official coins that contain gold, a numismatic gold coin containing one quarter of an ounce of gold with a face value of $100, and the Gold Maple Leaf bullion coin family. Prior to 1987, the numismatic coin contained half an ounce of gold.

The Gold Maple Leaf bullion coin, with its very high purity, is world-renowned. In 1988, Canada regained its position as the world's top user of gold for coinage, after losing the lead to the United States in 1986 and 1987 when the

United States launched the Eagle coin. In 1989, Canada kept its leading position with about 34.9 t of gold consumed and about 30% of the world coin market.

The Maple Leaf coin plays an important role in the Canadian gold industry. Since its introduction in 1979, the program has consumed some 410 t of gold, or 41.5% of total Canadian production during that period.

The domestic carat jewellery industry has two main components: smaller manufacturers producing jewellery pieces in Canada, and larger sales companies importing stock jewellery pieces for direct sale. On average, Canadian gold consumption for jewellery is about 10 t/y.

Most other gold products used in Canada are imported either in end-use form or in semi-manufactured alloy form. Canadian consumption of gold in electronics, dentistry and other industrial uses totalled just above one tonne in 1989 and was not expected to show any dramatic change in 1990.

MARKETS, PRICES AND STOCKS

In the last 15 years, gold-trading practices have changed drastically in response to liberalized trading laws and the development of electronic markets in major financial centres. The price of gold used to be controlled by Central Banks' interventions on terminal physical markets. Now, the physical market represents only a fraction of the gold equivalent traded on the gold futures and options contracts on the New York Commodity Exchange (COMEX), the London Gold Market and the Tokyo Gold Exchange. While the price of gold is linked to supply-demand conditions, daily fluctuations motivated by speculation, computerized program trading and arbitrage are other key factors.

Another recent innovation on the gold market is the gold loan transaction in which gold holders lend their gold for a fee. These loan transactions are used primarily by gold producers who earn instant cash flow by selling the borrowed gold and repaying the loan at some point in the future out of their gold mine production. The market usually reacts negatively on news of large loan agreements as more gold is added to the market. As we are now entering a period of repayment of these loans, new gold loans and repayments of old loans should largely offset each other and have minimal impacts on the market.

Gold prices peaked at US$421/oz in the first quarter of 1990, declined to a low of $346/oz at the end of the second quarter, and increased gradually to $370/oz before the invasion of Kuwait by Iraq on August 2. Prices increased to a high of $416/oz on August 23 followed by a decline to $380/oz in November.

OUTLOOK

Canadian gold production is expected to continue growing as a result of expansions at existing mines and the continued development of new mines. Canada's cost-competitive position is good; stable grades and production costs should protect the Canadian industry from any serious deterioration in the foreseeable future. However, further reductions in gold prices could affect the feasibility of many operations. Gold exploration is still active and there are many promising properties which could more than compensate for future mine closures due to ore exhaustion.

Production is also expected to grow in the United States, PNG, Brazil, China and the U.S.S.R., and to remain stable in South Africa. Australian production is expected to decline because income from gold operations will become taxable in 1991.

The expected world mine supply in the 1990s is likely to grow at a rate of about 2%/y, compared to 6% in the 1980s. However, even with existing depressed prices, the world's first and third largest producers, South Africa and the U.S.S.R., will need to sell important quantities of gold in light of their balance-of-payments difficulties, and both need to generate large balance-of-trade surpluses to reduce their external debts. China and Brazil also fall into that category. At the same time, the current depressed prices should reduce the incentive for both recycling and sales by Central Banks from their official reserves.

On the demand side, the jewellery market has performed very well in periods of general economic expansion. It is uncertain whether demand will continue to expand in a recession scenario, but gold jewellery demand does tend to be quite price responsive.

Barring very unusual events such as a major world conflict or spiralling inflation, gold prices in the next three years are expected to fluctuate between US$350 and $400/oz in constant 1990 dollars, with periodic swings outside this range. This forecast is based upon the assumption that inflation in the Western World will remain at an acceptable rate, and that Western World gold production will continue to grow at 2%/y.

Note: Information contained in this review was current as of mid-January 1991.

TARIFFS

Item No.	Description	Canada			United States	EEC	Japan[1]
		MFN	GPT	USA	Canada	MFN	MFN
71.08	Gold (including gold plated with platinum) unwrought or in semi-manufactured forms, or in powder form						
	Non-monetary						
7108.11.00	Powder	11%	7%	Free	Free	4.1%	Free
7108.12.00	Other unwrought forms containing by weight not less than 99.95% of gold	Free	Free	Free	Free-4.9%	Free	Free
7108.13	Other semi-manufactured forms						
7108.13.10	Of a purity of 10 carats or more	Free	Free	Free	1.8%-4.9%	0.5%-1.8%	Free
7108.13.20	Of a purity of less than 10 carats	10.3%	6.5%	4.1%	1.8%-4.9%	0.5%-1.8%	Free

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States effective January 1, 1990; Official Journal of the European Communities, Vol. 33, No. L247, 1990, "Conventional" column; Custom Tariff Schedules of Japan, 1990.
[1] GATT rate is shown, lower tariff rates may apply circumstantially.

Gold

TABLE 1. CANADA, GOLD PRODUCTION AND TRADE, 1989 AND 1990

Item No.		1989		1990p	
		(kilograms)		(kilograms)	
Production					
	Newfoundland	x		x	
	Prince Edward Island	–		–	
	Nova Scotia	x		x	
	New Brunswick	359		744	
	Quebec	36 966		39 388	
	Ontario	78 675		79 647	
	Manitoba	4 056		2 382	
	Saskatchewan	2 829		3 295	
	Alberta	25		x	
	British Columbia	15 635		16 106	
	Yukon	5 652		4 602	
	Northwest Territories	12 208		15 063	
	Total	159 494		164 991	
	Total Value ($000)	2 315 860		2 378 344	
	Mine output (kg)	159 527		165 453	
				(Jan.-Sept.)	
		(kilograms)	($000)	(kilograms)	($000)
Exports					
2600.00	Gold in ores and concentrates	9 917	114 280	8 677	110 631
7108.11	Gold powder				
	United States	76	332	110	1 584
	Belgium	30	225	–	–
	Total	106	557	110	1 584
7108.12	Other unwrought forms				
	Switzerland	21 755	312 667	33 326	495 198
	Japan	21 458	316 996	18 589	300 409
	United States	62 875	898 062	20 009	289 396
	Hong Kong	39 738	573 109	15 907	203 341
	United Kingdom	5 319	76 151	8 210	119 997
	People's Republic of China	2 669	37 903	2 887	40 787
	Other countries	2 821	37 340	12 291	176 005
	Total	156 635	2 252 240	111 219	1 625 140
7108.13	Other semi-manufactured forms				
	Belgium	4 837	30 238	714	6 518
	Other countries	96	161	142	1 748
	Total	4 934	30 403	856	8 269
Imports					
2600.00	Gold in ores and concentrates	998	11 927	358	4 131
7108.11	Gold powder				
	United States	9	103	11	114
	Other countries	. . .	4	. . .	1
	Total	9	108	11	115
7108.12	Other unwrought forms				
	United States	33 255	393 670	24 672	312 774
	Uruguay	5 025	63 763	1 835	28 909
	Nicaragua	1 303	11 477	1 938	12 471
	Mexico	12 269	172 129	75	1 179
	Other countries	594	8 392	1 181	15 502
	Total	52 445	649 440	29 700	370 840
7108.13	Other semi-manufactured forms				
	United States	410	3 121	278	2 798
	West Germany	230	2 559	116	1 337
	Switzerland	105	1 099	101	973
	Other countries	22	329	45	249
	Total	767	7 113	539	5 360

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary; – Nil; x Confidential; . . . Too small to be expressed.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, GOLD PRODUCTION BY SOURCE, 1970, 1975, 1980 AND 1983-89

	Auriferrous Quartz Mines		Placer Operations		Base-Metal Ores		Total	
	(kg)	(%)	(kg)	(%)	(kg)	(%)	(kg)	(%)
1970	58 592	78.2	229	0.3	16 095	21.5	74 915	100.0
1975	37 530	73.0	335	0.6	13 569	26.4	51 433	100.0
1980	31 929	63.1	2 060	4.0	16 632	32.9	50 620	100.0
1983	55 522	75.5	3 235	4.4	14 756	20.1	73 512	100.0
1984	62 554	75.0	3 393	4.1	17 499	20.9	83 446	100.0
1985	67 241	76.8	3 464	4.0	16 857	19.2	87 562	100.0
1986	83 197	80.9	2 802	2.7	16 900	16.4	102 899	100.0
1987	94 723	81.8	4 009	3.5	17 086	14.8	115 818	100.0
1988	112 404	83.4	4 879	3.6	17 530	13.0	134 813	100.0
1989	138 211	86.6	5 354	3.4	15 930	10.0	159 494	100.0
1990p	144 866	87.8	4 082	2.5	16 043	9.7	164 991	100.0

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary.
Note: Totals may not add due to rounding.

TABLE 3. CANADA, GOLD PRODUCTION, AVERAGE VALUE AND PERCENT OF TOTAL MINERAL PRODUCTION

	Total Production	Total Value	Average Value[1]	Gold as a Percent of Total Mineral Production
	(kg)	($000)	($/g)	(%)
1970	74 915	88 057	1.18	1.5
1975	51 433	270 830	5.27	2.0
1980	50 620	1 165 416	23.02	3.7
1981	52 034	922 089	17.72	2.8
1982	64 735	968 012	14.95	2.9
1983	73 512	1 230 886	16.74	3.2
1984	83 446	1 252 283	15.01	2.9
1985	87 562	1 219 653	13.93	2.7
1986	102 899	1 689 292	16.42	5.2
1987	115 818	2 204 472	19.03	6.1
1988	134 813	2 331 989	17.30	6.3
1989	159 494	2 315 860	14.52	5.9
1990p	164 991	2 378 344	14.41	5.8

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Value is based on average reported sales.
p Preliminary.

TABLE 4. NON-SOCIALIST WORLD GOLD CONSUMPTION, 1980 AND 1986-89

Fabricated Gold	1980	1986	1987	1988	1989
			(tonnes)		
Developed countries					
Carat jewellery	315	565	561	646	782
Electronics	94	120	118	127	130
Dentistry	63	49	45	48	47
Other uses	58	51	51	53	56
Medals and fake coins	18	4	7	8	8
Official coins	170	301	170	98	97
Total	718	1 090	952	981	1 120
Developing countries					
Carat jewellery	187	552	589	831	1 029
Electronics	2	4	6	7	8
Dentistry	2	2	3	3	3
Other uses	4	5	6	6	6
Medals and fake coins	3	8	8	11	11
Official coins	21	26	30	27	30
Total	219	597	642	885	1 086
Totals					
Carat jewellery	502	1 117	1 150	1 477	1 811
Electronics	96	124	124	134	138
Dentistry	65	51	48	51	49
Other uses	62	56	57	59	62
Medals and fake coins	21	12	15	19	19
Official coins	191	327	200	126	127
Total	937	1 686	1 594	1 866	2 206

Source: Consolidated Gold Fields PLC, "Gold 1990."

TABLE 5. GOLD MINE PRODUCTION IN THE NON-COMMUNIST WORLD, 1980 AND 1986-89

	1980	1986	1987	1988	1989
			(tonnes)		
South Africa	675.1	640.0	607.0	621.0	608.3
Canada	50.6	102.9	114.4	134.8	158.5
United States	30.2	115.8	154.9	201.0	259.1
Other Africa					
Ghana	10.8	11.5	11.7	12.1	13.4
Zimbabwe	11.4	14.9	14.7	14.8	16.0
Zaire	3.0	8.0	12.0	12.5	12.1
Other	8.0	18.2	25.0	27.5	25.2
Total other Africa	33.2	52.6	63.4	66.9	66.7
Latin America					
Brazil	35.0	67.4	83.8	100.2	96.9
Bolivia	2.0	6.0	6.0	9.0	11.5
Colombia	17.0	27.1	32.5	33.4	30.7
Dominican Republic	11.5	9.1	7.9	6.7	5.5
Chile	6.5	18.9	19.2	24.9	26.1
Peru	5.0	10.9	10.8	10.0	12.6
Mexico	5.9	8.3	8.3	10.7	11.5
Venezuela	1.0	15.0	16.0	20.0	15.0
Other	4.8	13.0	15.1	16.1	18.6
Total Latin America	88.7	175.7	201.1	231.0	228.6
Asia					
Philippines	22.0	38.7	39.5	39.2	37.1
Japan	6.7	14.0	13.6	14.4	11.0
Other	5.0	8.6	8.1	11.4	12.4
Total Asia	35.8	69.7	73.4	77.0	70.9
Europe	11.8	15.3	16.9	18.6	20.9
Oceania					
Papua New Guinea	14.3	36.1	33.9	36.6	33.7
Australia	17.0	75.1	108.0	157.0	197.0
Other	1.0	4.0	4.5	6.6	9.2
Total Oceania	32.3	115.2	146.4	200.2	237.9
Total	957.7	1 292.5	1 382.3	1 550.5	1 652.8

Source: Consolidated Gold Fields PLC, "Gold 1990."

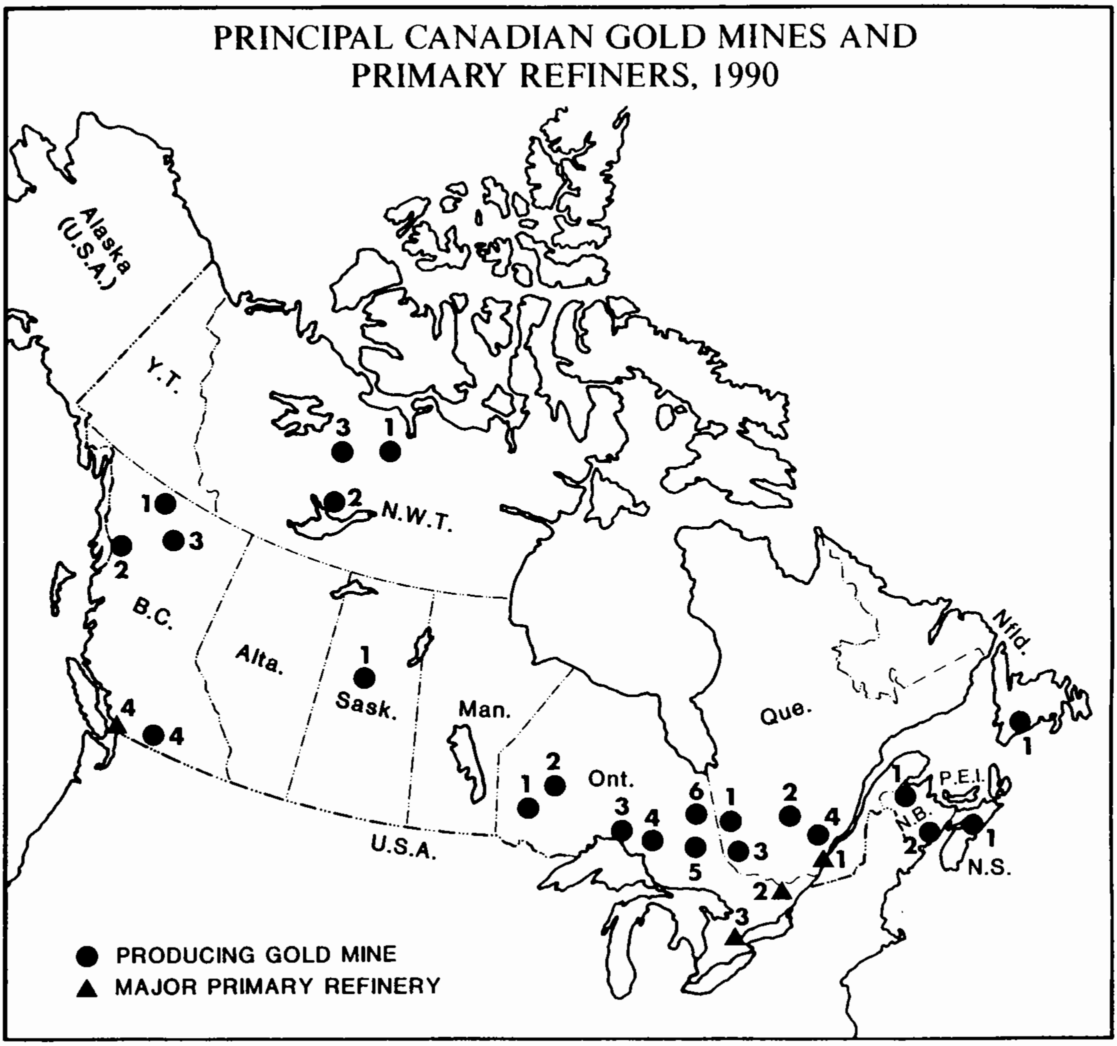
TABLE 6. AVERAGE ANNUAL GOLD PRICES 1970-90 (MONTHLY 1988-90)

Year	US$/oz	C$/oz	Year	US$/oz	C$/oz
1970	35.97	37.54	1980	614.38	719.08
1971	40.87	41.27	1981	459.22	550.57
1972	58.22	57.66	1982	375.52	463.51
1973	97.22	97.24	1983	423.52	521.82
1974	158.80	155.36	1984	360.63	466.99
1975	160.96	163.76	1985	367.58	510.73
1976	124.78	123.01	1986	367.58	510.73
1977	147.80	157.10	1987	446.66	592.18
1978	193.51	220.74	1988	436.45	554.76
1979	305.69	358.12	1989	381.27	451.33
			1990	383.72	447.79

Month	1988		1989		1990	
	(US$/oz)	(C$/oz)	(US$/oz)	(C$/oz)	(US$/oz)	(C$/oz)
January	477.71	614.34	404.45	481.70	410.12	480.32
February	442.12	561.00	387.97	461.21	416.54	498.35
March	443.49	554.02	390.28	466.31	393.67	464.76
April	451.56	557.21	384.72	457.23	374.93	436.49
May	451.32	558.01	371.35	442.65	368.85	433.20
June	451.66	550.00	367.73	440.64	352.66	413.69
July	437.46	528.40	375.21	446.15	361.83	418.71
August	431.29	527.06	365.53	429.54	394.86	452.18
September	414.81	509.34	361.80	427.70	389.56	451.05
October	406.39	489.92	366.80	430.78	381.33	442.08
November	420.00	511.45	394.36	461.21	381.71	444.11
December	422.14	504.88	409.71	475.94	378.16	438.76

Source: London Gold Market. Compiled by Energy, Mines and Resources Canada.

Gold


PRINCIPAL CANADIAN GOLD MINES AND
PRIMARY REFINERS, 1990
Alaska (U.S.A.)
Y.T.
N.W.T.
B.C.
Alta.
Sask.
Man.
Ont.
Que.
Nfld.
P.E.I.
N.B.
N.S.
U.S.A.
PRODUCING GOLD MINE
MAJOR PRIMARY REFINERY

MAJOR PRIMARY GOLD MINES IN CANADA, 1990

Northwest Territories:

1. Echo Bay Mines Ltd. - Lupin mine
2. Giant Yellowknife Mines Limited - Giant mine
   NERCO Minerals Company - Con mine
   Treminco Resources Ltd. - Ptarmingan and Tom mines
3. NorthWest Gold Corp. - Colomac mine

British Columbia:

1. Golden Bear Operating Company Limited - Golden Bear mine
2. Westmin Resources Limited - Premier mine
3. Cheni Gold Mines Inc. - Lawyers mine
   International Shasta Resources Ltd. - Shasta mine
4. Corona Corporation - Nickel Plate mine

Saskatchewan:

1. La Ronge Area
   - Cameco Coporation - Star Lake mine, Jasper mine
   - Corona Corporation - Jolu mine

Ontario:

1. Red Lake Area
   - Placer Dome Inc. - Campbell mine
   - Dickenson Mines Limited - Arthur W. White mine
2. Pickle Lake Area
   - Bond Gold Canada Inc. - Golden Patricia mine
   - Placer Dome Inc. - Dona Lake mine
3. Hemlo Area
   - Corona Corporation/Teck Corporation - Williams mine
   - Hemlo Gold Mines Inc. - Golden Giant mine
   - Teck-Corona Operating Corporation - David Bell mine
4. Wawa Area
   - Corona Corporation - Renabie mine
   - Muscocho Explorations Ltd. - Magino mine
5. Timmins - Kirkland Lake Area
   - Placer Dome Inc. - Dome mine
   - Giant Yellowknife Mines Limited - Pamour #1, #3 and Hoyle mines
   - Falconbridge Gold Corporation - Hoyle Pond mine
   - LAC Minerals Ltd. - Macassa and Lake Shore tailings project
   - American Barrick Resources Corporation - Holt-McDermott mine
   - Canamax Resources Inc. - Bell Creek mine
   - Eastmaque Gold Mines Ltd. - Kirkland Lake tailings project
   - Deak Resources Corporation - Kerr mine
   - St. Andrew Goldfields Ltd. - Stock Township mine
6. Placer Dome Inc. - Detour Lake mine

Gold

Quebec:

1. Northwestern Area
   - Agnico-Eagle Mines Limited - Agnico-Eagle and Telbel mines
   - Inco Gold Company - Golden Pond East and West mines
2. Desmaraisville - Chibougamau Area
   - Minnova Inc. - Lac Short mine
   - Campbell Resources Inc. - Joe Mann mine
3. Rouyn Noranda - Val-d'Or Area
   - LAC Minerals Ltd. - Doyon and Bousquet 1 and 2 mines
   - Agnico-Eagle Mines Limited - Donald LaRonde mine
   - American Barrick Resources Corporation - Camflo Malartic Hygrade mine
   - Placer Dome Inc. - Sigma and Kiena mines
   - Belmoral Mines Ltd. - Ferderber and Dumont mines
   - Aurizon Mines Ltd. - Beacon mine
   - Aur Resources Inc. - Kierens mine
   - Cambior inc. - Pierre Beauchemin, Lucien C. Beliveau, Chimo mines
   - Noranda Minerals Inc. - Silidor mine
   - Société Minière Sphynx Inc. - Duvay mine
4. Aurtec Mining Development Inc. - Montauban mine

New Brunswick:

1. NovaGold Resources Incorporated - Murray Brook mine

Newfoundland:

1. Hope Brook Gold Inc. - Hope Brook mine

PRIMARY GOLD REFINERS

1. Noranda Minerals Inc. Canadian Copper Refiners
2. Royal Canadian Mint
3. Johnson Matthey Limited
4. Nesmont Precious Metals Corporation

Graphite

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SUMMARY

Stratmin Inc. remained Canada's only commercial producer of natural graphite in 1990.

Consumption of graphite in Canada in 1989, the latest year for which statistics were available, was 13 358 t, compared with 15 775 t in 1988. About 35% of graphite consumption is natural graphite, of which 90% is flake. Most graphite is used as foundry facing, and in the metallurgical and refractory industries.

Imports of natural graphite for the first nine months of 1990 were 1644 t, valued at $1.490 million. Imports for twelve months in 1989 were 2001 t, valued at $2.041 million.

During 1990, development of graphite deposits continued to be active, especially in Ontario and Quebec. Efforts were made by several companies in Canada to produce very high-purity graphite for specialty applications, and exfoliated graphite for the manufacture of graphite foil in uses such as gasketing material and pipe-joint packing.

World demand for natural graphite continued to be strong in 1990.

NATURAL GRAPHITE

Graphite is a natural form of carbon. Natural graphite is a lustrous, black carbon mineral, crystallized in the hexagonal system with rhombohedral symmetry. Flake graphite is opaque, flexible and sectile, and exhibits perfect basal cleavage. Natural graphite is unctuous and relatively soft with a hardness of 1-2 on the Mohs scale. It has a black colour and a black streak on glazed porcelain. Its specific gravity is 2.26 g/cm^3. Graphite is an excellent conductor of heat and electricity, and it has a high melting temperature of 3500°C. It is extremely resistant to acid, chemically inert and highly refractory.

Natural graphite is widely distributed throughout the world and is of common occurrence in metamorphic rocks produced by regional or contact metamorphism. Commercially, natural graphite is classified as amorphous, crystalline lump (or vein) and flake. Amorphous graphite is a microcrystalline graphite formed by crystallization of the carbon from organic sediments. The graphite occurs as distorted seams of minute microcrystalline particles intermixed with ungraphitized materials. The graphite content may vary from 15%-98%, depending on the degree of metamorphism and the original carbon content in the sediments. Crystalline lump occurs in the form of massive vein or circular accumulation formed probably from hydrothermal origin. Deposits are found in fissures or other cavities in igneous or metamorphic rocks. The size of the particles varies from fine grains to large lumps. The vein deposits vary widely in width from 2 mm to more than 2 m. Flake graphite is found disseminated in metamorphosed siliceous or calcareous sediments such as marble, gneiss and schist.

Flake is defined as thin flakes which are classified from coarse to fine and which are graded according to their graphitic carbon content.

OCCURRENCES

Graphite deposits of potentially commercial interest in Canada occur principally in rocks of the Grenville series of eastern Canada. The mineral is found in disseminated crystalline flake and vein forms. Most Canadian graphite deposits are associated with graphite gneiss and crystalline limestones which have been subjected to contact metamorphism associated with tectonic features such as folding, compression and fracturing, and with pegmatitic intrusions. The richest ore zones occur as a succession of veins or lenticular bodies that gradually merge into the adjacent non-graphitic host rock and that are bordered by lenses of lower grade ore.

Graphite

Fine to coarse flake graphite deposits have been reported mainly in Quebec and Ontario, but also in New Brunswick, Nova Scotia, Saskatchewan, Labrador and British Columbia.

In Quebec, graphite deposits are located mainly along the Grenville series in several townships of western Quebec: Buckingham, Argenteuil and Pontiac. The disseminated flake graphite variety is dominant in biotite gneiss and crystalline limestone associated with biotite quartzite, but the vein variety is also reported along the contact of intrusive rocks and crystalline limestone. Occurrences of graphite are associated with metasedimentary rocks which have been subjected to several deformations and where metamorphism has reached amphibolitic or granulitic phases.

Graphite also occurs in Esmanville Township, south of Fermont. Several graphite-rich schist zones, measuring 1-25 m in thickness, are found interlayered with quartz-feldspar gneiss. Some graphite zones locally contain more than 15% graphite in the form of fine and well-crystallized flakes.

In Ontario, graphite deposits are found in several townships of eastern Ontario in rocks of the Grenville Geological Province. Flake graphite occurs disseminated in marbles and gneiss. The occurrences of major interests are in semipelitic and pelitic gneiss units within paragneiss sequences. Graphite is present in amounts up to 10%. Accessory minerals consist of biotite, garnet and pyrite; trace elements in these graphitic rocks are nickel, cobalt, boron and vanadium.

CANADIAN PRODUCTION AND DEVELOPMENT

In 1990 Canada's only commercial production of graphite came from Stratmin Inc. with a mine and concentrator at Lac-des-Îles, Quebec and a concentrator at Notre-Dame-du-Laus, also in Quebec.

The year 1990 was marked by active development work in both Ontario and Quebec. The major companies involved were Cal Graphite Corporation, Stewart Lake Resources Inc., North Coast Industries Ltd. and Victoria Graphite Inc. in Ontario, and Stratmin Inc., Mazarin Mining Exploration Inc. and Graphicor Resources Inc. in Quebec.

Cal Graphite Corporation of Lively, Ontario, holds a 100% interest in mining claims in the Township of Butt near Huntsville where crystalline flake graphite occurs in mafic gneiss and paragneiss. Since 1985, Cal Graphite Corporation has undertaken exploration work and in 1988, the company reported it had outlined some 60 Mt of proven and probable reserves grading almost 3% graphitic carbon measured by double ignition loss. An open-pit mine and a processing plant with an initial milling capacity of 3000 t/d ore, which could be expanded to 5000 t/d ore, was completed during the year and production started during October. Although the grade of the ore is relatively low, the company reports that only light crushing will be necessary to free the crystalline flakes, and a simple upgrading process, including autogenous rotary crushing and vertical column flotation, will be used. Flake graphite concentrates grading 94%-97% carbon will be sold to crucible, lubricant and refractory companies, mainly in the United States and Europe. A refinery (leaching plant) to produce higher grade concentrates for specialty applications at Walden near Sudbury was also completed during the year. Cal Graphite's exclusive marketing agent is Premetalco Inc.

Stewart Lake Resources Inc. of Oakville, Ontario announced the completion of the feasibility study on its Kirkham, Ontario flake graphite project by Kilborn Limited. The study concluded that the project can be successfully developed and placed into production at an estimated cost of $9.8 million. Graphite ore would be mined by open-cast method at the beginning, moving to an underground operation eventually. Mining would proceed five days a week at about 350 t/d ore and milling would proceed seven days a week at 250 t/d ore, yielding approximately 8000 t/y of graphite concentrate. Permitting and re-zoning should be complete in early 1991. The mining plan is based on mineable, diluted reserves of just over 1 Mt grading 8.61% graphitic carbon–sufficient for about 12 years of operation. However, the company reported that drill results indicate that an expansion of mineable reserves is achievable, which will support a longer operation. Stewart Lake also reported that negotiations are under way with end users to secure medium- to long-term marketing contracts for the concentrate. Discussions are also taking place in order to obtain the funds necessary to build the production facilities and initiate mining.

Victoria Graphite Inc. completed a surface drilling program at its graphite deposit near Portland, Ontario, where graphite occurs in silicated marble in three steeply dipping zones. The ore is reported to average 6% graphitic carbon down to 20 m in two zones. Proven reserves are reported to be 245 000 t. The company is gearing up for pilot production with a mill capacity of some 100 t/d ore using an existing mill building on the site and second-hand equipment. Samples sent to Lakefield Research indicated that the graphite would be suitable for the production of exfoliated graphite used in the manufacture of graphite foil.

North Coast Industries Ltd. of Vancouver, British Columbia is seeking financing to develop its flake graphite project in Bissett Creek, Ontario. North Coast is proposing an annual production of 17 000 t of marketable flake graphite grading 90%-92% carbon. The company has an agreement with Possehl of Germany for the marketing of its production. The deposit has established reserves of 20 Mt of proven and probable flake graphite ore with an average grade of 3.2% carbon.

Stratmin Inc. of Montreal, Quebec has completed the construction of a mill with a production capacity of 20 000 t/y concentrates at its Lac-des-Îles graphite property near Mont-Laurier, Quebec. Production started in April 1990. Total reserves (proven, probable, and possible) of Stratmin's Lac-des-Îles properties are 23.7 Mt averaging 7.5% carbon. Mining is by open-cast method. Concentrates of 92%-98% carbon are being produced. Stratmin also operates a mill at Notre-Dame-du-Laus that has a production capacity of 9000 t/y concentrates. The mill is fed with ore from its Lac-des-Îles property. Combined production at the two mills was 5000 t of concentrates in 1989 and 14 500 t of concentrates in 1990.

At year-end, Mazarin of Quebec City, Quebec, was negotiating an agreement with Cambior inc. after the negotiations with Cassiar Mining Corporation fell through during 1990 to jointly develop its Fermont, Quebec graphite property. A feasibility study on putting the property into production proposes an open-pit mining operation for six months of the year, which would supply enough ore to feed a 400 t/d concentrator on a year-round basis for an annual production of 23 000 t. The property's reserves (proven, probable and possible) are estimated at 8.75 Mt, averaging 14.2% graphitic carbon after dilution. However, the proven mining ore reserves available for the first 20 years of operation stand at some 3 Mt, grading 17% carbon. Mazarin will be responsible for the marketing of graphite.

Graphicor Resources Inc. of Ste-Scholastique, Quebec, completed the construction of a mill near Notre-Dame-du-Laus, Quebec. The mill is expected to produce some 500 t/d ore when production starts. Graphicor Resources Inc. owns two graphite deposits in the area that grade some 7.5%, and has a 50% interest with Société québécoise d'exploration minière (SOQUEM) in another deposit that grades 10.4% carbon.

During October, Global Graphite Group announced the opening of a plant in Anjou, Quebec for the purification and exfoliation of natural graphite concentrates using acid leaching, heat and/or pressure processing.

The company claims it can produce graphite to a purity level of 99.99% carbon. High-purity graphite will be sold for the manufacturing of graphite gaskets and seals, brake and clutch linings, refractory bricks, etc.

CANADA, CONSUMPTION AND TRADE

Reported consumption of graphite in 1989 amounted to 13 358 t, and was mainly used in foundries, metallurgy and refractories.

In 1990, imports of crude graphite for the first nine months were valued at $1.490 million. Some 90% of Canada's imports originate from the United States. Crude graphite is used mainly in Ontario (70%) and Quebec (15%).

USES AND SPECIFICATIONS

The uses of natural graphite depend on its physical and chemical properties. The strength of graphite increases as its temperature rises. It has a high thermal conductivity and a low absorption coefficient for X rays and electrons.

Flake graphite is used in the manufacture of crucible for the steel, nonferrous and precious metals industries. It is preferred to microcrystalline graphite because it burns more slowly, has a high attrition resistance and imparts structural strength through the orientation of the flakes.

Carbon refractories consist of more than 7% carbon in a blend with either microcrystalline or flake graphite, and are known as magnesia carbon brick. Mag-Carbon brick is used in high temperature and corrosion-prone applications such as in steel furnace lining, ladles, slag-lines, hotpots, nozzles and blast furnaces. Graphite is used because of its thermal conductivity and thermal and chemical resistances. Flake graphite must have a carbon content between 90% and 97% and sizes ranging from 75-180 microns.

The use of graphite in brake linings reduces the wear rate. High-carbon, fine crystalline graphite, below 75 microns, is used with a minimum carbon content of 98%, although a concentrate of 90% can be used if abrasive impurities such as silica are at a low level.

Traditionally, graphite has been used in dry-cell zinc-carbon batteries due to its electrical conductivity. Fine-grain carbon, below 75 microns, or microcrystalline graphite with a minimum carbon content of between 85% and 90%, is required. Alkaline batteries require a purer natural graphite with a carbon content of at least 98% or a synthetic grade. Carbon material should be free of metallic impurities such as copper, cobalt or antimony.

Electric motor components use a wide variety of graphite, natural or synthetic. Powdered graphite, 150 microns, with a minimum carbon content of 95%-99% is required. Lump graphite, low-silica microcrystalline graphite and synthetic graphite are usually suitable.

In powder metallurgy where steel is reinforced by the absorption of carbon, high-purity graphite is required for the sintering. It also acts as a lubricant and as a source of carbon. Dry powder graphite should be of an average particle size of five microns and must have a carbon content of between 96% and 99%.

Lubricants for industrial usage are also made from graphite because of its softness, low friction, inertness and heat resistance. High-carbon, fine crystalline graphite, below one micron, is specified with a carbon content of between 96% and 99%.

In paint manufacture, graphite is used to protect metal surfaces exposed to a corrosive environment and to eliminate the accumulation of static electricity in floor coatings. Microcrystalline graphite of low carbon content, 50%-55%, is usually required.

In the manufacture of lead pencils, natural graphite is used because of its marking properties. The degree of hardness of a pencil is determined by the clay-to-graphite ratio of its lead. Microcrystalline graphite, 80%-82%, is used in the cheaper grades of leads. However, a finely ground graphite with a higher carbon content, over 90%, is usually required.

For foundry application such as mould coating, graphite prevents the adhesion of metals. Foundry facings are usually made of lump graphite or microcrystalline graphite, between 53 and 75 microns, with a low carbon content of 40%-70%.

Iron foundries use microcrystalline graphite as a recarburizer for raising the carbon content of iron melted in electrical furnaces from charges containing large proportions of scrap. A wide variety of material, such as synthetic graphite and coke, may serve as a substitute.

Other uses for natural graphite include engineering components, polishes, rubber products and explosives.

Growth areas: Growing markets include exfoliated flake graphite rolled into sheet for the manufacture of gaskets and seals used in the automotive industry, heat exchangers, etc.; high alumina and magnesia graphite bricks for the refractory industry; zirconia-graphite; alumina-SiC-graphite refractories; and friction materials. Other growing markets are very high-purity graphite for specialty applications, metal powders and motor brushes.

Flexible graphite: According to Polycarbon Inc., a manufacturer of flake graphite in the United States, the world market for flexible graphite products is estimated at between 5500 and 6000 t/y in 1990. This amount requires between 8000 and 8600 t/y of flake graphite raw material due to losses in the manufacturing process. To date, the natural graphite flake normally widely used to manufacture flexible graphite has come from mines located in Madagascar, China, Brazil, Canada, India, Zimbabwe, Sri Lanka, Mexico and Norway. The flake quality and price are dependent upon the flake size distribution, fines content, carbon content, and ash content and distribution. Ash is defined as those elements present other than graphite. The size of ash particles as well as the content has an effect on the quality of the finished flexible graphite product. The ash normally consists of varying amounts of trace elements plus larger quantities of silica, sulphur, iron, aluminum and magnesium. The quality of the graphite raw material is also dependent on the quality and process control of the benefication process at the mine site, and must be closely monitored by the flexible graphite manufacturer.

The following table shows the markets for flexible graphite by use and geographic regions.

FLEXIBLE GRAPHITE MARKETS (1990)

Region	Industrial	Automotive
	(t/y)	
North America	400	2 600
Japan	100	1 900
Europe	300	50
Other	100	50
Total	900	4 600

Source: Polycarbon Inc.

Prices for graphite foil averaged US$12/kg in 1990.

Major producers of flexible graphite include Polycarbon, Union Carbide Corporation and Flexitallic in the United States; SIGRI GmbH in Germany; Le Carbone Lorraine in France; and Nippon Carbon, Hitachi Chemical and Toyo Tanso in Japan.

WORLD PRODUCTION, TRADE AND CONSUMPTION

Estimated figures for 1989 indicated that world production of natural graphite was 631 213 t. Some 35%-40% was flake graphite. China was the largest producer of graphite with 200 000 t, followed by South Korea (99 000 t), the U.S.S.R. (84 000 t), Mexico (47 000 t) and Czechoslovakia (25 000 t). During the past ten years, world production has increased about 15 000 t/y, or the size of one large graphite mining operation.

The major world producer countries, by type of graphite and by decreasing order of importance, are as follows:

Flakes:
China, the U.S.S.R., Brazil, India, Madagascar, Germany, Canada and Norway. World flake production was estimated at about 225 000 t to 250 000 t in 1988, the latest year for which world statistics are available.

Microcrystalline:
China, South Korea, Mexico, Czechoslovakia, Austria, North Korea, the U.S.S.R. and Zimbabwe.

Lump:
Sri Lanka.

A résumé of the largest exporter and importer countries of graphite in recent years is as follows:

Graphite

MAJOR EXPORTER AND IMPORTER COUNTRIES OF GRAPHITE IN RECENT YEARS

Country	Exports	Country	Imports
	(000 t/y)		(000 t/y)
China	70-80	Japan	70-90
South Korea	35-45	United States	40-47
Mexico	20	Germany	30-35
Madagascar	15	United Kingdom	20-22
Zimbabwe	13	Taiwan	8
Canada[1]	6-10	Italy	6
Austria	10	France	5
Germany	10	Austria	4
Brazil	9		
Norway	5-7		

[1] Exports are expected to increase rapidly during the next five years as production capacity increases.

The largest consumers of graphite are the large producers of iron and steel, base metals and precious metals. Together they consume about 50% of all graphite and are the largest users of flake graphite. The largest consumer countries are the U.S.S.R., Japan, the United States, China, Germany, the United Kingdom, Italy, France and Brazil.

PRICE

Published prices for natural graphite provide only a range and are not representative of market prices which are contracted price negotiated between suppliers or distributors and consumers. The prices of flake graphite and lump graphite are higher than those for microcrystalline (amorphous) graphite because of the nature of mining and processing operations. Prices for flake graphite concentrate vary, depending on the carbon content, the size of the flakes and their distribution, and the ash content.

In Europe, published prices remained the same as in 1989. In the United States, flake graphite prices increased by 23%.

OUTLOOK

Graphite has excellent physical and chemical properties; its resource base is large and it is readily available from several countries. For these reasons, growth should continue.

The grade of Canadian deposits discovered so far is generally lower than that of most producers in the world. Also, labour costs in Canada are relatively high compared to those in many producing countries. However, Canadian deposits are of the flake type, relatively easy to upgrade to +90% carbon, and many contain graphite that is expandable. These products command high prices and the outlook for growth is good. Countries that rely mainly on China and Madagascar for their supplies of flake graphite may wish to diversify their sources and purchase concentrates from closer sources in eastern Canada.

Note: Information contained in this review was current as of mid-January 1991.

PRICES

"Industrial Minerals"[1] pricing quotation, c.i.f., United Kingdom port, US$ per tonne

			1988		1989	1990
		Dec. 1984	Nov.	Dec.	Dec.	Dec.
Crystalline lump	92-99% C	550 – 1 100	550 – 1 100	750 – 1 500	750 – 1 500	750 – 1 500
Crystalline large flake	85-90% C	630 – 1 000	630 – 1 000	820 – 1 300	820 – 1 300	820 – 1 300
Crystalline medium flake	85-90% C	490 – 860	490 – 860	770 – 1 120	770 – 1 120	770 – 1 120
Crystalline small flake	80-95% C	300 – 800	300 – 800	540 – 900	540 – 900	540 – 900
Powder (200 mesh)	80-85% C	250 – 275	250 – 275	325 – 360	325 – 360	325 – 360
	90-92% C	410 – 460	410 – 460	520 – 600	520 – 600	520 – 600
	95-97% C	550 – 750	550 – 750	770 – 1 000	770 – 1 000	770 – 1 000
	97-99% C	750 – 1 000	750 – 1000	1 000 – 1 300	1 000 – 1 300	1 000 – 1 300
Amorphous powder	80-85% C	175 – 350	175 – 350	220 – 440	220 – 440	220 – 440

"Chemical Marketing Reporter"[2] pricing quotation, New York, U.S. basis, bags, drums, US$ per pound

			1988	1989	1990
Crystaline, powder		88-90%	.30 – .60	.30 – .60	.30 – .60
		90-92%	.40 – .75	.40 – .75	.40 – .75
		95-96%	.60 – .90	.60 – .90	.60 – .90
		97% and up	.80 – 1.20	.80 – 1.20	.80 – 1.20
Flake	No. 1 (large)	90-95%	.65 – .75	.65 – .75	.80 – .95
	No. 2 (medium)	90-95%	.65 – .75	.65 – .75	.80 – .95
	No. 3 (small)	90-95%	.65 – .75	.65 – .75	.80 .95
Amorphous	powder		.16 – .40	.16 – .40	.16 – .40
	powder	97% and up	.80 – 1.20	.80 – 1.20	.80 – 1.20

1 "Industrial Minerals," December 1984, November and December 1988, December 1989 and December 1990. 2 "Chemical Marketing Reporter," December 1988, December 1989 and December 1990.
c.i.f. Cost, insurance and freight.

Graphite

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
25.04	Natural graphite				
2504.10.10	in powder	9.2%	6%	Free	Free
2504.10.20	in flakes	4%	2.5%	Free	Free
69.02	Refractory bricks, blocks, tiles and refractory constructural ceramic goods, other than those of siliceous fossil meals or similar siliceous earths				
6902.90.10	Other, containing by weight 85% or more of carbon or graphite	6.8%	4.5%	4.7%	Free-3.9%
6902.90.90	Other, containing by weight more than 50% but less than 85% of carbon or graphite	Free	Free	Free	Free-3.9%
69.03	Other refractory ceramic goods, other than those of siliceous fossil meals or of other similar siliceous earths				
6903.10	containing by weight more than 50% of graphite or other forms of carbon or of a mixture of these products				
6903.10.10	crucibles and covers therefor	6.8%	Free	4.7%	3.9%
8545.20	Carbon or graphite brushes	10.2%	6.5%	7.1%	2.9%

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, effective January 1, 1990.

TABLE 1. IMPORTS OF CRUDE GRAPHITE AND GRAPHITE-RELATED PRODUCTS, 1989 AND 1990

Item No.		1989		Jan.-Sept. 1990p	
		(tonnes)	($000)	(tonnes)	($000)
2504.10	Natural graphite in powder or flake				
	United States	1 837	1 821	1 503	1 314
	Other countries	161	218	140	174
	Total	2 001	2 041	1 644	1 490
6902.90	Refractory bricks, etc., n.e.s. (containing by weight more than 50% carbon or graphite)				
	United States	37 376	28 825	22 418	17 548
	West Germany	899	2 681	1 483	2 578
	Japan	873	2 023	1 182	2 093
	Other countries	3 094	3 020	3 235	3 971
	Total	42 252	36 560	28 324	26 194
6903.10	Refractory ceramic goods, n.e.s. more than 50% of graphite or other forms of carbon, etc. (including crucibles)				
	United States	..	1 810	..	1 137
	Japan	..	25	..	352
	United Kingdom	..	336	..	289
	Other countries	..	377	..	419
	Total	..	2 555	..	2 201
8545.20	Carbon or graphite brushes				
	United States	143	3 944	113	3 149
	Other countries	12	415	11	388
	Total	156	4 367	125	3 542

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary; .. Not available; n.e.s. Not elsewhere specified.
Note: Totals may not add due to rounding.

TABLE 2. GRAPHITE WORLD PRODUCTION, BY COUNTRY[1]

Country[2]	1985	1986	1987	1988[p]	1989[e]
			(tonnes)		
Argentina	32	40	216	24	50
Austria	30 764	36 167	39 391	7 577	7 000
Brazil (marketable)[3]	27 239	28 586	31 404	32 000	30 000
Burma[4]	234	722	–	–	–
China[e]	185 000	185 000	185 000	200 000	200 000
Czechoslovakia[e]	35 000[r]	25 254[a]	25 000[r]	25 000[r]	25 000
Germany, Federal Republic of	12 798	13 233	9 891	7 000[e]	7 000
India (mine)[5]	27 337	38 412	42 589	52 134	55 000
Korea, North[e]	25 000	25 000	25 000	25 000	25 000
Korea, Republic of:					
Amorphous	69 877	96 577	106 507	107 767	98 000
Crystalline flake	1 602	641	838	678	1 000
Madagascar	13 971	16 187	13 169	14 106	14 000
Mexico:					
Amorphous	33 468	36 018[r]	36 674	42 096	45 000
Crystalline flake	1 910	1 838	1 787	1 735	2 000
Norway	2 684	–	–	–	–
Romania[e]	12 000	12 000	12 000	12 000	10 000
Sri Lanka	7 413	7 453	9 400	8 547	4 163[a]
Turkey (mine)	5 000[e]	3 586	11 760	12 833	13 000
U.S.S.R.[e]	82 000	83 000	84 000	84 000	84 000
United States	–	–	–	w	w
Zimbabwe	10 450	15 004	13 530	11 441	11 000
Total	583 779[r]	624 718[r]	648 156[r]	643 938	631 213

Source: U.S. Bureau of Mines.
[1] Table includes data available through May 8, 1990. [2] In addition to the countries listed, Canada produced graphite during the period covered by this table, but output is unreported. [3] Does not include the following quantities sold directly without beneficiation: 1985–16 425 t; 1986–19 074 t; 1987–10 505 t; 1988–20 000 t[e]; and 1989–20 000 t[e]. [4] Data are for fiscal year beginning April 1 of that stated. [5] Indian marketable production is 10%-20% of mine production.
[a] Reported figure; [e] Estimated; [p] Preliminary; [r] Revised; w Withheld to avoid disclosing company proprietary data; – Nil.

TABLE 3. REPORTED CONSUMPTION OF GRAPHITE IN CANADA, 1975, 1980 AND 1985-89

	1975	1980	1985	1986	1987	1988	1989p
				(tonnes)			
Reported consumption[1] of graphite							
Foundry facing	3 822	3 078	6 132	10 294	10 003	6 650	5 465
Ferroalloys and primary steel	568	468	398	795	950	639	643
Refractories	523	583	472	757	740	673	450
Other[2]	429	1 788	1 335	1 911	2 710	7 813	6 800
Total	5 342	5 917	8 337	13 757	14 403	15 775	13 358

[1] Reported from EMR survey on the consumption of nonmetallic minerals by Canadian manufacturing plants.
[2] Includes brake linings, chemicals, abrasives, batteries and other end uses.
p Preliminary.

Gypsum and Anhydrite

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GYPSUM

SUMMARY

Shipments of crude gypsum were 8 202 000 tonnes (t) valued at $80.9 million in 1990, compared to 8 196 000 t valued at $86.1 million in 1989. Total purchases by manufacturers of wallboard products in the United States and British Columbia remained about the same, according to preliminary figures. However, the quantity and value of gypsum shipped from Ontario was about 20% less, mainly in response to the downturn in construction.

Atlantic Canada, mainly Nova Scotia, accounts for more than 75% of Canada's output and nearly all of its exports. Deposits in Nova Scotia and Newfoundland in general are characterized by high quality, are amenable to inexpensive mining methods, and are situated so as to take advantage of coastal bulk-shipping facilities. Ontario production is used on-site, except in the case of Westroc Industries Limited at Drumbo, which ships to the company's Mississauga wallboard plant. Production from Manitoba and from Windermere, Canal Flats (Lussier River) and Falkland in British Columbia serves the Prairie region and a portion of the B.C. market not served by imports. Rail traffic is now associated with about 60% of Canadian shipments of crude gypsum, according to the National Transportation Agency.

The Portland cement industry requires up to 5% by weight of gypsum intimately ground with cement clinker to act as a set inhibitor. Amounts consumed may total more than 500 000 t/y in Canada.

CANADIAN DEVELOPMENTS

Canadian operations are mainly subsidiaries of U.S. gypsum products manufacturers with output in direct response to demand by the wallboard industry in the United States and Canada. In turn, this industry serves the residential, institutional and commercial building sectors. In recent years, housing starts have become a less-than-accurate indicator of the demand for gypsum wallboard because improved fire-retardant qualities, along with more renovation work, have encouraged broader use.

Domtar Inc., producing from two mines in 1990, continued its $20 million underground development to supply the company's adjacent board complex at Caledonia, Ontario. The full use of continuous miners is planned and new reserves, at present levels of output, are expected to be sufficient for 75 years. The board complex supplies about 70 million m^2/y of wallboard to construction and renovation markets in Canada and the United States. In Manitoba, Domtar opened its new quarry at Amaranth to replace depleting reserves at Gypsumville. In the United States, the company opened its new US$35 million gypsum board plant in Newington, New Hampshire. At full capacity, plant output is expected to be about 50 million m^2/y. Crude gypsum is supplied from the company's long-established mine at Flat Bay, Newfoundland.

CGC Inc., a diversified public company owned 75% by USG Corporation of Chicago, continued work on its six-year, $7 million expansion program at Hagersville, Ontario. This is expected to assure the availability of ore to maintain long-term output at about 650 000 t/y.

Westroc Industries Limited, a subsidiary of British-owned BPB Industries PLC, completed a modernization plan at its Winnipeg plant.

Louisiana-Pacific Corporation, a major forest products firm based in Portland, Oregon, completed its $65 million fibre-gypsum board plant at Port Hawksbury, Nova Scotia. The plant uses recycled paper, local gypsum and imported perlite, marking the first time that a local gypsum board product has become available for regional and export markets.

Several companies are beginning to recycle waste gypsum from their product plants. Domtar's Surrey, British Columbia, plant was the first in North America to use large quantities of waste board equivalent to about 30 000 t/y of crude gypsum.

Eastern Gypsum Inc., a New Brunswick-based company, began operating its new gypsum wallboard plant in McAdam, New Brunswick.

Occurrences of gypsum other than those being exploited are known in the southwest lowlands west of the Long Range Mountains in Newfoundland; throughout the central and northern mainland of Nova Scotia as well as on Cape Breton Island; in the southeastern counties of New Brunswick; on the Magdalen Islands of Quebec; in the Moose River, James Bay and southwestern regions of Ontario; in Wood Buffalo National Park, in Jasper National Park, along the Peace River between Peace Point and Little Rapids, and north of Fort Fitzgerald in Alberta; on Featherstonhaugh Creek, near Mayook, at Canal Flats, at Loos and at O'Connor River in British Columbia; on the shores of Great Slave Lake, the Mackenzie, Great Bear and Slave rivers in the Northwest Territories; and on several Arctic islands.

WORLD DEVELOPMENTS AND TRADE

Gypsum occurs in relative abundance throughout the world; however, with dependence on the building construction sector, developments are generally limited to the industrialized countries. Reserves are extremely large and are conservatively estimated at over 2.5 billion t. Canada is the world's second largest producer of natural gypsum after the United States, together accounting for about 25% of world output. In recent years, with low production costs and competitive shipping arrangements, gypsum from Spain has become more important in North American markets. For example, United States imports of gypsum from Spain increased from several hundred thousand t/y in the early 1980s, to more than 1 Mt/y at present. Back-haul freight rates associated with returning grain ships are believed to account for some of the lower shipping rates.

Imports of gypsum from Mexico and the United States are used by both wallboard and cement manufacturers in British Columbia, whereas Spanish imports are consumed solely by cement manufacturers.

Gypsum products, particularly wallboard, have limited market range because of high unit weight, susceptibility to damage, high transportation costs and relatively low unit values. These factors generally dictate that markets be supplied by the nearest producer. Imports of wallboard into Canada have increased substantially since 1986 and now amount to more than 7% of domestic production.

Gypsum wallboard capacity in the United States will increase in 1990/91 by about 93 million m^2, or about 4%. In addition to Domtar's new plant in New Hampshire, new plants were built in Miami, Florida by South Florida Gypsum Company, and in East Providence, Rhode Island by Highland-American Corp. The latter companies are newcomers to the wallboard industry.

PROCESSING AND MARKETS

Gypsum is a hydrous calcium sulphate ($CaSO_4.2H_2O$) which, when calcined at temperatures ranging from 120°-205°C, releases three quarters of its chemically combined water. The resulting hemihydrate of calcium sulphate, commonly referred to as plaster of Paris, when mixed with water can be moulded, shaped or spread and subsequently dried, or set, to form a hard plaster. This is particularly suited to products including wallboard, lath and tile. Anhydrite, an anhydrous calcium sulphate ($CaSO_4$), is commonly associated geologically with gypsum but is not a suitable substitute for most uses.

The type of processing necessary depends upon end use. Crude gypsum is crushed, pulverized and calcined to form stucco, which may be mixed with water and aggregate (sand, vermiculite or expanded perlite) and applied over wood, metal or gypsum lath to form interior wall finishes. Gypsum wallboard, accounting for more than 70% of uses in North American markets, along with lath and sheathing, are formed by introducing a slurry of stucco, water, foam, pulp and starch between two unwinding rolls of absorbent paper resulting in a continuous "sandwich" of wet board. As the stucco hardens, the board is cut to pre-determined lengths, dried, bundled and stacked for shipment. Gypsum for use in cement is crushed to -13 mm only. For agricultural or filler use, it is dried and finely ground to about 100 mesh. Sheathing products may contain asphalt-impregnated paper along with asphalt added to the gypsum core to improve water resistance.

In addition to its use in the manufacture of Portland cement as a set regulator, crude gypsum is used as a filler in paint and paper manufacture, as a substitute for salt cake (sodium sulphate) in glass manufacture and as a soil conditioner.

The use of lime or limestone to desulphurize stack gases from utility plants, industrial plants burning high-sulphur fuel, or from sulphide ore-smelting plants, results in the production of large amounts of waste gypsum in the form of a sludge presenting disposal problems. In Europe and Japan, by-product gypsum of this type is used by gypsum products manufacturers, by cement manufacturers and also in agriculture for soil stabilization. To further address the use of by-product gypsum, ORTECH International is sponsoring an international conference on flue-gas derived (FGD) and chemical gypsum to be held in Mississauga in 1991.

By-product gypsum produced by the acidulation of phosphate rock in phosphate fertilizer manufacture has not been utilized in Canada despite available technology. In the case of phosphogypsum produced from sedimentary phosphate rock, which can contain significant quantities of uranium and radium, studies have indicated that a potential radiation hazard exists. In the United States, interest is increasing in FGD gypsum and at least partial substitution of synthetic gypsum for natural gypsum has been accomplished at several wallboard plants.

Canadian Standards Association (CSA) Standards A 82.20 and A 82.35 relate to gypsum and gypsum products.

PRICES

Prices for gypsum in non-captive markets are negotiated, the only published figure being an approximate minimum price for crude material, ex-mine or c.i.f. United Kingdom, published in the Industrial Minerals magazine. In the United States, prices in real terms for crude material, f.o.b. mine, have tended to fall according to information by the U.S. Bureau of Mines.

OUTLOOK

The recession that began in the second quarter of 1990 deepened and affected most sectors of the economy. Housing starts were 222 562 in 1988, 215 382 in 1989 and then fell to about 182 000 in 1990. The outlook for new housing and office building construction remains uncertain; however, general construction activity outside of central Canada is expected to improve. Activity associated with the petroleum industry, roads, natural gas pipelines and forestry projects in western Canada, along with Hibernia-related construction in Newfoundland, is expected to improve the general outlook in 1991/92.

The weak construction sector in the United States, with housing starts down more than 13% in 1990, is expected to adversely affect Canadian exports of both gypsum and wallboard in 1991.

Although new construction materials are being introduced, the demand for gypsum wallboard is expected to remain popular because of its low price, ease of installation and well-recognized insulating and fire-retarding properties. The present structure of the industry in Canada is not expected to change greatly, although future availability of by-product gypsum, based on satisfying stricter environmental controls, will likely influence developments in some areas.

The demand for gypsum and related products is expected to remain relatively weak in 1991, given the recession. In particular, housing starts in Canada, which approached an eight-year low, may be down another 10%-15% according to some forecasts. Similarly, exports to the United States are expected to weaken based on lower construction spending, tight credit, high vacancy rates and faltering consumer confidence because of the Persian Gulf crisis.

ANHYDRITE

Production and trade statistics for anhydrite are included with gypsum. Anhydrite–the anhydrous form of gypsum, which is about twice as hard and also heavier than gypsum–is produced by Fundy Gypsum Company Limited, at Wentworth, Nova Scotia, and by Little Narrows Gypsum Company Limited, at Little Narrows, Nova Scotia.

Production of anhydrite in 1989 was 124 000 t based on final figures, and in 1990 was an estimated 168 000 t, according to the Nova Scotia Department of Mines and Energy. Most output was shipped to the United States for use in Portland cement manufacture and as a peanut crop fertilizer. Cement plants in Quebec and Ontario also used some Nova Scotian anhydrite.

Note: Information contained in this review was current as of mid-January 1991.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2520.10	Gypsum; anhydrite	Free	Free	Free	Free
68.09	Articles of plaster or of compositions based on plaster: Boards, sheets, panels, tiles and similar articles, not ornamented				
6809.11	Faced or reinforced with paper or paperboard only				
6809.11.10	Gypsum wallboard	9.4%	Free	6.5%	1.9%
6809.11.90	Other	9.2%	Free	6.4%	1.9%
6809.19.00	Other	10.2%	6%	7.1%	4.8%
6809.90	Other articles				
6809.90.10	Models and casts, of a kind used in the manufacture of dental prosthesis	Free	Free	Free	3.4%
6809.90.90	Other	10.2%	6.5%	7.1%	3.4%

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States effective January 1, 1990.

TABLE 1. CANADA, GYPSUM PRODUCTION AND TRADE, 1988–90

Item No.		1988		1989		1990p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Production	**(shipments)**						
	Crude gypsum						
	Nova Scotia	7 245 182	66 776	5 926 449	53 847	6 212 814	54 176
	Ontario	1 452 739	15 716	1 344 561	20 347	1 086 000	16 113
	British Columbia	419 356	4 936	357 742	x	396 404	4 819
	Manitoba	x	x	x	x	x	x
	Newfoundland	x	x	x	x	x	x
	New Brunswick	x	x	–	–	–	–
	Total[1]	9 511 581	92 544	8 196 340	86 127	8 202 378	80 862
Imports						**(Jan.-Sept.)**	
2520.10	Gypsum; anhydrite						
	Mexico	91 810	3 041	98 673	3 496	79 526	2 603
	United States	66 753	1 626	94 823	1 481	78 045	1 360
	Spain	115 058	1 030	97 224	943	41 059	621
	Other countries	295	8	653	27	511	23
	Total	274 917	5 707	291 373	5 953	199 141	4 610
		(square metres)		**(square metres)**		**(square metres)**	
6809.11	Plasterboards, etc. not ornamental; faced or reinforced with paper or paperboard						
	United States	17 887 893r	19 563r	19 004 868	21 595	13 749 356	15 418
	United Kingdom	. .	63	. .	218	. .	165
	Other countries	47 022	31	–	–	–	–
	Total	17 934 915r	19 660r	19 004 868	21 816	13 749 356	15 583
6809.19	Plasterboards, etc. not ornamental; faced or reinforced n.e.s.						
	United States	. .	600r	. .	1 741	. .	1 363
	United Kingdom	. .	158	–	–	. .	10
	Italy	. .	5	–	–	–	–
	Total	. .	764r	. .	1 741	. .	1 374
6809.90	Articles of plaster or compositions based on plaster, n.e.s.						
	United States	. .	887r	. .	761	. .	1 131
	United Kingdom	. .	136	. .	533	. .	725
	Italy	. .	272	. .	216	. .	221
	Other countries	. .	31	. .	170	. .	336
	Total	. .	1 329r	. .	1 685	. .	2 418
	Total imports of gypsum and gypsum products	. .	27 460	. .	31 195	. .	23 985

		(tonnes)		(tonnes)		(tonnes)	
Exports							
2520.10	Gypsum; anhydrite						
	United States	5 615 039	51 917	5 189 603	52 797	4 538 637	41 122
	Other countries	36 248	655	123	145	346	125
	Total	5 651 286	52 576	5 189 726	52 943	4 538 983	41 248
		(square metres)		(square metres)		(square metres)	
6809.11	Plasterboards, etc. not ornamental; faced or reinforced with paper or paperboard						
	United States	. .	77 351	34 975 291	32 787	23 924 665	24 578
	Other countries	. .	185	452 483	36	40 558	49
	Total	. .	77 541	35 427 774	32 825	23 965 223	24 630
6809.19	Plasterboards, etc. not ornamental; faced or reinforced n.e.s.						
	United States	. .	6 954r	. .	8 086	. .	2 499
	Other countries	. .	179	. .	373	. .	158
	Total	. .	7 136r	. .	8 460	. .	2 659
6809.90	Articles of plaster or compositions based on plaster						
	United States	. .	915	. .	756	. .	2 630
	Other countries	. .	308	. .	50	. .	121
	Total	. .	1 226	. .	807	. .	2 753
	Total exports of gypsum and gypsum products	. .	138 479	. .	95 035	. .	71 290

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Totals do not include gypsum produced by or shipped for use by Canadian Portland cement producers.
p Preliminary; r Revised; – Nil; . . Not available; x Confidential; n.e.s. Not elsewhere specified.
Note: Totals may not add due to rounding.

TABLE 2. CANADA, GYPSUM MINING AND GYPSUM PRODUCTS MANUFACTURING OPERATIONS, 1990

Company	Location	Operation
Newfoundland		
Domtar Inc.[1]	Flat Bay	Open-pit mining
Atlantic Gypsum Limited	Corner Brook	Wallboard manufacture
Nova Scotia		
Domtar Inc.	McKay Settlement	Open-pit mining
	Windsor	Plaster and "Gypcrete" manufacture
Fundy Gypsum Company Limited	Wentworth and Miller Creek	Open-pit mining of gypsum and anhydrite
Georgia-Pacific Corporation	River Denys, Sugar Camp	Open-pit mining of gypsum
Little Narrows Gypsum Company Limited	Little Narrows	Open pit mining of gypsum and anhydrite
National Gypsum (Canada) Ltd.	Milford	Open-pit mining of gypsum
New Brunswick		
Lafarge Canada Inc.	Havelock	Open-pit mining of gypsum for cement manufacture ceased
Quebec		
CGC Inc.	Montreal	Wallboard manufacture
	St-Jerome	Wallboard manufacture
Domtar Inc.	Montreal	Wallboard plant now used only as distribution terminal
Westroc Industries Limited	Ste. Catherine d'Alexandre	Wallboard manufacture
Ontario		
CGC Inc.	Hagersville	Underground mining and wallboard manufacture
Domtar Inc.	Caledonia	Underground mining and wallboard manufacture
Westroc Industries Limited	Clarkson	Wallboard manufacture
Manitoba		
Domtar Inc.	Gypsumville	Open-pit mining
	Winnipeg	Wallboard manufacture
Westroc Industries Limited	Amaranth	Open-pit mining
	Winnipeg	Wallboard manufacture
Saskatchewan		
Domtar Inc.	Saskatoon[1]	Closed wallboard manufacturing plant in 1988
Alberta		
Domtar Inc.	Edmonton[1]	Wallboard manufacture
Westroc Industries Limited	Calgary	Wallboard manufacture
British Columbia		
Domtar Inc.	Canal Flats	Open-pit mining
	Vancouver	Gypsum products manufacture
Westroc Industries Limited	Vancouver[2]	Gypsum products manufacture
	Windermere	Open-pit mining

[1] Genstar Corporation affiliated operation acquired by Domtar Inc. in June 1985. [2] Genstar plant in Vancouver acquired by Westroc Industries Limited in June 1985.

TABLE 3. CANADA, GYPSUM PRODUCTION, TRADE AND CONSUMPTION, 1975 AND 1980-90

	Production[1]	Imports[2]	Exports	Apparent Consumption[3]
		(tonnes)		
1975	5 719 451	553 338	3 691 676	2 083 113
1980	7 336 000	154 717	4 960 240	2 530 477
1981	7 025 000	143 500	5 094 873	2 073 627
1982	5 987 000	93 843	4 775 755	1 305 088
1983	7 507 000	100 939	5 187 032	2 420 907
1984	7 775 082	131 809	6 224 574	1 682 317
1985	7 760 783	121 802	5 879 664	2 002 921
1986	8 802 805	221 644	5 921 982	3 102 467
1987	9 093 926	217 625	5 704 853	3 606 698
1988[4]	9 511 581	274 917	5 651 286	4 135 212
1989	8 196 340	291 373	5 189 726	3 297 987
1990p	8 202 378	303 395	5 757 327	2 748 446

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Producers' shipments, crude gypsum. [2] Includes crude and ground, but not calcined. [3] Production plus imports minus exports. [4] Beginning in 1988 imports and exports are based on the new Harmonized System and may not be in complete accordance with previous method of reporting. Imports and exports include H.S. class 2520.10.00 gypsum; anhydrite.
p Preliminary.

TABLE 4. CANADA, HOUSE CONSTRUCTION, BY PROVINCE, 1989 AND 1990

	Starts			Completions			Under Construction		
	1989	1990	% Diff.	1989	1990	% Diff.	1989	1990	% Diff.
Newfoundland	3 536	3 245	–8.2	3 783	3 127	–17.3	3 168	3 201	1.0
Prince Edward Island	815	762	–6.5	927	683	–26.3	380	463	21.8
Nova Scotia	5 359	5 560	3.8	4 904	5 477	12.0	3 364	3 376	0.4
New Brunswick	3 681	2 683	–27.1	3 383	2 959	–12.5	1 638	1 359	–17.0
Total (Atlantic Provinces)	13 391	12 250	–8.5	12 997	12 246	–5.8	8 550	8 402	–1.7
Quebec	49 058	48 070	–2.0	50 855	52 630	3.5	19 527	14 719	–24.6
Ontario	93 337	62 649	–32.9	99 817	80 562	–19.3	66 695	47 808	–28.3
Manitoba	4 084	3 297	–19.3	6 461	4 028	–37.7	2 032	1 316	–35.2
Saskatchewan	1 906	1 417	–25.7	2 743	1 575	–42.6	979	809	–17.4
Alberta	14 712	17 227	17.1	12 763	17 467	36.9	6 297	5 973	–5.1
Total (Prairie Provinces)	20 702	21 941	6.0	21 967	23 070	5.0	9 308	8 098	–13.0
British Columbia	38 894	36 720	–5.6	31 735	37 655	18.7	23 483	21 645	–17.8
Total Canada	215 382	181 630	–15.7	217 371	206 163	–5.2	127 563	100 672	–21.1

Source: Canada Mortgage and Housing Corporation.

TABLE 5. CANADA, VALUE OF CONSTRUCTION BY TYPE[1], 1988-90

	1988	1989	1990
		($ millions)	
Building Construction[2]			
Residential	38 936	43 122	44 963
Industrial	3 842	4 264	4 001
Commercial	14 116	16 154	16 175
Institutional	4 540	4 954	5 441
Other building	2 452	2 781	3 315
Total	63 885	71 276	73 895
Engineering Construction[2]			
Marine	504	523	677
Highways, airport runways	5 721	6 327	6 469
Waterworks, sewage systems	2 477	2 742	3 069
Dams, irrigation	398	492	560
Electric power	4 198	5 290	6 249
Railway, telephones	3 090	3 294	3 376
Gas and oil facilities	7 288	6 006	7 597
Other engineering	3 311	4 116	4 097
Total	26 986	28 790	32 093
Total construction	90 871	100 065	105 987

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Actual expenditures 1988; preliminary 1989; intentions 1990. [2] Includes total value of new and repair work purchased.

TABLE 6. WORLD PRODUCTION OF GYPSUM, 1989 AND 1990

	1989	1990e
	(000 tonnes)	
United States	15 988	16 329
Iran	8 437	8 437
Canada	8 196	8 202
People's Republic of China	8 074	8 074
Japan	6 260	6 260
Spain	5 498	5 535
France	5 684	5 715
U.S.S.R.	4 808	4 808
Mexico	4 813	4 808
United Kingdom	3 992	3 992
Germany, Federal Republic of	1 851	1 814
Australia	1 796	1 814
Other countries	22 642	22 589
World total	98 039	98 377

Sources: Energy, Mines and Resources Canada; U.S. Bureau of Mines Mineral Commodity Summaries, January 1991.
e Estimated.

Iron Ore

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World iron ore production in 1990 is estimated at 980 Mt, equal to production in 1989, which was higher than ever before. Again the largest producers were the U.S.S.R., Brazil, the People's Republic of China and Australia. Canada with 36 Mt ranked seventh behind the United States and India.

Worldwide, shipments of iron ore roughly equalled demand; the net amount of stockpiled ore did not change significantly. In 1989, stocks had been drawn down to meet steel industry requirements, but in 1990, steel production, and consequently iron ore demand, decreased slightly bringing ore production and consumption into balance.

International trade in iron ore declined slightly over the year in response to lower demand by the steel industries in Europe. Canadian exports accounted for about 6% of the world total and Canada remained the fifth largest world exporter.

CANADIAN DEVELOPMENTS

A number of events in 1990 were responsible for bringing iron ore shipments down to 36.4 Mt, a drop of 10% since 1989. Two iron ore mines closed permanently in March, bringing the number of operating mines to four. In addition, a major strike in the steel industry included workers at one mine and indirectly affected other mines. Finally, a new mining plan severely affected production at Canada's largest producer. Therefore, in spite of an increase in iron ore prices, the value of shipments fell by 4% relative to 1989.

Employment at Canadian iron ore mines, concentrators, agglomerating plants and support services fell to 6200 by the end of 1990, after increasing from 6500 to nearly 6900 over the previous three years.

Canadian mines and ancillary plants produced concentrates, pellets and sinter from hematite, magnetite and siderite ores. The production of concentrate that was not further processed to pellets or sinter remained at 12.7 Mt for the third year in a row. Acid pellet production, however, fell by 5.7 Mt to 15.6 Mt in 1990, as more emphasis was put on fluxed pellets and concentrate sales. Fluxed pellet production increased by 25% to 6.9 Mt. Sinter produced at the one mine-site sinter plant fell from 1.2 Mt to 769 000 t due to a strike.

The Iron Ore Company of Canada (IOC) shipped 14.2 Mt of iron ore, of which 6.2 Mt was acid pellets, 2.4 Mt was fluxed pellets, 0.1 Mt was pellet fragments (included with acid pellets in the Canadian totals), and 5.4 Mt was concentrate. Also shipped was the last 38 000 t of the Schefferville red ore that had been stockpiled at Sept-Îles for the past six years. IOC shut down three of its pellet lines at different times during the year, with the effect on annual production equivalent to running only five of its six pellet lines. Pellet production decreased from 10.5 Mt to 8.5 Mt, but all of the cut-back was in acid pellets while fluxed pellet production increased. Capital purchases in 1990 were for the replacement of existing equipment but included two 16 yd^3 shovels, six mining trucks and two drills.

On July 15, 1990, IOC celebrated its 50 millionth ton of iron ore shipped to Japan, the outcome of a relationship that stretches over two decades. IOC supplied Japan's steel industry with iron ore concentrate containing only 0.007% phosphorus and 0.1% alumina, the lowest levels of these unwanted elements of all of Japan's iron ore suppliers.

Quebec Cartier Mining Company (QCM) changed its mine plan to extend the life of the Mt. Wright mine by 10 years and, as a result, encountered production difficulties that lowered production to 14.5 Mt, some 1.6 Mt less than in 1989. In spite of these difficulties, QCM shipped 15.3 Mt of ore by drawing down stocks of concentrate accumulated over previous years. Pellet production was maintained with 4.8 Mt of acid pellets, 2.1 Mt fluxed pellets and 0.9 Mt of pellets for direct reduction. In 1991, QCM expects to increase both production and shipments to 15.7 Mt.

In March, QCM settled what many consider a generous contract with employees, members of the United Steelworkers of America (USWA), and set the standard for contract settlements at the other two major mines. The contract will raise wages by 31% over three years and increase a number of social benefits including pensions.

Wabush Mines produced only 5.7 Mt in 1990, and shipped 5.5 Mt after two years of capacity operation at 6 Mt/y. The main cause for the decrease was strikes; first in the spring, when rail transportation to its Pointe-Noire pellet plant was interrupted for 17 days, and from August to November when Wabush's largest owner/client, Stelco Steel, was on strike. Wabush produced four grades of iron ore pellets, acid pellets with 1% and 2% manganese, and fluxed pellets, also in grades of 1% and 2% manganese. In 1991, Wabush is planning a July shutdown which will keep production at close to the 1990 level.

Construction of the pollution control equipment at Wabush's Pointe Noire pellet plant proceeded on schedule and should go into operation between June and August 1991. The stack emission control system will have cost $50 million on completion, and will reduce dust emissions to one eighth of the former level, to between 34 and 36 kg/hr.

The Algoma Ore Division (AOD) of The Algoma Steel Corporation, Limited was closed for 18 weeks by a strike of USWA workers at the mine, sinter plant and steel plant. In spite of the shutdown, AOD managed to produce 769 000 t of superfluxed sinter using siderite ore and 190 000 t of recycled material. The company forecasts that production will return to a normal level in 1991 and that recycled steel mill scale and sludges will account for as much as 44% of the iron units in the sinter plant feed.

Plans announced in 1989 were for closure of the mine and sinter plant in 1992, but the company is evaluating an alternative procedure for treating the Wawa ore that might prolong the life of the operation.

Dofasco Inc.'s two mines in Northern Ontario, the Adams and Sherman, closed on March 31, 1990. However, the two mines produced at close to capacity for the three months of operation during the year. Shipments from the Adams mine continued into June and from the Sherman mine into May.

Hollinger North Shore Exploration Inc., owned by the La Fosse Platinum Group Inc., continued to promote the sale of direct shipping ore from the Schefferville area, but there were no major developments by year-end.

A number of deposits on the west shore of Ungava Bay were re-evaluated in 1990 as possible areas for investment in the coming decade.

WORLD DEVELOPMENTS

World trade in iron ore reached 200 Mt for the first six months of 1990, and is estimated to have reached 400 Mt for the year, a drop of 20 Mt relative to 1989. Brazil led the world in exports with a new record of close to 115 Mt. Australia was second (101), and the next largest exporters were the U.S.S.R. (40), India (34) and Canada (25). Japan took 30% of world imports and the European Communities took 34%.

The greatest dislocation in world trade resulted from events in Liberia. In August 1989, the Lamco joint venture, which had been supplying up to 6 Mt/y to Europe, closed due to exhaustion of reserves; in June 1990, Bong Mining Company Inc., which had been supplying over 8 Mt/y to Europe, stopped shipments due to what it called the Liberian civil war. Total shipments of iron ore from Liberia therefore fell from 12.7 Mt in 1989 to 4 Mt in 1990, and may be zero in 1991. This collapse of a major supplier to Europe is expected to have an effect on international iron ore contracts including the 1991 contracts for Canadian iron ore.

Canada exports about 75% of its iron ore and, although the largest single customer is the United States, western European destinations account for 54%. The Canadian industry is, therefore, very sensitive to competition from U.S. mines in the North American market, and to competition from the iron ore-exporting countries that ship to Europe.

The three iron ore producers that have the greatest influence on the Canadian industry are therefore the United States, Brazil and Australia.

In 1990, U.S. steel production increased by 0.6% relative to 1989. Consumption of iron ore, however, remained at about 73 Mt. The major change for the year was a 24% drop in reliance on iron ore imports from offshore. Based on 10 month data, the full year 1990 offshore iron ore imports were 9 Mt, down from 12 Mt in 1989. The difference was made up by increased shipments from domestic mines. Two mines, the Empire and Tilden mines, were shut down from August 1 to December 1, by a strike, but other operations compensated for the lost production. Cyprus Northshore Mining Corp. began shipping iron ore pellets from properties in Minnesota that Reserve Mining Company had closed in 1986. Production for 1990 was estimated at 2 Mt.

Brazil continued as the world's largest exporter and second largest producer of iron ore. Brazil's largest producer, Companhia Vale do Rio Doce, increased production at its biggest and newest mine at Carajas to 34 Mt/y. It is planning some $500 million in investments at a number of mines, spread over several years, to maintain total production at the current level. Brazil's second largest iron ore company, Minerações Brasileiras Reunidas SA, and Samarco Mineração SA are currently investing in expansions and new mines to increase their production capacities.

Australian iron ore production increased to a record 110 Mt in 1990 due to increased production at a number of major mines and the opening of the Channar deposit in Western Australia. Exports, however, fell by 6 Mt since about 8 Mt of exports in 1989 had been based on stockpiled ore belonging to Hamersley Iron Pty., Ltd. The stockpile was virtually exhausted by the end of 1989.

One of the three largest producers of iron ore in the world, the People's Republic of China, has become a significant importer of ore in recent years in its quest for material suitable for blending with its domestic ore. It has an equity stake in the new iron ore mine at Channar in Australia and a long-term purchase commitment with Brazil. A delegation from China's Ministry of Metallurgical Industries visited Canada in September 1990 to discuss possible purchase commitments or a joint venture arrangement to develop or expand Canadian iron ore mines and concentrating plants. The delegation asked for follow-up information on two greenfield projects, Hollinger North Shore Exploration Inc. at Schefferville, and Ungava Iron Ores Ltd. at Ungava Bay.

In 1989, a number of countries, including Canada, cooperated in setting up a trust fund under the United Nations Conference on Trade and Development (UNCTAD) to retain an economist until the end of 1990 to collect and publish statistics on iron ore for all the major producing, consuming and trading countries. The arrangement was successful in allowing the economist to produce two reports during the year. Sufficient funds were collected to continue the arrangement until April 1991 and to publish one more report.

UNCTAD DIALOGUE ON IRON ORE

The Intergovernmental Group of Experts on Iron Ore (IGE), under UNCTAD, met in Geneva from October 22-24, 1990. There was representation from 37 countries and 9 international agencies. Some 25 industry advisors also participated in the meeting. The group worked toward improving market transparency through improved quality and comparability of published statistics as well as dialogue among producing and consuming countries on supply/demand issues and related problems. Previously released statistics were updated at the meeting and a market review prepared by the secretariat was discussed and parts were amended.

Iron Ore

The IGE asked the secretariat to prepare, early in 1991, preliminary full-year 1990 statistics and, before the next meeting in October 1991, to survey countries for six-month 1991 data and estimates for the full year.

PRICES

Iron ore exporters were able to negotiate significant price increases for deliveries in 1990. In Europe, the price increased by an average 18% for fines and concentrates used as sinter feed, and 9% for pellets. The Japanese steel mills were consistent in settling with all their suppliers at increases of 15.96% for fines, concentrates and lump ore, and at 9.02% for pellets.

The price difference between pellets and fines decreased only marginally and remained close to 21¢ on the basis of US¢/Fe unit.[1]

OUTLOOK

World iron ore production in 1991 is forecasted to increase due mainly to developments in Australia and Brazil. In Canada, there is little scope for growth in the near term since production capacity was reduced by the closure of the two mines in Ontario. However, iron ore production in 1991 may surpass the 1990 level, since QCM is expected to operate at close to capacity through the year.

The long-term outlook for iron ore sales is for growth at about 1%/y, in line with forecasted growth in the world steel output. However, iron ore market growth may exceed growth in steel production due to a tightening in the market for high-quality ferrous scrap. The factors driving this trend will continue to be the growing demand for scrap by electric furnaces, production of less self-generated scrap as continuous casting use increases, and a falling off in the quality of obsolete scrap as more alloyed and galvanized steel is recycled. The potential long-term strength of the scrap market will make iron ore more competitive as a source of iron units for the steelmakers.

Price negotiations for the 1991 calendar year in Europe and the 1991/92 fiscal year in Japan were not resolved by year-end. In view of the continuing problems in Liberia, and the rather tight supply of iron ore at the end of 1990, exporters are expecting another significant price increase that will provide capital for expansions and new projects. On the other hand, steel producers are forecasting a downturn in steel production in 1991 and, with lower requirements, they are hoping to hold iron ore prices close to current levels.

Note: Information contained in this review was current as of mid-January 1991.

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1 Price is reported in cents, U.S. currency, for each percentage point of iron in a tonne of ore; e.g., at 30¢/Fe unit, ore grading 65% iron would bear a price of 65 x 30¢ = US$19.50/t.

TABLE 1. CANADA, IRON ORE PRODUCTION AND TRADE, 1989 AND 1990

Item No.		1989		1990p	
		(tonnes)[1]	($000)	(tonnes)[1]	($000)
Production (mine shipments)					
	Newfoundland	20 662 293	722 527	19 955 290	695 824
	Quebec	15 362 984	x	15 300 000	x
	Ontario	3 346 626	x	1 084 487	x
	British Columbia	73 144	2 616	102 953	3 620
	Total[2]	39 445 047	1 369 193	36 442 730	1 312 245
Imports				(Jan.-Sept.)	
2601.11	Iron ore concentrates, non-agglomerated				
	United States	19 781	618	16 323	545
	Total	19 781	618	16 323	545
2601.12	Iron ore, agglomerated				
	United States	4 975 905	219 214	3 166 586	132 793
	Brazil	372 192	13 677	278 955	10 817
	Total	5 348 098	232 891	3 445 542	143 611
Exports					
2601.11	Iron ore concentrates, non-agglomerated				
	United States	577 193	14 565	2 158 076	90 377
	West Germany	2 884 723	58 309	1 597 339	37 988
	United Kingdom	1 539 537	31 118	1 276 578	26 102
	France	1 510 881	27 123	1 151 887	24 669
	Japan	2 220 628	35 170	1 461 920	22 987
	Netherlands	1 842 934	32 990	1 185 161	19 550
	Italy	482 658	10 662	352 255	7 854
	South Korea	548 260	8 595	379 651	6 522
	Philippines	–	–	267 498	4 146
	Sweden	183 133	3 744	151 210	3 350
	Belgium	455 215	8 000	143 625	3 161
	Yugoslavia	109 976	1 814	180 845	2 983
	Portugal	167 850	3 281	88 752	2 165
	Spain	181 848	3 484	93 124	2 078
	Australia	25 004	989	–	–
	Brazil	55 000	2 104	–	–
	Austria	112 688	1 859	–	–
	Total	12 897 528	243 817	10 487 921	253 898
2601.12	Iron ore, agglomerated				
	United States	9 062 673	414 840	4 144 865	178 552
	United Kingdom	3 299 686	113 037	1 447 043	52 596
	West Germany	1 034 137	35 547	664 430	25 564
	Netherlands	854 880	27 505	567 824	18 173
	Italy	728 543	34 878	379 877	17 240
	Spain	500 801	17 830	296 760	13 063
	France	821 723	25 786	326 103	11 984
	Belgium	423 097	14 770	207 925	6 653
	Portugal	256 467	9 454	135 039	5 244
	Venezuela	48	2	34	3
	Japan	250 386	2 754	–	–
	Yugoslavia	42 968	1 374	–	–
	Austria	49 406	1 580	–	–
	Total	17 324 815	699 365	8 169 900	329 077
Total exports all classes					
United States		9 639 866	425 502	6 302 941	268 889
United Kingdom		4 839 223	140 160	2 723 621	78 698
West Germany		3 918 860	42 070	2 261 769	63 552
Netherlands		2 697 814	48 948	1 752 985	37 723
France		2 332 604	70 717	1 477 990	36 653
Italy		1 211 201	62 675	732 132	25 094
Japan		2 471 014	33 872	1 461 920	22 987
Spain		682 649	27 600	389 884	15 141
Belgium		878 312	14 770	351 550	9 814
Portugal		424 317	18 514	223 791	7 409
South Korea		548 260	–	379 651	6 522
Philippines		–	–	267 498	4 146
Sweden		183 133	8 000	151 210	3 350
Yugoslavia		152 944	4 858	180 845	2 983
Venezuela		48	2 754	34	3
Australia		25 004	–	–	–
Brazil		55 000	–	–	–
Austria		162 094	669 309	–	–
Total		30 222 343	943 182	18 657 821	582 975
Consumption of iron ore at Canadian iron and steel plants		15 451 121	. .	11 556 153p	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada; American Iron Ore Association.
[1] Dry tonnes for production (shipments) by province; natural weight for imports and exports. [2] Total iron ore shipments include shipments of by-product iron ore.
p Preliminary; – Nil; x Confidential; . . Not available.
Note: Totals may not add due to rounding.

TABLE 2. CANADA, IRON ORE PRODUCTION (SHIPMENTS), 1987–90

Company and Location	Ore Mined	Product Shipped	1987	1988	1989	1990p
				(000 tonnes, natural or wet)		
Adams Mine Kirkland Lake, Ont.	Magnetite	Fluxed pellets	1 036	1 017	1 078	244
Algoma Ore Division, The Algoma Steel Corporation, Limited Wawa, Ont.	Siderite	Sinter	1 118	1 066	1 243	769
Iron Ore Company of Canada Schefferville, Que.	Hematite, goethite and limonite	Direct shipping	1 173	788	177	38
Carol Lake, Lab.	Specular hematite and magnetite	Concentrate	2 958	4 127	5 130	5 396
		Acid pellets	7 920	7 899	8 106	6 241
		Fluxed pellets	1 215	1 954	1 732	2 432
		Broken pellets	–	–	–	147
Quebec Cartier Mining Company Mount Wright, Que.	Specular hematite	Concentrate	8 155	8 506	7 734	7 500
		Acid pellets	7 453	7 749	6 031	4 800
		Fluxed pellets	744	582	2 033	3 000
Sherman Mine Temagami, Ont.	Magnetite	Fluxed pellets	1 090	865	1 023	281
Wabush Mines Wabush, Lab. and Pointe-Noire, Que.	Specular hematite and magnetite	Acid pellets	5 478	6 035	5 953	4000
		Fluxed pellets				1 460
British Columbia Producers	Magnetite	Concentrate	61	59	73	103
Other Ontario	Magnetite	Concentrate	2	2	1	–
Total			38 403	40 649	40 314	36 411

p Preliminary; – Nil.

TABLE 3. RECEIPTS AND CONSUMPTION OF IRON ORE AT CANADIAN IRON AND STEEL PLANTS, AND INVENTORIES, 1989 AND 1990

	1989	Jan.-Oct. 1990
	(000 tonnes)	
Receipts imported	5 684	2 652
Receipts from domestic sources	9 892	5 970
Total receipts at iron and steel plants	15 576	8 622
Consumption of iron ore	15 451	9 288
Inventory at docks, plants, mines and furnace yards, December 31	8 178	8 276
Inventory change	689	97

Source: American Iron Ore Association.

TABLE 4. WORLD IRON ORE PRODUCTION, 1987–89

	1987	1988	1989
		(000 tonnes)	
U.S.S.R.	251 000	249 700	241 000
Brazil	134 500	145 040	153 740
Australia	105 310	99 450	108 680
People's Republic of China	157 000	154 380	162 000
India	48 420	49 420	49 230
United States	47 570	56 440	59 030
Canada	38 403	40 649	40 314
Republic of South Africa	22 000	24 680	29 960
Liberia	13 810	12 810	12 300
Sweden	19 640	20 310	21 760
Venezuela	17 200	18 220	19 030
Other countries	87 900	89 990	86 250
Total	942 753	961 089	983 294

Source: Association of Iron Ore Exporting Countries (APEF) and the Trust Fund Project on Iron Ore Information.

TABLE 5. CANADIAN CONSUMPTION OF IRON-BEARING MATERIALS BY INTEGRATED[1] IRON AND STEEL PRODUCERS, 1989

	Consumed In				
			Iron and Steel Furnaces		
Material Consumed	Sinter Plants at Steel Mill	Direct Reduction Plants	Production of Pig Iron	Steel Furnaces	Total in Furnaces
			(tonnes)		
Iron Ore					
Crude and concentrate	285 168	134 194	8 139	–	8 139
Pellets	59 318	900 202	12 670 615	8 898	12 679 513
Sinter	49 806	–	1 184 144	–	1 184 144
Sinter produced at steel plant	–	–	665 155	–	665 155
Direct reduced iron	–	–	–	698 985	698 985
Other iron-bearing materials including flue dust, mill scale, cinder, slag, etc.	328 508	–	318 548	79 700	398 248
Total	722 800	1 034 397	14 846 601	787 584	15 634 185

Source: Company data.
[1] Dofasco Inc.; Sidbec-Dosco Inc.; Sydney Steel Corporation; The Algoma Steel Corporation, Limited; Stelco Inc.
– Nil.

TABLE 6. NORTH AMERICAN PRICES OF SELECTED ORES AT YEAR-END, 1975, 1980, 1985, 1989 AND 1990

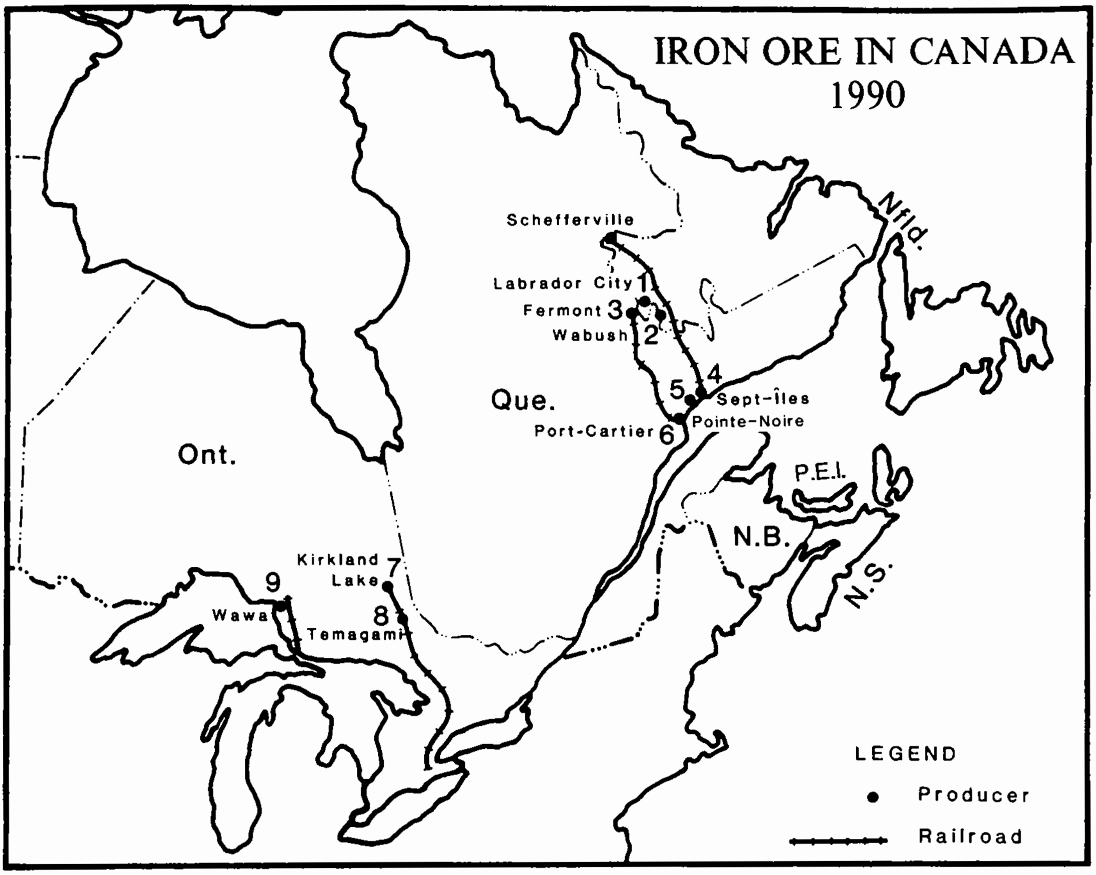
	1975	1980	1985	1989	1990
			(US$/t)		
Mesabi non-bessemer[1]	17.92	27.61	29.557-31.03	29.557-31.03	29.557-31.03
Old range non-bessemer and manganiferous[1]	18.16	27.85	32.264	32.264	32.264
Pellets			(US¢/t iron unit)[2]		
Lake Erie base price[3]	45.7	71.36	85.53	71.31-73.47	71.31-73.47
USX Corporation[4]	–	–	–	36.756	36.756
Upper Lakes[5]	–	–	58.46	46.10-58.46	46.10-58.46
Wabush[6]	–	62.5	62.5	62.5	62.5
Mineral Services Inc.	–	–	57.09	57.09	57.09
			(US$/t)		
Direct reduced iron	–	–	115-135	115-135	115-135

Sources: Skillings Mining Review; Iron Age.
[1] US$/t, 51.5% of iron natural, at rail of vessel, lower lake ports. [2] One iron unit equals one percentage point of iron content in a tonne of ore; an ore containing 60% iron, therefore, has 60 iron units. [3] Cleveland–Cliffs Inc., M.A. Hanna Company, Oglebay Norton Company at rail of vessel lower lake port. [4] At mine. [5] Pickands Mather & Co. and Inland Steel Mining Co. in hold of vessel upper lake port. [6] F.o.b. Pointe-Noire.
– Nil.

TABLE 7. SELECTED PRICES OF IRON ORE BOUND FOR JAPAN AND EUROPE, 1984–90

Ore	Market	Source	1984	1985	1986	1987	1988	1989	1990
			(US¢/Fe Unit Dmt, f.o.b.)						
Fines (including concentrate)	Europe	CVRD	26.15	26.56	26.26	24.50	23.50	26.56	30.80
		Iscor	20.60	23.50	22.70	. .	20.55	20.70	24.75
		Kiruna	27.70	28.50	27.90	25.25	26.00	30.00	35.70
		Carol Lake	26.80	26.80	26.50	24.03	23.685	27.00	31.77
		Mt. Wright	26.80	26.80	26.50	24.03	23.685	27.00	31.77
	Japan	CVRD	23.89	24.26	23.29	21.89	20.90	23.61	27.38
		Iscor	23.51	21.91	20.23	18.85	17.75	20.05	23.25
		Hamersley	26.25	26.62	25.56	24.28	23.31	26.34	30.54
		Carol Lake	23.00	23.00	22.09	20.93	19.93	22.52	26.11
Lump	Europe	Iscor	24.00	29.00	26.70	23.50	22.34	. .	. .
		Hamersley[1]	36.15	38.48	36.20	33.15	36.00	43.00	49.97
	Japan	CVRD	23.89	24.26	23.29	21.89	21.89	25.20	29.22
		Iscor	26.76	25.45	23.53	21.99	21.86	25.64	29.73
		Hamersley	30.38	31.05	29.81	28.33	27.88	33.23	38.53
Pellets	Europe	CVRD	36.00	36.00	35.60	36.70	40.35	47.33	51.60
		Kiruna	38.60	38.60	38.15	41.15	46.35	53.50	59.00
		Carol Lake	. .	36.50	36.50	37.15	39.95	48.35	52.58
		Mt. Wright	. .	36.50	36.50	37.15	39.95	48.35	52.58
	Japan	CVRD (Nibrasco)	36.72	35.68	34.73	35.04	37.93	44.49	48.50
		Savage River	37.70	36.52	35.45	34.17	35.89	42.10	34.17

Source: The Tex Report.
[1] C.i.f. Rotterdam.
. . Not available; Dmt Dry metric tonne; f.o.b. Free on board.



PRODUCERS
(numbers refer to numbers on map above)

1. Iron Ore Company of Canada, Carol Division (mine/concentrator/pellet plant)
2. Wabush Mines (mine/concentrator)
3. Quebec Cartier Mining Company (mine/concentrator)
4. Iron Ore Company of Canada (port)
5. Wabush Mines (pellet plant/port)
6. Quebec Cartier Mining Company (pellet plant/port)
7. Dofasco Inc., Adams mine (mine/concentrator/pellet plant)
8. Dofasco Inc., Sherman mine (mine/concentrator/pellet plant)
9. Algoma Ore division of The Algoma Steel Corporation, Limited (mine/concentrator/sinter plant)

Lead

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Western World lead consumption was estimated at 4.393 million tonnes (Mt) in 1990, a decrease of 0.8% from 1989. Metal production, including both primary and secondary material, decreased by approximately 2.1% in 1990 to 4.319 Mt. Total metal stocks at year-end were estimated at 451 000 t, an increase of 13% from the level reported a year earlier.

Lead prices on the London Metal Exchange (LME) rose substantially in 1990, averaging US37¢/lb. In 1989, the average price was 31¢.

CANADIAN DEVELOPMENTS

Canadian mine production of lead declined by 17% in 1990 to 224 000 t, compared with 269 000 t in 1989. Refined metal output fell to 195 000 t from 242 845 t. The reductions of annual output were attributed to labour disputes, production difficulties or temporary mine suspensions.

In January, Westminer Canada Limited, a subsidiary of Western Mining Corporation Holdings Limited of Australia, re-opened the Gays River mine in Nova Scotia at a production rate of 10 000 t/y of lead in concentrate.

In central Newfoundland, Noranda Exploration Company, Limited (60%) and BP Resources Canada Limited (40%) continued to explore for additional reserves at their Duck Pond polymetallic massive sulphide deposit. Drill indicated reserves stand at 4.3 Mt grading 1.05% lead, 6.73% zinc, 3.58% copper, 68.31 g/t silver and 1.0 g/t gold. Although no new significant finds were announced at Duck Pond, BP did intersect a new massive lead-zinc zone at Daniels Pond located 20 km west of Duck Pond.

Production in New Brunswick was estimated to have dropped by 20% from 1989, due largely to technical problems and labour disputes at Brunswick Mining and Smelting Corporation Limited's Bathurst operations.

At the Brunswick No. 12 mine, output continued to be affected by a cutback in hoisting capacity resulting from work to deepen the No. 3 shaft. This caused a reduction in availability of concentrate feed and forced the closure of the Belledune smelter, beginning February 26, for two weeks.

On July 1, 1100 mine workers at the Brunswick No. 12 mine went on strike, followed by the 470 employees at the Belledune smelter. During the strike, which continued through the latter half of 1990, output was maintained at 25% of capacity with management personnel. The principal issues for the strike included higher wages and protection against contracting out. In December, the company retracted its latest offer after it was rejected by union members, and announced that production would continue at 25% of capacity with salaried personnel until March 1991. The mine normally produces about 64 000 t/y of lead in lead concentrate and 13 000 t/y of lead in bulk concentrate.

The Caribou mine near Bathurst re-opened in January, some six months after operations had been suspended due to production difficulties. Later in the year, Breakwater Resources Ltd. obtained ownership of the mine through the acquisition of Bathurst Base Metals Ltd. Output was increased to 3000 t/d, and the company commenced a $30 million development program which was to include the sinking of a 471-m production shaft. Unfortunately, a $15 million expansion program was also required for the mill to handle the increased output, and the company decided to suspend production in October rather than assume the extra debt at a time when base-metal prices were forecasted to drop.

During late 1990, Stratabound Minerals Corp. treated a 10 900 t bulk sample from the

Captain North Extension deposit through the Heath Steele mine's mill near Bathurst.

In Quebec, Breakwater Resources Ltd. commenced production at its 175 000 t/y Estrades deposit during the latter half of 1990. Ore reserves are estimated at 0.94 Mt grading 0.9% lead and 10.7% zinc, with a mine life of about five years. Ore will be milled at Noranda Inc.'s Mattagami mill and the company expects to produce about 1000 t/y of lead in concentrate.

Exploration continued at Cameco Corporation's (67%) and Trimin Resources Inc.'s (33%) Hanson Lake Property in Saskatchewan. Preliminary reserves for the main ore zone are estimated at 10.8 Mt grading 0.42% lead and 5.8% zinc. Also in Saskatchewan, Trimin Resources Inc. continued to drill its McIlvenna Bay deposit and was in the process of conducting a feasibility study of the polymetallic massive sulphide body which grades less than 1% lead.

British Columbia reported the greatest drop in Canadian mine production, with an estimated 70% decrease from 1989. The reduction was largely due to the suspension of operations at Cominco Ltd.'s Sullivan mine in Kimberley on January 31, 1990. The mine reopened in November after labour contract settlements were reached with United Steelworkers of America members at both its Kimberley and Trail operations and after the completion of an $11 million development program. The labour contract was reported to contain a 19% wage increase over 27 months as well as a new Sullivan mine bonus plan. Mine life is estimated at 10 years with measured and indicated ore reserves of 21.1 Mt grading 4.5% lead, 7.2% zinc and 0.8 oz/short ton silver. Sullivan produced about 53 000 t of lead in concentrate in 1989 and Trail produced 103 500 t of refined lead.

Problems at Cominco's new 160 000 t/y QSL smelter and related operations at Trail, British Columbia continued throughout 1990. In December, the company announced that it had halted extensive modifications of the plant and postponed the March 1991 start-up pending the outcome of tests by supplier Lurgi GmbH at Metallgesellschaft AG's new QSL plant in Stolberg, Germany. The old 136 000 t/y conventional sinter and blast furnace smelter was operating at 50% capacity until September when it increased output to 80% after repairs to the lead sinter plant were completed.

Minnova Inc.'s and Rea Gold Corporation's Samatosum mine near Kamloops, British Columbia, completed its first full year of operation and produced about 1150 t of lead in 1990. Exploration commenced to prove up underground reserves and extend the mine's life through 1993. Drilling, from a 200-m adit, is planned for completion during early 1991 with a development decision expected by mid-year.

In northwestern British Columbia, Cominco Ltd. (60%) and Redfern Resources Ltd. (40%) reported significant successes from underground drilling at their Tulsequah Chief property. A total of five separate polymetallic lenses have been discovered.

Curragh Resources Inc. (85%) and Asturiana de Zinc S.A. (ADZ) (15%) carried out bulk sampling and underground drilling on the Cirque deposit in northeastern British Columbia. The deposit could be brought into production during the latter half of 1992. Capital development costs are estimated at $130 million, with a production rate of 28 000 t/y of lead in concentrate when in full operation.

In the Yukon, Curragh Resources Inc. continued to develop its Vangorda and Grum deposits for production in late 1991. Combined reserves are estimated at 30 Mt grading 9% combined lead and zinc, 50-80 g/t silver and 1 g/t gold. Ore produced from the open-pit mines will replace depleting reserves at the company's nearby Faro mine.

In October, Curragh Resources Inc. (80%) and Hillsborough Resources Limited (20%) started construction of the mill and tailings dam at their Mount Hundere lead-zinc deposit north of Watson Lake. The mine is expected to come on stream during 1991 and produce 30 000 t/y of lead in concentrate. Open-pit and underground reserves total about 5.1 Mt grading 4.7% lead, 12.6% zinc and 65 g/t silver.

WORLD DEVELOPMENTS

The International Lead and Zinc Study Group (ILZSG) indicated that non-socialist world lead mine production increased to 2.338 Mt in 1990 from 2.254 Mt in 1989. The United States and Australia recorded the largest increases in output while Canada posted the largest production decline for the second year in a row.

In Australia, Pasminco Ltd. announced that it will earn a 40% interest in CRA Limited's Dugald River project in Queensland, by spending A$25 million on further exploration and a feasibility study. Reserves are estimated at 20 Mt grading 2% lead, 14.5% zinc and 48 g/t silver. Pasminco also intends to maintain lead production at about 200 000 t/y at the Port Pirie smelter now that an environmental and economic improvement plan is being implemented.

Also in Queensland, the Thalanga mine, jointly owned by Pancontinental Mining Ltd. (50%), Outokumpu Oy (25%) and Agip Australia Pty. Ltd. (25%), opened on May 29, 1990, and is expected to produce up to 13 000 t/y of lead in concentrate. Mine life is estimated at 10 years with mineable reserves totalling 5.2 Mt grading 3.1% lead, 10.2% zinc, 2.4% copper, 82 g/t silver and 0.56 g/t gold. The same three partners are conducting a feasibility study on their jointly owned Lady Loretta deposit near Mount Isa, which is estimated to have the capacity to produce 20 000 t/y of lead in concentrate from mineable reserves of 6.5 Mt grading 9.2% lead, 18.8% zinc and 138 g/t silver.

Mount Isa Mines Ltd. (MIM) officially opened the Hilton mine on May 15, 1990. The mine is located 20 km north of Mount Isa and can process 750 000 t/y of ore. Proven reserves are 8 Mt averaging 6.5% lead, 8.2% zinc and 147 g/t silver, with indicated reserves of about 100 Mt. Production from the integrated Mount Isa and Hilton operations will raise annual lead in concentrate output from 180 000 t/y to 200 000 t/y. The existing smelter is scheduled to reduce output to 140 000 t/y as the new 60 000 t/y Sirosmelt lead smelter comes on stream.

MIM also continued a feasibility evaluation of the MacArthur River deposit in the Northern Territory, where direct smelting technology is expected to overcome processing problems resulting from the fine-grained ore. Reserves are estimated at 227 Mt grading 4.1% lead, 9.2% zinc and 41 g/t silver.

CRA Limited discovered significant mineralization at its Century prospect, 250 km northwest of Mount Isa. The new zone is about 30-40 m wide and averages 1% lead, 7% zinc and 30 g/t silver.

In Tasmania, Aberfoyle Limited announced that the Hellyer mine, which opened in March 1989, was operating near design capacity of 1 Mt/y of ore during 1990.

The Bulgarian government announced plans to close the 30-year-old Dimiter Blagoev lead-zinc plant in 1991 due to pollution problems. The plant produced 65 000 t of lead in 1989. It was reported that a new plant is under consideration.

In Honduras, Breakwater Resources Ltd. purchased the El Mochito mine from American Pacific Mining Company, Inc. American Pacific re-opened the mine in 1987. Breakwater plans to expand the plant by 3000 t/y of lead in concentrate to bring the capacity to 13 000 t/y.

In Italy, Nuova Samim, SpA restarted its Porto Vesme Kivcet smelter in June 1990. The new plant had been closed since August 1989 due to a technical failure which damaged a boiler and fusion vat. Repairs included an expansion program which increased capacity by 16 000 t/y to 100 000 t/y of refined lead.

Conroy Petroleum and Natural Resources PLC completed a positive feasibility study on the Galmoy deposit in Ireland. The operation is expected to come on stream in 1992 and produce 2000 t/y of lead in concentrate from 650 000 t of ore.

In India, Hindustan Zinc Ltd.'s new ISF plant in the Rajasthan region is expected to commence production in June 1991 and reach full capacity of 35 000 t/y refined lead by 1993. Forty percent of feed for the smelter is expected to be obtained from the company's mines.

Lead

Sumitomo Metal Mining Co., Ltd. expanded capacity at its electrolytic refinery in Harima, Japan by 4000 t/y to 30 000 t/y refined lead.

MIM, Nippon Mining Company Limited and Mitsui Mining & Smelting Co. Ltd. are considering the construction of an ISF smelter in Hokkaido, Japan, with a capacity to produce 60 000 t/y of lead. Japan currently has two ISF smelters at Harima and Hachoche. It is believed MIM's MacArthur River deposit would provide a bulk lead-zinc concentrate as feed for the new smelter.

In Peru, Cia. Minera San Ignacio de Morococha, S.A.'s San Vicente mine resumed production in November after the settlement of a one-month strike. The mine produced 3930 t of lead in concentrate in 1989. Also in Peru, Centromin Perú S.A.'s Casapalca mine and 2970 t/d mill resumed operations in July after guerilla sabotage halted production in June. The company also lost three days of output in October from its 93 000 t/y La Oroya smelter when workers went on strike over wage disputes. In 1989, La Oroya produced 60 000 t of lead and Casapalca provided 8450 t of lead in concentrate.

In the United States, Cominco Ltd.'s Red Dog mine in Alaska officially opened in August. The first shipment of concentrates destined for Vancouver and Antwerp, Belgium, was shipped in July from the Chukchi Sea port site. The mine experienced some start-up problems in 1990 as one of the concentrator's grinding circuits required realignment and oxidized ores near the surface hampered lead recovery. The mine's life is estimated to be in excess of 50 years with reserves of 77 Mt grading 5.0% lead, 17.1% zinc and 82.3 g/t silver. The mine is expected to produce 67 000 t/y of lead in lead concentrate and 7000 t/y of lead in bulk concentrate.

Equinox Resources Ltd. completed a US$1.05 million purchase of the Van Stone deposit in Washington State and plans to reopen the mine, which closed during the early 1970s, in early 1991. Production is expected to total 2000 t/y of lead in concentrate.

Resource Finance increased ore reserves at the Pend Oreille project in Washington State by 25% to 3.4 Mt grading 1.6% lead and 8.8% zinc.

ASARCO Incorporated decided not to purchase The Doe Run Company from Fluor Corporation. Fluor had obtained 100% ownership in the company after purchasing Homestake Mining Company's 42.5% share earlier in the year.

Bunker Hill Mining Company (U.S.) Inc.'s Kellogg mine in Idaho, which reopened in 1988, was expanded by 3000 t/y to 9000 t/y lead in concentrate. The expansion was undertaken to reduce operating costs.

In Yugoslavia, technical problems forced Sour Rudarsko-Metalursko Hemijski Kombinat Olovai Cinka (Trepca Works) to temporarily suspend production for a few weeks at its aging 90 000 t/y lead smelter in Kosovo Province. The company expected to produce 80 000 t of lead in 1990.

RECYCLING

Environmental and health concerns continue to support moves toward increased recycling. Although statistics are not yet available, it is expected that Western World secondary lead output will have surpassed primary production in 1990.

Various governments are pressing for increased recycling of spent lead acid batteries. Some 22 U.S. states have adopted the Battery Council Institute's recycling model. The plan prohibits the disposal of used batteries in landfills or incinerators and requires wholesalers and retailers to take back old batteries.

New York State introduced legislation controlling storage and recycling of used batteries including a US$5 return incentive payment. A deposit, collected by retailers when selling new batteries, is refundable with the return of a used battery.

In Canada, the British Columbia government introduced a "green tax" of C$5 on automobile batteries and tires to support recycling. Cominco has submitted a plan to the province on a system to collect, process and recycle the batteries.

As the rate of recycling continues to grow, so will the competitiveness to source feed material. This, in part, explains why a number of secondary producers are launching recycling programs with battery producers and retailers to form an integrated production, collection and recycling chain based on the cradle-to-grave concept.

In Canada, Canadian Tire Corporation, Limited offers a refund to consumers for spent lead acid batteries, and receives a credit from Battronics Inc. who in turn transports the batteries to Nova Pb. Inc. or Tonolli Canada Ltd. for recycling.

Similar partnerships have materialized in the United States such as: Exide-General Corp. and K Mart Corporation; GNB Inc., Johnson Controls, Inc. and Wal-Mart Stores Inc.; and RSR Corporation, Delco Remy and Western Auto Supply Co. Integrated secondary operators and battery producers like East Penn Manufacturing Co. Inc. and Alco Pacific Inc. work with a variety of large and small retailers.

Tonolli Canada Ltd. completed phase II of its new CX battery processing facility in January 1991. The new addition to the Mississauga, Ontario plant can process 22.6 t of scrap batteries per hour and produce both sodium sulphate for fertilizer and lead carbonate which can be processed by the existing smelter.

Exide-General Corp. closed its 20 000 t/y Dixie lead smelter in Texas at the end of 1990, after the Dallas city council ruled it was a health hazard to the neighbouring community. Exide's Muncie, Indiana smelter, which reopened in 1989, is reported to be operating at two thirds of its 50 000 t/y rated capacity.

The Doe Run Company's new 54 000 t/y CX secondary plant in Buick, Missouri is expected to be on stream in mid-1991. The company's 140 000 t/y primary lead smelter in Buick closed in May 1986.

The Tenessee State Regulatory Commission ruled that slag from Refined Metals Corp.'s 30 000 t/y lead smelter is hazardous waste and cannot be sent to low-cost, non-hazardous landfills. The Environmental Protection Agency fined the company US$355 000 for mishandling lead waste.

RSR Corporation announced modernization and expansion plans at its plants in Indianapolis, Indiana; City of Industry, California; and Walkill, New York. It was reported that the company may consider the introduction of electrowinning technology in the future.

Production of refined lead was temporarily reduced at Master Metals Inc.'s 10 000 t/y plant in Cleveland due to excessive levels of lead in the occupational environment. The Occupational Safety and Health Authority (OSHA) had found that plant workers had been exposed to twice the permissible limit of 50 micrograms of lead per cubic metre of air.

The Erandio secondary lead plant in Bilbao, Spain was ordered to close and modernize its anti-pollution equipment after lead emissions were found to be in excess of permitted levels.

In Austria, BBU Metall GmbH increased capacity from 8000 t/y to 32 000 t/y of refined lead at the Arnoldstein secondary plant by tripling battery-breaking capacity with the installation of a CX battery-breaking system.

CONSUMPTION AND USES

On the basis of preliminary statistics from the International Lead and Zinc Study Group (ILZSG), lead consumption in 1990 fell to 4393 Mt, the first decline in eight years. Consumption in 1989 was 4427 Mt.

Lead is a dense, bluish-white metal whose physical and chemical properties find application in a variety of uses in the manufacturing, construction and chemical industries.

Lead acid batteries constitute the largest market for lead, representing over 60% of total usage in the non-socialist world. In the United States, battery manufacturing constitutes almost 80% of total lead demand. The largest single battery market, representing about 80% of lead used in the industry, is the automotive sector. The average automobile battery contains about 10 kg of lead. A potential growth area for the lead acid battery is in energy storage facilities for utilities. These are designed to supplement existing generators during the peak morning and evening hours without drawing on other sources or building new power plants.

Electric cars may provide the greatest growth in demand for lead acid batteries and lead in the future. In September, California approved tough automobile emission standards which will require 2% of new cars sold in the state, estimated at about 40 000 vehicles, to be electric powered by 1998, with the figure increasing to 10% by the year 2003. However, this potentially new market for lead will also increase the incentive to develop a longer lasting, more efficient and cost-competitive substitute for the lead acid battery.

In this regard, Isuzu Motors Ltd. and Fuji Electrochemical Co., Ltd. expect to market, in two years, a new revolutionary battery made of activated carbon and diluted sulphuric acid that recharges faster and produces more power than conventional batteries. Also competing are Kansai Electric Power Co., Inc. and Japan Storage Battery Co., Ltd., who are developing a new nickel-zinc battery. Due on the market in 1992, the nickel-zinc battery will reportedly provide double the mileage of fuel batteries in current use, with an expected price of 5-10 times more than the lead acid battery.

The use of lead in chemicals and compounds constitutes the second largest use of the metal. The principal uses are in PVC stabilizers, which prevent degradation during processing or from ultraviolet radiation; colour pigments; and the manufacture of glass, including crystal, light bulbs, insulators and television/computer screens. While lead is still used for some specific paint applications, its general use has declined significantly due to the potential risk involved in exposure to weathered or flaked paint.

Until the mid-1970s, the production of lead additives for gasoline, including tetraethyl lead, constituted one of the most important markets for the metal. However, with the adoption of environmental regulations that have either prohibited or severely restricted the use of such additives, the demand for lead has declined dramatically. In Canada, lead was eliminated, through legislation, as an additive in gasoline at the end of 1990.

Lead is alloyed with tin in the production of solder used in both the electronics and plumbing sectors, although these markets have declined in recent years. In the plumbing industry, the demand for lead has fallen as a result of the increasing use of plastic piping. Where metal systems are still used for potable water systems, new regulations, which have been adopted or are being considered, will reduce the amount of lead in solder. In the electronics field, the move to miniaturization combined with the replacement of printed circuit boards have reduced the demand for lead.

Other important applications of both lead metal and lead alloys include: the production of free machining steel and brass, rolled sheet and strip for roofing applications, power and communication cable sheathing, especially for underground or submarine environments, and as a sound barrier material in construction.

Lead's high resistance to gamma radiation and X-rays makes it the preferred metal for shielding around X-ray equipment and at nuclear installations.

MARKETS, PRICES AND STOCKS

Lead prices on the London Metal Exchange (LME) averaged US37¢/lb in 1990, up substantially from 31¢ in 1989. The U.S. domestic lead price was also higher at 47¢, compared with 39¢ in 1989. Table 3 provides a detailed price history for both price quotations.

LME prices were strong during the first half of 1990 with a high of 60¢ recorded in mid-March. The elevated prices were attributed to a combination of strong demand and relatively low stock levels as a result of production problems and labour disputes at several lead smelters.

Prices declined rapidly during the last quarter, reaching a low of US27.4¢ in December, as production difficulties were resolved and stock levels rose.

The world is progressively heading towards global unification and so, it appears, are metal-pricing systems. In 1990, two of North America's largest lead producers, Cominco Ltd. and ASARCO, moved away from a producer pricing system for lead to an international pricing system based on the LME price plus a premium.

According to the latest statistics compiled by the ILZSG, lead stocks totalled 451 000 t at the end of 1990 compared with 400 000 t one year earlier. The stocks were held as follows: 195 000 t by producers, 195 000 t by consumers, 4000 t by merchants and 57 000 t by the LME.

INTERNATIONAL LEAD AND ZINC STUDY GROUP

The ILZSG was formed in 1959 to improve market information and to provide opportunities for regular intergovernmental consultations on lead and zinc markets. Particular attention is given to providing regular and frequent information on supply and demand and its probable development.

The Study Group is headquartered in London, England. Its membership includes most major lead- and zinc-producing and consuming countries. While it has an extensive information gathering and dissemination role, the Group has no market intervention powers. Member countries' delegations generally include industry representatives as advisors. Canada has been an active member since its inception and chaired the Group in 1988 and 1989.

HEALTH, SAFETY AND THE ENVIRONMENT

In response to concern over the health effects of exposure to lead and lead compounds, and to an overall increase of environmental awareness, governments in the industrialized nations have moved to restrict or ban the use of lead additives in gasoline. In Canada, leaded gasoline was phased out during 1990, prior to the December 31 legislated deadline banning its use. In addition to the potential benefits associated with the removal of lead emissions, the use of unleaded fuel permits the removal of hydrocarbons, carbon monoxide and nitrous oxides from automobile exhaust gases.

The International Lead-Zinc Research Organization (ILZRO) has established a Lead and Cancer Task Force to undertake a program of research into lead carcinogenicity and specifically to develop the critical information required for the establishment of acceptable exposure limits related to lead. The task force has developed a multi-project plan calling for expenditures on various scientific studies costing $2.76 million over three years.

In March 1989, the Basel Convention was signed by a number of countries, including Canada. This regulatory initiative, which will control the transboundary movement of hazardous waste, could adversely affect recycling, including lead acid batteries. Before ratifying the Basel Convention, countries are reviewing its potential implications on the recycling industry.

During 1990, there were a large number of regulatory initiatives with regard to lead.

In Canada, Environment Canada's proposed Secondary Lead Smelter Release Regulations, pursuant to the Canadian Environmental Protection Act (CEPA), appeared in the Canada Gazette Part 1 on September 15, 1990. These regulations, which govern the concentration of particulate lead matter emitted from a secondary smelter, will replace a 1989 interim order which was established as part of the process to roll over, into CEPA, similar regulations that existed under the Clean Air Act of 1976.

There were also a large number of proposed legislative changes affecting lead in the United States. In July, Representative (Rep.) T. Luken introduced the Lead Pollution Prevention Act of 1990, which proposed the banning of lead in many commercial and consumer items. Other bills proposed by Senators H. Reid, J. Lieberman and B. Bradley were designed to address the health effects of lead. These bills sought to ban certain uses of lead, to mandate 100% recycling of batteries and to discourage the use of virgin lead by applying a fee to its use in lead acid batteries. Meanwhile, it was reported that Rep. E. Torres attempted to build economic incentives into the recycling process through the Lead Battery Recycling Incentives Act with a view to increasing the rate of recycling to 95% over the next 10 years. The present rate of recycling in the United States is estimated to be about 80 to 85%. These bills failed to win approval but may resurface in 1991.

In September, the U.S. Environmental Protection Agency (EPA) released the final draft of its strategy paper "Reducing Lead Exposures." The goal is to reduce lead exposures to the fullest extent possible, with emphasis on reducing the risk to children. One of the actions considered is the Lead Pollution Prevention Program which, in part, intends to reduce or eliminate the use of lead in current and future products through market-based incentives and regulatory mechanisms.

In November, the Organization for Economic Co-operation and Development (OECD) distributed a draft analysis of possible strategies on lead risk reduction. This preliminary report, prepared by the U.S. EPA for the OECD, initiated substantial concern and response from both industry and government organizations in some member countries. Canada is actively involved in the review process and has provided the OECD secretariat with constructive comments concerning the document.

In December, the U.S. EPA established an industry-government advisory committee to develop rules that would increase battery recycling to 100%. An April 15, 1991 deadline has been set for completion of negotiations. Any consensus reached is to be used by the EPA as a basis for the proposed rule, which is expected to be released for public comment in October 1991.

OUTLOOK

The lead market during 1991 is predicted to be in surplus as a result of softening demand from weakening economies and growing supply as labour disputes are settled, production difficulties are resolved and new capacity comes on stream. Subsequently, the annual LME price for lead is expected to drop significantly and average in the 25¢-30¢/lb range.

In the medium to long term, it is expected that lead metal capacity will increase by more than 400 000 t/y as expansion programs are completed and new smelters come on stream. With demand expected to grow at a rate of only 1.5% throughout the 1990s, a serious oversupply is forecasted.

Environmental and health concerns are also expected to affect supply and demand in the future by increasing pressure to restrict or ban the development of new uses for lead in certain key market areas, promote substitution, and require increased recycling which will increase supply.

Note: Information contained in this review was current as of mid-January 1991.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada[1]	EEC MFN	Japan[1] MFN
2607.00.00	Lead ores and concentrates	Free	Free	Free	1.3¢/kg on Pb	Free	Free
78.01	Unwrought lead						
7801.10	Refined lead						
7801.10.10	Pig and block	Free	Free	Free	2.4% on Pb	3.5%	8 yen/kg
7801.10.90	Other	10.2%	Free	7.1%	2.4% on Pb	3.5%	8 yen/kg
7801.91	Containing by weight antimony as the principal other element						
7801.91.10	Lead antimony - tin alloys	6.8%	Free	4.7%	2.4% on Pb	3.5%	6.5%
7801.91.90	Other	10.2%	Free	7.1%	2.4% on Pb	3.5%	6.5%
7801.99	Other						
7801.99.10	For refining, containing 0.02% or more by weight of silver (bullion lead)	10.2%	Free	7.1%	2.8% on Pb	Free	6%
7801.99.91	Lead alloys	10.2%	Free	7.1%	2.4% on Pb	3.5%	6%
7801.99.99	Other	10.2%	Free	7.1%	2.4% on Pb	3.5%	8 yen/kg
7802.00.00	Lead waste and scrap	Free	Free	Free	Free	Free	3.2%
7804.20	Powders and flakes						
7804.20.10	Powders, not alloyed	4%	Free	2.8%	9%	2.2%	6.5%
7804.20.20	Alloyed powders; flakes	10.2%	Free	7.1%	9%	2.2%	6.5%

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States,1990; Official Journal of the European Communities, Vol. 33, No. L247, 1990, "Conventional" column; Customs Tariff Schedules of Japan, 1990.
[1] GATT rate is shown, lower tariff rates may apply circumstantially.

Lead

TABLE 1. CANADA, LEAD PRODUCTION AND TRADE, 1989 AND 1990, AND CONSUMPTION, 1988 AND 1989

Item No.		1989		1990p	
		(tonnes)	($000)	(tonnes)	($000)
Shipments					
	All forms[1]				
	Newfoundland	–	–	–	–
	Prince Edward Island	–	–	–	–
	Nova Scotia	–	–	x	x
	New Brunswick	65 180	67 787	51 278	61 380
	Quebec	–	–	–	–
	Ontario	1 074	1 117	x	x
	Manitoba	1 365	1 419	1 908	2 284
	Saskatchewan	–	–	–	–
	Alberta	–	–	–	–
	British Columbia	67 006	69 686	20 449	24 478
	Yukon	94 529	98 310	106 489	127 468
	Northwest Territories	39 734	41 323	38 091	45 595
	Total	268 887	279 643	224 000	268 128
	Mine output[2]	276 065	..	238 791	..
	Refined production				
	Primary	157 330	..	102 700	..
	Secondary	85 515	..	92 300	..
	Total	242 845	..	195 000	..
Exports				(Jan.-Sept.)	
2607.00	Lead ores and concentrates				
	United States	2 936	2 836	7 488	12 386
	West Germany	14 197	7 861	40 165	28 851
	Japan	56 517	17 637	51 311	23 794
	Italy	25 043	15 458	16 352	12 113
	Morocco	11 984	6 833	13 568	11 469
	Belgium	27 672	11 616	11 213	10 466
	Australia	2	4	9 233	6 383
	South Korea	11 192	6 665	–	–
	Other countries	5 633	2 736	18 382	15 114
	Total	155 175	71 652	167 713	120 582
2607.00.20	Lead content of lead ores and concentrates	155 052	59 775	166 272	102 077
2603.00	Copper ores and concentrates				
2603.00.20	Lead content	1 840	111	1 928	616
2608.00	Zinc ores and concentrates				
2608.00.20	Lead content	13 676	4 488	8 657	4 760
78.01	Unwrought lead				
7801.10	Refined lead				
	United States	36 142	34 169	28 777	28 955
	Italy	5 893	6 058	7 835	8 154
	Japan	5 560	4 666	6 470	6 230
	United Kingdom	16 844	11 196	8 971	4 903
	Netherlands	9 932	8 798	3 344	3 167
	Belgium	3 090	3 037	2 502	2 436
	South Korea	6 794	5 479	994	952
	People's Republic of China	19 242	14 751	–	–
	Other countries	6 905	5 707	4 617	4 247
	Total	110 404	93 869	63 511	59 053
7801.91	Containing by weight antimony as the principal other element	2 975	2 689	3 351	3 458
7801.99	Other	9 978	10 719	21 634	21 439
7802.00	Lead waste and scrap				
	United States	4 764	1 213	7 662	2 519
	United Kingdom	261	336	1 116	791
	Philippines	942	251	2 724	616
	Brazil	7 156	2 119	1 885	595
	Other countries	2 544	1 169	2 008	1 129
	Total	15 667	5 095	15 395	5 658
7803.00	Lead bars, rods, profiles and wire				
	United States	2 698	2 259	168	316
	Other countries	30	49	6	52
	Total	2 728	2 311	174	368

TABLE 1. (cont'd)

Item No.		1989		Jan.-Sept. 1990p	
		(tonnes)	($000)	(tonnes)	($000)
Exports (cont'd)					
78.04	Lead plates, sheets, strip and foil; lead powders and flakes				
	Plates, sheets, strip and foil				
7804.11	Sheets, strip and foil of a thickness (excluding any backing) <0.2 mm	60	107	206	310
7804.19	Other	6 360	2 691	273	68
7804.20	Powders and flakes	1 892	473	24	61
7805.00	Lead tubes, pipes and tube or pipe fittings (i.e. couplings, elbows, sleeves)	15	90	19	23
7806.00	Other articles of lead				
	United States	..	4 228	..	1 234
	Brazil	..	1 413	..	–
	India	..	649	..	–
	Other countries	..	770	..	99
	Total	..	7 069	..	1 335
Imports					
2607.00	Lead ores and concentrates				
	United States	17 167	18 180	17 321	19 040
	Peru	7 581	31 770	11 170	17 669
	Australia	3 408	3 266	8 055	6 251
	Honduras	3 018	5 239	–	–
	Italy	3 201	2 163	–	–
	Other countries	1	...	–	–
	Total	34 375	60 622	36 546	42 960
2607.00.00.20	Lead content of lead ores and concentrates	30 163	19 239	31 396	19 253
2608.00	Zinc ores and concentrates				
2608.00.00.20	Lead content	980	552	4 490	4 032
78.01	Unwrought lead				
7801.10	Refined lead				
7801.10.10.10	Pig and block	10 877	10 064	7 896	7 672
7801.10.90.00	Other	20	33	257	232
7801.91	Containing by weight antimony as the principal other element	186	258	204	228
7801.99	Other	49	52	466	496
7802.00	Lead waste and scrap				
	United States	26 208	11 070	26 375	9 571
	Poland	396	277	–	–
	Italy	35	510	–	–
	Other countries	21	8	42	35
	Total	26 660	11 867	26 417	9 606
7803.00	Lead bars, rods, profiles and wire				
	United States	143	208	82	115
	Other countries	29	42	77	148
	Total	172	254	159	266
78.04	Lead plates, sheets, strip and foil; lead powders and flakes				
	Plates, sheets, strip and foil				
7804.11	Sheets, strip and foil of a thickness (excluding any backing) < 0.2 mm	164	272	123	202
7804.19	Other	385	588	270	386
7804.20	Powders and flakes	90	126	153	215
7805.00	Lead tubes, pipe and tube or pipe fittings (i.e. couplings, elbows, sleeves)	12	29	13	34
7806.00	Other articles of lead				
	United States	..	2 652	..	1 858
	West Germany	..	63	..	60
	Japan	..	40	..	10
	Other countries	..	99	..	59
	Total	..	2 859	..	1 994

TABLE 1. (cont'd)

	1988			1989		
	Primary	Secondary[4]	Total	Primary	Secondary[4]	Total
			(tonnes)			
Consumption[3]						
Lead used for, or in the production of:						
Antimonial lead	x	22 641	x	x	x	x
Batteries and battery oxides	28 974	6 453	35 427	27 485	14 664	42 149
Chemical uses; white lead, red lead, litharge, tetraethyl lead, etc.	10 532	x	x	x	x	x
Copper alloys; brass, bronze, etc.	305	29	334	141	21	162
Lead alloys:						
solders	921	1 403	2 324	916	863	1 779
others (including babbitt, type metals, etc.)	x	x	4 614	412	3 568	3 980
Semi-finished products:						
pipe, sheet, traps, bends, blocks for caulking, ammunition, etc.	2 199	903	3 102	1 980	715	2 695
Other lead products	4 801	1 223	6 024	3 875	1 082	4 957
Total, all categories	50 500	37 541	88 041	44 045	43 245	87 290

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Production includes recoverable lead in ores and concentrates shipped, valued at the average Montreal price for the year. [2] Lead content of domestic ores and concentrates exported. [3] Available data, as reported by consumers. [4] Includes all remelt scrap lead used to make antimonial lead.
p Preliminary; – Nil; x Confidential; ... Amount too small to be expressed; .. Not available.
Note: Totals may not add due to rounding.

TABLE 2. CANADA, LEAD PRODUCTION, TRADE[1] AND CONSUMPTION, 1970, 1975, 1980, AND 1982-90

	Production		Exports[1]			Imports	Consumption[4]
	All forms[2]	Refined[3]	In ores and concentrates	Refined	Total	Refined	
				(tonnes)			
1970	353 063	185 637	186 219	138 637	324 856	1 995[a]	85 360
1975	349 133	171 516	211 909	110 882	322 791	1 962[a]	89 192
1980	251 627	234 580	147 008	126 539	273 547	2 602[a]	106 836
1982	272 187	238 882	106 744	146 130	252 874	5 661[a]	103 056
1083	271 961	241 957	85 459	147 263	232 722	2 550[a]	88 579
1984	264 301	254 380	114 720	124 149	238 869	6 313[a]	111 642
1985	268 291	240 011	93 657	113 993	207 650	5 675[a]	104 447
1986	334 342	264 922	118 373	111 831	230 204	4 247[a]	94 680
1987	373 215	230 661	207 936	100 204	308 140	12 558[a]	97 281[r]
1988	351 148	268 076	200 822[r]	179 946	380 768	15 132	88 041
1989	268 887	242 845	170 568	121 444	292 012	11 708	87 290[p]
1990	224 000	195 000	176 857[b]	64 188[b]	241 045[b]	8 858[b]	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Beginning in 1988, Exports and Imports are based on the new Harmonized System and may not be in complete accordance with previous method of reporting. Ores and concentrates include H.S. classes 2603.00.20, 2607.00.20 and 2608.00.20. Refined exports include H.S. classes 7801.10, 7803.00, 7804.11, 7804.19 and 7804.20. Refined imports include H.S. classes 7801.10.10.00, 7801.10.90.00, 7803.00, 7804.11, 7804.19 and 7804.20. [2] Recoverable lead in ores and concentrates shipped. [3] Primary refined lead from all sources; includes secondary lead beginning in 1980. [4] Consumption of lead, primary and secondary in origin, as measured by survey of consumers.
[a] Lead in pigs, blocks and shot. [b] January to September 1990. [p] Preliminary; [r] Revised; .. Not available.

TABLE 3. AVERAGE ANNUAL LEAD PRICES, 1975-90

Year	London Metal Exchange Settlement		London Metal Exchange 3 Months		U.S. Domestic
	(£/t)	(US¢/lb)	(£/t)	(US¢/lb)	(US¢/lb)
1975	185.63	18.755	186.78	18.821	21.529
1976	250.70	20.480	259.79	21.275	23.102
1977	354.11	28.022	359.12	28.433	30.703
1978	342.79	29.886	342.94	29.895	33.653
1979	567.66	54.574	542.66	52.161	52.642
1980	391.29	41.237	392.08	41.343	42.455
1981	363.37	33.327	370.93	34.025	36.531
1982	310.72	24.679	321.55	25.516	25.547
1083	279.97	19.290	290.62	19.983	21.377
1984	332.49	20.156	333.20	20.196	25.548
1985	304.01	17.876	304.03	17.877	19.067
1986	277.36	18.456	277.61	18.473	22.047
1987	363.66	27.098	346.40	25.736	35.943
1988	368.40	29.748	358.35	28.834	37.140
1989	412.39	30.669	406.41	29.908	39.350
1990	458.21	37.097	443.06	35.871	47.069

Sources: London Metal Exchange; Metals Week.

TABLE 4. AVERAGE MONTHLY LEAD PRICES, 1989 AND 1990

	London Metal Exchange				U.S. Domestic	
	Settlement		3 Months			
	(£/t)	(US¢/lb)	(£/t)	(US¢/lb)	(C¢/lb)	(US¢/lb)
1989						
January	380.95	30.650	381.36	30.465	48.2	40.5
February	354.54	28.197	359.62	28.377	45.7	38.4
March	343.66	26.725	352.15	27.206	44.8	37.5
April	367.52	27.582	360.34	27.611	44.6	37.5
May	394.57	29.186	384.99	28.290	43.5	36.5
June	426.93	30.215	406.67	28.338	45.4	37.9
July	424.46	31.322	425.10	31.369	46.1	38.8
August	440.43	31.856	431.76	30.857	46.5	39.5
September	463.33	33.027	456.65	32.162	47.9	40.5
October	473.59	34.101	464.68	32.983	47.6	40.5
November	440.55	31.424	436.21	30.615	47.4	40.5
December	445.29	32.252	434.71	30.970	45.9	39.5
1990						
January	428.66	32.1	422.52	31.1	47.1	40.2
February	459.77	35.4	423.70	32.1	49.9	41.7
March	653.91	48.2	501.18	36.3	63.0	53.4
April	510.68	37.9	495.01	36.2	57.2	49.2
May	492.21	37.4	488.20	36.6	55.8	47.5
June	489.93	38.0	492.86	37.6	55.7	47.5
July	483.71	39.7	486.69	39.3	58.4	50.5
August	460.80	39.7	465.61	39.5	58.4	51.0
September	446.13	38.0	452.59	38.0	58.3	50.4
October	391.10	34.5	391.36	34.0	55.0	47.4
November	356.96	31.8	361.97	31.8	50.2	43.1
December	325.06	28.3	334.96	28.8	48.8	42.0

Source: Metals Week.

TABLE 5. NON-SOCIALIST WORLD LEAD CONSUMPTION, 1986-89

	1986		1987		1988		1989[1]	
	(000 t)	(%)	(000 t)	(%)	(000 t)	(%)	(000 t)	(%)
Batteries	2 171.2	59.7	2 312.3	60.5	2 395.8	61.1	2 489.2	61.6
Cable sheathing	199.8	5.5	193.1	5.1	183.6	4.7	197.7	4.9
Rolled and extruded products	284.4	7.8	289.0	7.6	313.4	8.0	317.9	7.9
Shot/ammunition	92.0	2.5	87.7	2.3	85.4	2.2	95.5	2.3
Alloys	142.1	3.9	148.4	3.9	146.9	3.7	136.7	3.4
Pigments and other compounds	492.3	13.5	517.4	13.5	526.2	13.4	546.5	13.5
Gasoline additives	110.3	3.1	106.4	2.8	95.9	2.4	91.8	2.3
Miscellaneous	145.7	4.0	169.1	4.3	174.7	4.5	164.9	4.1
Total	3 637.8	100.0	3 823.4	100.0	3 921.9	100.0	4 040.2	100.0

Source: International Lead and Zinc Study Group.
1 The 1989 statistics are for: Australia, Canada, France, the Federal Republic of Germany, Japan, Mexico, the United Kingdom and the United States.

TABLE 6. REFINED LEAD CONSUMPTION BY COUNTRY, 1986-90

	1986	1987	1988	1989	1990
			(000 t)		
Canada	95	103	102	93	90
United States	1 134	1 217	1 236	1 262	1 240
Mexico	103	100	77	86	85
Brazil	88	93	95	100	81
Other America	93	95	83	64	20
Total America	1 513	1 608	1 593	1 605	1 516
United Kingdom	282	288	303	301	310
Federal Republic of Germany	359	345	373	375	380
Italy	238	244	246	259	262
France	205	207	216	244	260
Spain	112	128	123	119	126
Other EEC	196	187	184	183	131
Other Europe	269	253	263	252	300
Total Europe	1 661	1 652	1 708	1 733	1 769
Japan	389	378	406	406	403
Republic of Korea	88	122	146	155	154
Taiwan	59	75	75	65	70
India	77	70	75	80	86
Other Asia	154	165	174	194	209
Total Asia	767	810	876	900	922
Australia	60	62	60	61	58
Other Oceania	8	8	9	9	9
Total Oceania	68	70	69	70	67
South Africa	49	51	56	63	63
Egypt	13	16	10	11	11
Algeria	21	19	21	20	20
Other Africa	21	23	23	25	25
Total Africa	104	109	110	119	119
Total Non-Socialist World	4 113	4 249	4 356	4 427	4 393

Source: International Lead and Zinc Study Group.

TABLE 7. LEAD MINE PRODUCTION BY COUNTRY, 1986-90

	1986	1987	1988	1989	1990
			(000 t)		
Canada	349	414	367	275	239
United States	353	318	394	419	494
Mexico	195	177	178	163	180
Peru	194	204	149	192	185
Other America	60	55	70	65	62
Total America	1 151	1 168	1 158	1 114	1 160
Yugoslavia	103	94	95	86	72
Sweden	89	89	85	82	85
Spain	82	82	74	64	63
Ireland	36	34	32	32	35
Federal Republic of Germany	22	25	18	9	9
Other EEC	52	56	69	51	62
Other Europe	10	10	7	21	5
Total Europe	394	390	380	345	331
Japan	40	28	23	19	18
Iran	22	20	17	10	8
Thailand	30	34	29	24	21
India	25	29	23	25	25
Other Asia	40	28	31	35	32
Total Asia	157	139	123	113	104
Australia	418	455	457	499	567
South Africa	98	96	90	78	66
Morocco	73	72	69	63	70
Zambia	17	15	14	12	12
Other Africa	41	36	34	30	28
Total Africa	229	219	207	183	176
Total Non-Socialist World	2 349	2 371	2 325	2 254	2 338

Source: International Lead and Zinc Study Group.

TABLE 8. REFINED LEAD PRODUCTION BY COUNTRY, 1986-90

	1986	1987	1988	1989	1990
			(000 t)		
Canada	258	231	268	245	195
United States	932	1 042	1 091	1 169	1 230
Mexico	185	185	179	174	171
Peru	85	88	98	86	82
Brazil	66	71	54	70	73
Other America	56	56	48	50	24
Total America	1 582	1 673	1 738	1 794	1 775
United Kingdom	329	347	374	350	360
Federal Republic of Germany	367	341	345	350	350
Italy	132	168	177	181	172
France	231	245	256	268	266
Spain	130	126	122	122	127
Yugoslavia	138	128	131	119	101
Other EEC	161	150	179	165	164
Other Europe	107	116	109	93	28
Total Europe	1 595	1 621	1 693	1 648	1 568
Japan	362	339	340	333	328
Iran	60	83	90	87	84
Taiwan	54	66	67	58	60
India	29	32	32	37	42
Other Asia	63	64	73	76	86
Total Asia	568	584	602	591	600
Australia	171	217	204	210	223
Other Oceania	4	4	5	5	5
Total Oceania	175	221	209	215	228
South Africa	30	35	36	37	33
Morocco	55	62	71	66	65
Zambia	7	9	8	5	4
Other Africa	53	52	43	55	46
Total Africa	145	158	169	163	148
Total Non-Socialist World	4 065	4 257	4 411	4 411	4 319

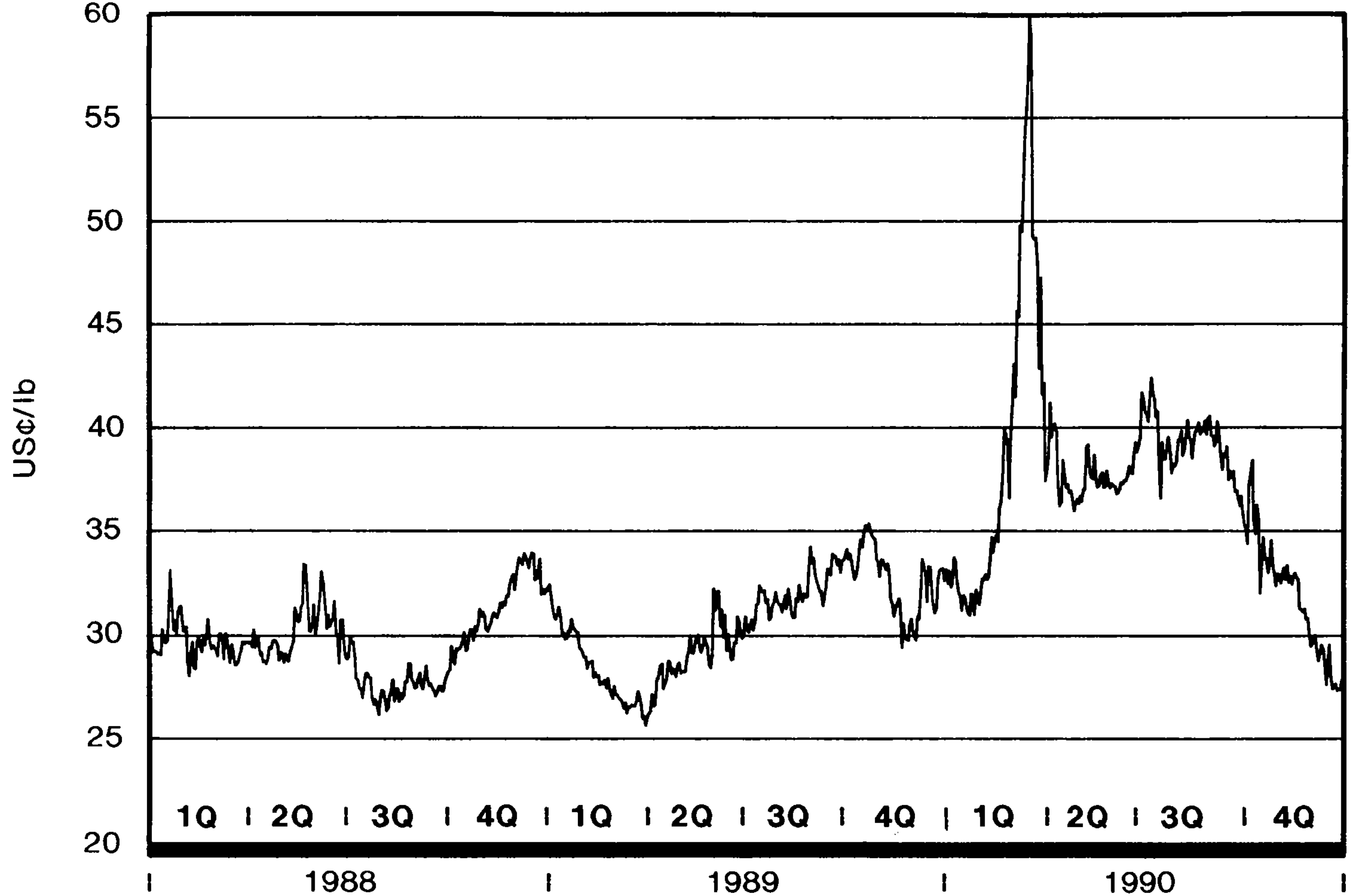
Source: International Lead and Zinc Study Group.

TABLE 9. CANADA, PRIMARY LEAD REFINED METAL CAPACITY, 1990

Company and Location	Annual Rated Capacity
	(000 t of refined lead)
Brunswick Mining and Smelting Corporation Limited Belledune, New Brunswick	72
Cominco Ltd. Trail, British Columbia	135
Canada, Total	207

DAILY LEAD PRICES 1988–90

LONDON METAL EXCHANGE



Lime

1990

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CANADIAN DEVELOPMENTS

Lime is a high-bulk, comparatively low-cost commodity which is usually sold within a 300-km radius of production centres due to the important contribution of freight charges to consumers' costs. The preferred location for a lime plant is near principal lime markets, adjacent to a source of high-quality raw material and close to a supply of energy. The more heavily populated and industrialized provinces of Ontario and Quebec together produce over 80% of Canada's total lime output, with Ontario contributing about two thirds of Canada's total. Production figures do not include some captive production from pulp and paper plants that burn sludge to recover lime for re-use in the causticization process.

In 1990, the lime industry in Canada comprised 14 companies that operated 20 plants, of which 13 were in eastern Canada. In 1990, employment rose to 927; since 1961, the level of employment in this sector has averaged 810 jobs.

Canadian lime shipments decreased 6% in 1990 to reach 2.4 Mt, valued at $180 million. During the year, the lime industry suffered several losses in sales and in production due to major strikes in the steel industry in Ontario. Other factors such as lower operating rates in the chemical and the pulp and paper sectors have also affected the sales of lime in Canada. Quicklime sales amounted to 2.2 Mt, a 6% decline over 1989, and accounted for 92% of total sales. Hydrated lime shipments dropped 4.2% to 194 137 t. Close to two thirds of total sales were from Ontario, followed by Quebec and Alberta.

The calcining capacity for quicklime in Canada continued to increase as a result of several expansion and development projects that were undertaken during the 1989/90 period. Quicklime capacity of production is projected to increase 11% over 1989 to 3.98 Mt/y by 1991. Quicklime capacity increased by 11% to 3.2 Mt/y in eastern Canada and by 10% to 739 000 t/y in western Canada. The 1990 rate of capacity utilization was estimated at 68%, a 5% increase over 1988.

The consumption of domestic lime in Canada can be divided into two segments: the captive market which consumes quicklime produced internally by chemical plants, sugar refineries and some steel producers; and the merchant market which is supplied by lime producers. In 1989, the captive market was estimated at 905 000 t and accounted for 38% of total domestic sales.

The consumption of quicklime in the merchant market amounted to 1 306 048 t in 1989. The major end-users were steelmaking (40%), environmental control (26%), pulp and paper (17%), chemicals (10%) and other industrial usages (7%). During 1989, the demand for quicklime rose in steelmaking, mine effluent treatment, chemicals manufacture and road and soil stabilization, while it decreased in the metal concentration, water purification and pulp and paper sectors. Hydrated lime shipments in the merchant market amounted to 150 011 t in 1989, and were mostly sold for environmental control (60%), industrial uses (16%), masonry (9%), metallurgy (5%), pulp and paper (4%) and other miscellaneous usages (2%). Eastern Canada accounted for three quarters of total merchant sales of quicklime. Shipments between eastern Canada and western Canada were reported minimal. Two thirds of Canada's quicklime exports were originating from eastern Canada.

In 1989, imports of quicklime amounted to 27 979 t, a 2% increase over 1988. All imports were from the United States and were valued at $2.8 million. Shipments were principally to Ontario which accounted for 70% of total imports, followed by British Columbia (15%) and Alberta (12%). Between 1984 and 1989, imports of quicklime increased significantly from an average of 8500 t/y prior to 1986 to an average of 27 000 t/y for the last four years; the increase was largely centred in Ontario where imports have doubled to 16 000 t/y since 1986. Hydrated lime showed a reverse trend as its imports have dropped threefold since 1987; the largest declines occurred in Ontario (-60%) and in British Columbia (-50%). In 1989, imports of hydrated lime reached 9541 t, valued at $1.3 million; sales were made in Ontario (70%) and British Columbia (28%). In 1989, reported exports of quicklime totalled 193 820 t of which two thirds originated from eastern Canada. Hydrated lime exports were estimated at 56 217 t.

For the first nine months of 1990, imports of quicklime amounted to 21 150 t, valued at $1.9 million; the unit value of imports at border crossings decreased 12% to $89.95/t. The unit value of imported hydrated lime was estimated at $155.38/t, an 18% increase over last year.

Several announcements were made during the1989/90 period affecting the future level of production of lime in Canada. Projects for expansion were announced in all producing provinces. Two operators commissioned new quicklime plants in central Canada during 1990.

In **New Brunswick,** Havelock Lime, a division of Dickenson Mines Limited continued the construction of a new kiln in Havelock, due for completion in early 1991. The project is expected to increase the calcitic quicklime capacity of production by 105 000 t/y to reach 175 000 t/y. In January 1990, the company commissioned a new 10 t/h hydrated lime facility; the total capacity of production has increased threefold to 129 000 t/y. During 1989, the parent company, Dickenson Mines Limited, was targeted in a takeover by Corona Corporation, the third largest gold miner in Canada. The offer, which amounted to $46 million for gaining control, was rejected by Dickenson's board in favour of a bid by Goldcorp Investments Limited.

In **Nova Scotia,** Brador Minerals Inc. of Toronto, Ontario, has been promoting a project in Cape Breton for producing Precipitated Calcium Carbonate (PCC) and sulphur from local deposits of coal and gypsum. A full-scale plant with greenfield processing facilities was estimated to cost $134 million and would produce up to 375 000 t/y of PCC and 100 000 t/y of sulphur.

In **Quebec,** Graybec Inc. announced an investment of $1.3 million at the Joliette plant late in 1988. The project, completed in mid-1990, allowed the reactivation of the number one kiln which has a 60 000 t/y capacity for quicklime. The company also completed the construction of a new storage facility near Cadillac in northwestern Quebec at a cost of $900 000. In the spring of 1989, Graybec Inc. announced a $13.2 million project for expanding its quicklime production capacity at the Domlim plant in St-Adolphe-de-Dudswell. A second kiln with a 150 000 t/y capacity is under construction, doubling the current volume that will reach 300 000 t/y by March 1991.

Dolo-Mine Inc. of St. Bruno-de-Guigues invested $2.5 million to start a new lime operation in the Abitibi region. The project was completed during the summer of 1990 with a production capacity reported to be close to 40 000 t/y. Dolomitic quicklime will be sold to mining operations and for environmental control of acidic underground waters and wastewaters. For many years, the firm has been selling agricultural lime and crushed stone.

In **Ontario,** BeachviLime Limited announced a project to modernize part of its quicklime facilities in Ingersoll. A new 230 000 t/y kiln will replace an older and less energy-efficient installation. The replacement is to be completed by April 1991 and is reported to modify the overall capacity slightly.

During the spring of 1990, Dymond Clay Products Limited of Haileybury commissioned a new lime plant near Lake Timiskaming, 5 km north of Cobalt. The reported production capacity for calcitic quicklime is around 40 000 t/y; sales will be mostly to the mining and paper sectors in northern Ontario and northwestern Quebec. The construction of a gas-fuelled vertical kiln started in 1988 and was completed during 1990. Traditional markets for Dymond Clay include flux limestone for iron mines, metallurgical limestone for smelters, crushed stone and aglime.

Two steel companies, Stelco Inc. and The Algoma Steel Corporation, Limited, were affected by a three-month strike that started in August 1990. Both companies own lime plants in Ontario which remained idle during the labour conflicts. A settlement was reached at each operation late in October, and both lime plants resumed operation, at a subdued rate, during December 1990.

In 1989, Koch Industries Incorporated of Wichita, Kansas, increased its equity interest in Reiss Lime Company of Canada, Limited to 100% by buying the 50% share owned by Denison Mines Limited.

In **western Canada,** Summit Lime Works Limited installed a new kiln in Hazell, Alberta, allowing a 10% increase in the current capacity which reached 40 000 t/y. Texada Lime, (BP Resources Canada Limited, Mining Division) started the construction of a new $9 million kiln in Fort Langley, British Columbia, for completion by early 1991. The quicklime capacity is to increase from 65 000 t/y to 135 000 t/y. The incremental production is expected to be sold mostly to the mining and pulp mill industries in British Columbia and the northwestern United States.

In 1989, Graymont Inc. of Vancouver, British Columbia, acquired Continental Lime Ltd. of Richmond, British Columbia, from Bricom Holdings of the United Kingdom. Late in 1989, Continental Lime sold its research laboratory in Tacoma, Washington, and its PCC unit in Prince Albert, Saskatchewan, to Georgia Kaolin Co., Inc. of Unica, New Jersey. Continental Lime Ltd. has retained its ownership of the PCC plant in Tacoma. During 1990, the parent company of Georgia Kaolin, Combustion Engineering, Inc., was purchased by Asea Brown Boveri Inc. (ABB) of Stanford, Connecticut. Later during the year, ABB reached an agreement to sell part of Georgia Kaolin Co., Inc. and its subsidiary, GK Carbonate, which controls the PCC facilities, to English China Clays plc of St. Austell, England, for close to US$340 million.

ENERGY

The lime industry has one of the highest ratios of energy costs to total material costs in any manufacturing process. Energy costs account for close to 40% of manufacturing costs in the production of quicklime. The importance of efficient fuel-conserving equipment has been recognized as new plants have incorporated preheater systems, computerized process control systems and improved kiln technology. While some kilns are fuelled with coal (12%), most kilns use natural gas (above 80%); electricity accounts for less than 6%. Long rotary kiln systems consume, on average, about 6.4 gigajoules per tonne (GJ/t) of calcined lime produced. New rotary kilns with preheaters consume less than 5.0 GJ/t while short shaft kilns use about 4.2 GJ/t. The North American lime industry predominantly uses rotary kilns with preheaters, compared to Western European producers which mostly use shaft kilns.

PRICES

Published prices for lime represent only a range of prices. Actual prices vary according to established marketing strategies and market balance. Average Canadian prices for high calcium quicklime and for high calcium hydrated lime, f.o.b. plant, in Ontario, in bulk, were quoted at $80.40/t and $70.80/t respectively.

Quicklime price quotations reported by Canadian suppliers registered a 4%-5% increase over 1989 and ranged from $85/t to $100/t; the price increases matched the inflation rate that prevailed in Canada during 1990. Prices in Ontario were reported 10% lower than the Canadian average while prices in western Canada were quoted 11% higher. A $2/t-$5/t premium was added to hydrated lime prices. During the last eight years, quicklime prices have shown a very slow progression, from an average of $55/t in 1982 to $80/t in 1989, in current dollars. On a 1988 constant dollar basis, the average prices of quicklime in Canada have declined $5/t since 1985. Prices in Ontario continued to be lower and demonstrated a wide variation (close to $25/t) during those years due to higher competition and larger captive sales.

USES

Carbonate rocks are basic to industry and, fortunately, are widely distributed and easily exploitable. The principal carbonate rocks utilized by industry are limestones–sedimentary rocks composed mainly of the mineral calcite ($CaCO_3$), and dolostones–sedimentary rocks composed mainly of the mineral dolomite ($CaCO_3.MgCO_3$). Commonly termed limestones, they can be classified according to their content of calcite and dolomite. Their importance to the construction industry is not only as building stone and aggregate, but also as the primary material in the manufacture of Portland cement and lime. Limestones are also used as flux material, in glass manufacture, in refractories, as fillers, abrasives, soil conditioners and in the manufacture of a host of chemicals.

Quicklime (CaO or CaO.MgO) is formed by the process of calcination, in which limestones are heated to the dissociation temperature of the carbonates (as low as 402°C for $MgCO_3$ and as high as 898°C for $CaCO_3$) and held at that temperature over sufficient time to release carbon dioxide. The term "lime" is often used to refer to a multitude of forms of calcareous material; however, lime is essentially a general term that should refer only to burned or calcined limestone (burnt lime or quicklime) and its secondary products, slaked lime and hydrated lime (or calcium hydroxide). High calcium quicklime is commercially available in six forms: lump lime, crushed or pebble lime, ground lime, pulverized lime, and briquettes or pelletized lime. Slaked lime is the product of mixing quicklime and water and could be obtained as a putty, dry powder or slurry. Hydrated lime is slaked lime dried and reground, and comes in various purities, such as high calcium, dolomitic, magnesian or hydraulic (containing siliceous, aluminous or ferrous impurities). Aglime or agricultural lime is essentially a reference to pulverized limestone used for soil neutralization in a very seasonal market involving primarily fall and spring spreading seasons.

Calcining is done in kilns of various types, but essentially those of vertical or rotary design are used. Of comparatively recent design are the rotary hearth, travelling grate, fluo-solid and inclined vibratory types. The cost of energy has made it imperative to include preheating facilities in any new plant design, and environmental regulations have necessitated the incorporation of dust collection equipment.

Lime is widely used in several diversified sectors; however, markets could be classified in four major groups: metallurgical, industrial, agricultural and construction.

The metallurgical industry provides the largest single market for lime. Lime is consumed by steel furnaces as a basic flux which enables impurities–silica, aluminum, phosphorus, sulphur–to melt and form a slag. Other fluxing agents are also used and include limestone, dolomite and fluorspar. Limestone and dolostone are mostly used in pig iron blast furnaces and in sinter plants at steel mills; limestone, lime and dolime are used in steel furnaces–electric arc and basic oxygen. In Canada, electric arc furnaces account for one third of steel production capacity, the remainder being predominantly of basic oxygen type. In 1989, the consumption of lime and dolomite in integrated iron and steel complexes was reported at 367 280 t and 323 041 t respectively. In Canada, the ratios of lime consumed per tonne of steel produced ranged between 38 and 41 kg/t in electric arc furnaces and between 83 and 89 kg/t in basic oxygen furnaces. The feed ratio between lime and pig iron varied between 1:10.3 and 1:10.6. The consumption of dolime, a pure dolomitic quicklime, averaged 21 kg/t in the North American metallurgical industry; dolime is also used as an additive to lime in order to extend the serviceability and durability of refractory linings in basic oxygen furnaces. Flux usage depends mostly on local resources availability, grades of steel produced and operating practices.

The industrial markets for lime comprise mainly the pulp and paper industry, mining operations, chemicals manufacture and environmental control. The pulp and paper industry remains the second largest consumer of lime, most of which is used in the preparation of digesting liquor for the manufacture of Kraft or sulphate paper, and in pulp bleaching. Although most of the lime used is recovered in pulp mills by calcining dewatered calcium carbonate sludges resulting from the causticization reaction, an important volume of lime is required as make-up. The increasing use of PCC in coated and uncoated printing and writing papers in North America has led to a major growth in the demand for lime. In North

Magnesium

MAGCAN joint venture from Houston-based Magnesium International Corporation Ltd.

MAGCAN employs the new MPLC process, considered to be the very latest in magnesium production technology. The heart of the process is a one-stage reactor which converts magnesite ore ($MgCO_3$) to molten anhydrous magnesium chloride, the raw material needed for electrolytic reduction to primary metallic magnesium. The process apparently uses 15% less energy than does the production of aluminum. The raw material comes from the Baymag high-grade magnesite deposit near Radium Hot Springs, British Columbia, about 300 km from High River. By year-end, production capacity at the MAGCAN facility had reached around 35% with 50% of the electrolytic cells being in operation. Further expansion of the 12 500 t/y facility, originally planned to be increased in two phases of 25 000 t/y to a maximum of 62 500 t/y, has yet to be confirmed and likely will be tailored to market conditions.

Timminco Metals, a div. of Timminco Limited produces high-purity metal (up to 99.95% pure) for specialized market applications at its 6000 t/y magnesium plant in Haley Station, Ontario. In 1989, its magnesium was used in such applications as alloys for aluminum and calcium, Grignard reagents for the pharmaceutical industry and electronic products. Timminco also produces metallic calcium and strontium, and has set up a research and development team to develop new applications for these specialized metals.

Timminco uses the Pidgeon magnesium process; calcined dolomite is reduced by ferrosilicon in a vacuum retort. The ferrosilicon used in the process is produced by the company at Beauharnois, Quebec, with the dolomite being mined at the plant site.

The Magnola joint venture of Noranda Minerals Inc. and Lavalin Inc. finalized their technical feasibility study concluding that the production of magnesium metal from asbestos tailings is economically feasible. During the next year, the two partners will address the market aspects of the project. The two companies will also seek partners interested in investing in the proposed 50 000 t plant, estimated to cost around $600 million.

The Institute of Magnesium Technology Inc. (IMT) was inaugurated in Quebec City on September 19, 1990. The new facility was built to accommodate about 15 researchers and 5 support staff, promotes the development of a downstream magnesium industry in Canada, and promotes the greater use of the metal generally. The IMT is expected to become an international centre of excellence for magnesium technology, where magnesium alloys and processing technologies will be developed as part of short- and long-term projects. Currently, more than 80% of IMT's research projects are from companies outside Canada. The Institute's membership has grown to about 11 members including producers, converters and end users.

For the second consecutive year, negotiations will take place between Canada and the United States regarding early elimination of custom duties on the trans-boundary movement of magnesium. The Canada-U.S. Free Trade Agreement allows tariffs on magnesium to be eliminated over ten years.

Researchers at the Canada Centre for Mineral and Energy Technology (CANMET) completed the first year of a four-year research on magnesium and corrosion. The program is budgeted at $760 000, and costs are shared by the International Magnesium Association (IMA) and CANMET.

WORLD

The United States, which is the world's largest magnesium producer, has three primary magnesium plants. The Dow Chemical Company, the largest U.S. producer, operates a 95 000 t/y electrolytic magnesium plant in Freeport, Texas. The magnesium chloride feedstock for the plant is derived from a seawater/dolomite process. The company reactivated idle electrolytic cells in the first quarter of 1989, adding an extra 5000 t/y of production. In 1990, the company's production capacity exceeded 1987 levels by more than 30 000 t/y. Dow indicated its intentions to

Magnesium

1990

G. Couturier

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In 1989, world shipments of magnesium stood at 246 200 t, a decrease of almost 2% compared with the total recorded for 1988. Production increased by over 10 000 t compared with the 1988 total, reaching 252 800 t. In September 1990, magnesium stocks had increased by 11 500 t over the September 1989 level of 28 000 t.

CANADA

All three Canadian magnesium producers should reach full capacity by mid-1991. Canadian production will be 60 000 t/y, making it the Western World's second largest producer after the United States.

Canada's total refinery magnesium production in 1990 reached 26 726 t, about 10% of Western World production. In 1990, all three Canadian producers, Norsk Hydro Canada Inc., Magnesium Company of Canada Ltd. (MAGCAN) and Timminco Limited, were in operation.

Canadian magnesium consumption in 1989 reached 15 407 t, an increase of 9.5% over the 1988 revised total of 14 066 t. This upward trend should continue over the next three years, primarily in the aluminum alloys sector because of construction and expansion projects under way in Canadian aluminum plants. These projects could lead to production increases of approximately 700 000 t/y of aluminum by 1993. Canadian consumption of magnesium used in aluminum alloys may increase by more than 3000 t/y over the next three years. In the same period, strong growth is expected in the die casting of magnesium parts for the automobile industry.

Norsk Hydro's magnesium plant in Bécancour, Quebec, was inaugurated officially on May 4, 1990. By the end of the year, the plant was reported to be producing at 75% of its total capacity of 40 000 t/y.

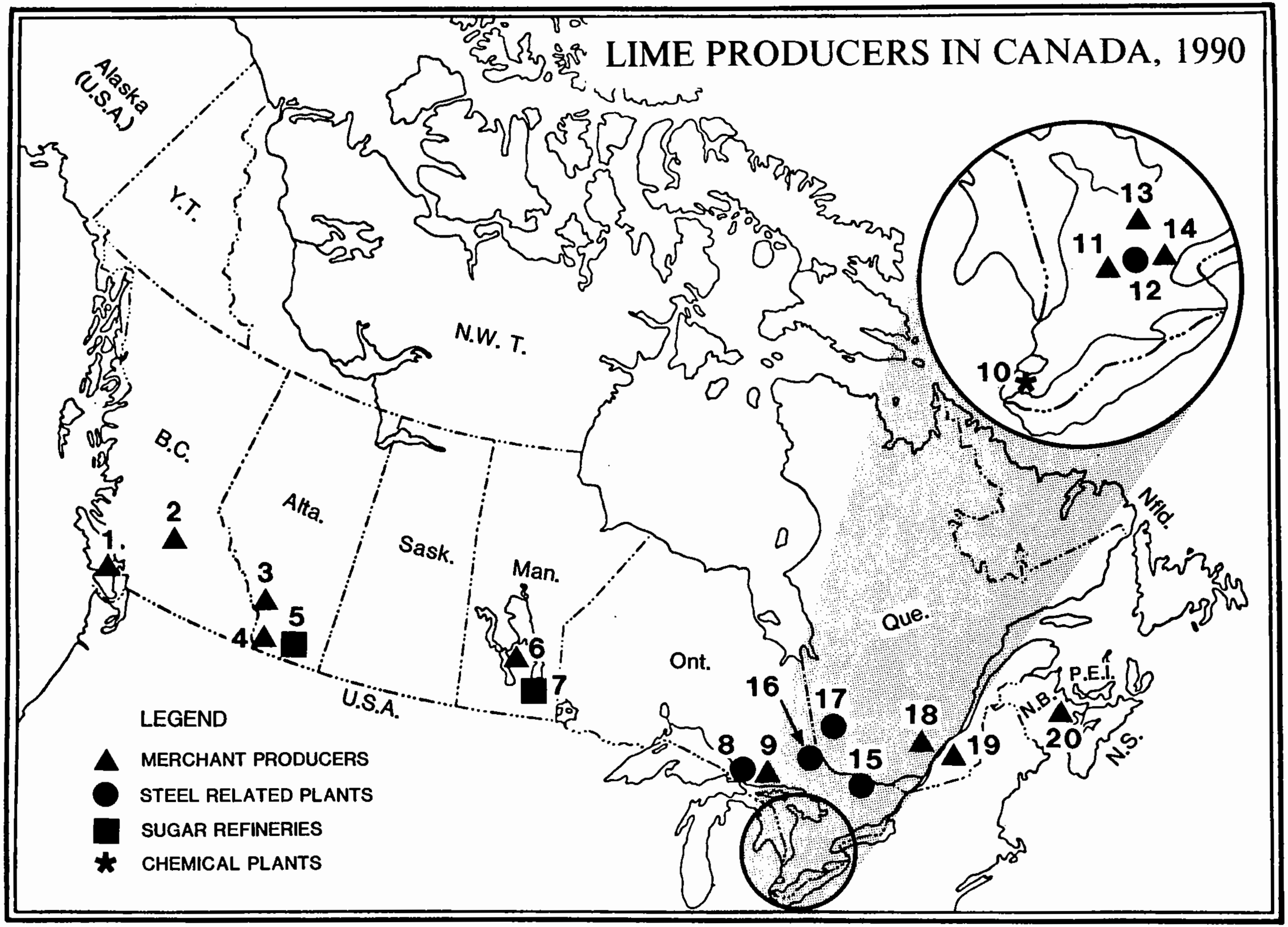
Norsk Hydro announced that it will build a $7 million refining facility in Bécancour to convert magnesium scrap into high-purity alloys. The facility will have the capacity to process internally generated scrap and customer die-cast scrap. The scrap-refining operation will start operation in late 1991.

Norsk Hydro also announced a $3 million expansion of its casting facilities at Bécancour to produce alloy billets for supply to magnesium extruders. The expansion allows the facility to serve a varied range of extruders who manufacture anodes, bakery rack profiles and luggage frames. Norsk Hydro has also been studying the feasibility of expanding the production capacity of the Bécancour operation from its current 40 000 t/y to 60 000 t/y. A decision on the expansion will be made as soon as market conditions warrant.

The Bécancour plant receives its raw magnesite material supply from China. At the current production rate of 40 000 t/y, magnesite consumption at Bécancour is estimated to be 160 000 t/y. The process technology used at the Bécancour plant involves leaching the magnesite with hydrochloric acid to produce a brine of magnesium chloride ($MgCl_2$), and then reducing the $MgCl_2$ granules in electrolytic cells to produce metallic magnesium.

MAGCAN commissioned its 12 500 t/y plant at Aldersyde, Alberta, during 1990. However, problems with the process related to the electrical resistance of the feedstock, which was less than originally anticipated, resulted in the original transformers being unable to provide sufficient power to operate the reactors properly. Start-up problems resulted in significant cost overruns for plant construction, originally estimated at $105 million. In August, Alberta Natural Gas Company Ltd. announced that it acquired controlling interest in the

1. Texada Lime (BP Resources Canada Mining Division), Fort Langley
2. Continental Lime Ltd., Pavilion Lake
3. Continental Lime Ltd., Exshaw
4. Summit Lime Works Limited, Hazell
5. The British Columbia Sugar Refining Company Limited, Taber
6. Continental Lime Ltd., Faulkner
7. The British Columbia Sugar Refining Company, Limited, Fort Garry
8. The Algoma Steel Corporation, Limited, Sault Ste. Marie
9. Reiss Lime Company of Canada, Limited, Spragge
10. General Chemical Canada Ltd., Amherstburg
11. Guelph DoLime Limited, Guelph
12. Stelco Steel, Ingersoll
13. Steetley Quarry Products Inc., Dundas
14. BeachviLime Limited, Ingersoll
15. Timminco Limited, Haley
16. Dolo-Mine Inc., St-Bruno-de-Guigues
17. Dymond Clay Products Limited, Haileybury
18. Graybec Inc., Domlin Division, Joliette
19. Graybec Inc., Joliette Division, Saint-Adolphe-de-Dudswell
20. Havelock Lime, a division of Dickenson Mines Limited, Havelock


LIME PRODUCERS IN CANADA, 1990
Alaska (U.S.A.)
Y.T.
N.W. T.
B.C.
Alta.
Sask.
Man.
Ont.
Que.
Nfld.
P.E.I.
N.B.
N.S.
U.S.A.
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19
20
LEGEND
MERCHANT PRODUCERS
STEEL RELATED PLANTS
SUGAR REFINERIES
CHEMICAL PLANTS

TABLE 5. WORLD PRODUCTION OF QUICKLIME AND HYDRATED LIME INCLUDING DEAD-BURNED DOLOMITE SOLD AND USED, 1985-90

	1985	1986	1987	1988	1989p	1990e
			(000 tonnes)			
U.S.S.R.	29 195	30 115	30 115	30 110	30 020	29 025
China	7 980	8 980	10 975	12 970	15 960	16 325
United States	14 250	13 150	14 290	15 490	15 580	15 780
Japan[1]	7 450	6 715	6 740	7 725	7 890	7 890
West Germany	6 840	6 475	6 110	7 200	7 345	7 620
Brazil	4 765	4 905	5 300	5 495	5 495	5 440
Poland	4 120	4 150	4 260	4 100	4 100	3 900
Mexico	5 090	5 540	6 250	6 000	5 995	5 985
Romania	3 715	3 720	3 630	3 535	3 265	3 175
East Germany	3 565	3 545	3 375	3 480	3 400	3 175
Czechoslovakia	3 225	3 330	3 235	3 300	3 200	3 175
France	3 100	2 900	2 990	3 090	3 080	3 080
United Kingdom	2 495	2 495	2 810	2 810	2 810	2 810
Yugoslavia	2 705	2 635	2 495	1 990	1 995	1 905
Italy	3 945	3 600	3 890	3 900	3 900	3 900
Canada	2 210	2 240	2 330	2 520	2 550	2 405
Belgium	1 810	1 785	1 760	1 890	1 905	1 905
South Africa	1 995	1 940	1 580	1 915	1 940	1 995
Other countries	14 395	14 675	14 395	15 195	14 980	15 425
Total	122 850	122 895	126 530	132 705	135 310	134 915

Sources: Energy, Mines and Resources Canada; Statistics Canada; U.S. Bureau of Mines, Mineral Commodity Summaries, 1990.
[1] Quicklime only.
p Preliminary; e Estimated.

TABLE 4. CANADA, CONSUMPTION[1] OF DOMESTIC LIME, QUICK AND HYDRATED, 1988 AND 1989

End-Uses	1988	1989
	(tonnes)	
Chemical and metallurgical		
Steelmaking	482 517	514 794
Water and sewage treatment	329 183	353 922
Water purification	64 564	72 495
Gas scrubbing	3 236	6 544
Metal concentration	95 866	47 698
Pulp and paper mills	242 424	224 831
Chemicals	117 677	126 541
Other industrial uses	138 462	78 296
Construction		
Road and soil stabilization	4 175	9 384
Mason and finishing lime	17 434	14 630
Other	893	1 876
Agriculture	8 184	5 048
Total	1 504 615	1 456 059

Sources: Energy, Mines and Resources Canada. Producing companies surveys 1988-90.
[1] Excluding captive use.

TABLE 3. CANADIAN LIME INDUSTRY, 1990

Company	Plant Location	Calcining Capacity	Market	Type of Quicklime and Other Products
		(000 t/y)		
New Brunswick				
Havelock Lime, a division of Dickenson Mines Limited	Havelock	175	Merchant	High calcium[1]
Quebec				
Graybec Inc., Domlin Division	St. Adolphe de Dudswell	300	Merchant	High calcium[1]
Graybec Inc., Jolichaux Division	Joliette	282	Merchant	High calcium[1]
Dolo-Mine Inc.	St-Bruno de Guigues	40	Merchant	High calcium and dolomitic[1]
Ontario				
The Algoma Steel Corporation, Limited	Sault Ste. Marie	200	Captive	High calcium and dolomitic
BeachviLime Limited	Ingersoll	922	Mechant/Captive	High calcium[1]
Dymond Clay Products Limited	Haileybury	40	Merchant	High calcium
General Chemical Canada Ltd.	Amherstburg	292	Captive	High calcium
Guelph DoLime Limited	Guelph	122	Merchant	Dolomitic[1]
Reiss Lime Company of Canada, Limited	Spragge	200	Merchant	High calcium
Steetly Quarry Products Inc.	Dundas	345	Merchant	Dolomitic
Stelco Steel	Ingersoll	215	Merchant/Captive	High calcium
Timminco Limited	Haley	53	Captive	Dolomitic
Manitoba				
The British Columbia Sugar Refining Company, Limited	Fort Garry	16	Captive	High calcium
Continental Lime Ltd.	Faulkner	117	Merchant	High calcium
Alberta				
The British Columbia Sugar Refining Company, Limited	Taber	66	Captive	High calcium
Continental Lime Ltd.	Exshaw	130	Merchant	High calcium[1]
Summit Lime Works Limited	Hazell	40	Merchant	High calcium and dolomitic[1]
British Columbia				
Continental Lime Ltd.	Pavilion Lake	235	Merchant	High calcium
Texada Lime (BP Resources Canada Limited, Mining Division)	Fort Langley	135	Merchant	High calcium[1]

Source: Mineral Policy Sector, Energy, Mines and Resources Canada.
[1] Production of hydrated lime.

TABLE 2. CANADA, LIME PRODUCTION, TRADE AND APPARENT CONSUMPTION, 1970, 1975, 1980-89

	Production[1]					Apparent
	Quick	Hydrated	Total	Imports	Exports	Consumption[2]
				(tonnes)		
1970	1 296 590	224 026	1 520 616	30 649	181 994	1 369 271
1975	1 533 944	199 195	1 733 139	30 099	234 034	1 529 204
1980	2 364 000	190 000	2 554 000	40 901	403 166	2 191 735
1981	2 359 000	196 000	2 555 000	23 144	432 845	2 145 299
1982	2 017 000	180 000	2 197 000	15 963	281 247	1 931 716
1983	2 060 000	166 000	2 232 000	22 844	215 942	2 038 902
1984	2 075 000	174 000	2 249 000	24 848	186 748	2 087 100
1985	2 054 294	157 286	2 211 580	23 056	194 097	2 040 539
1986	2 069 043	173 534	2 242 577	46 917	189 512	2 099 982
1987	2 140 793	189 278	2 330 071	44 290	163 767	2 210 594
1988[3]	2 306 831	211 151	2 517 982	28 861	111 177	2 435 666
1989	2 349 312	202 622	2 551 934	37 520	76 852	2 512 602

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Producers' shipments and quantities used by producers. [2] Production, plus imports, less exports.
[3] Beginning in 1988, Exports and Imports are based on the new Harmonized System and may not be in complete accord with previous method of reporting. Imports and Exports include H.S. classes 2522.10 and 2522.30.

TABLE 1. CANADA, LIME PRODUCTION AND TRADE, 1988-90

Item No.		1988		1989		1990p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Production[1]							
	By type						
	Quicklime	2 306 831	172 129	2 349 312	182 943	2 209 584	162 923
	Hydrated lime	211 151	19 544	202 622	18 627	194 137	17 333
	Total	2 517 982	191 672	2 551 934	201 571	2 403 721	180 256
	By province						
	New Brunswick	x	x	x	x	x	x
	Quebec	x	x	x	x	x	x
	Ontario	1 658 666	118 632	1 656 404	126 496	1 442 122	102 243
	Manitoba	x	8 275	x	x	x	x
	Alberta	179 993	17 230	195 157	16 379	240 346	18 706
	British Columbia	166 495	14 834	176 887	16 758	217 147	19 075
	Total	2 517 982	191 672	2 551 934	201 571	2 403 721	180 256
Imports						(Jan.-Sept.)	
2522.10	Quicklime						
	United States	24 364	3 028	27 979	2 845	21 098	1 897
	Other countries	–	–	–	–	2	. .
	Total	24 364	3 028	27 979	2 845	21 100	1 898
2522.20	Slaked lime						
	United States	2 282	362	1 090	181	3 481	498
	Other countries	1 400	308	485	326	–	–
	Total	3 682	670	1 575	507	3 481	498
2522.30	Hydraulic lime						
	United States	4 497	685	9 541	1 256	6 114	950
	Other countries	. . .	. .	–	–	–	–
	Total	4 497	686	9 541	1 256	6 114	950
Exports							
2522.10	Quicklime						
	United States	85 472	7 232	63 217	5 898	71 567	6 073
	Other countries	24	11	–	–	–	–
	Total	85 496	7 244	63 217	5 898	71 567	6 073
2522.20	Slaked lime						
	United States	11 723	1 301	6 738	637	20 749	2 188
	Other countries	–	–	18	2	17	2
	Total	11 723	1 301	6 756	640	20 766	2 190
2522.30	Hydraulic lime						
	United States	25 664	2 603	13 617	1 500	16 730	1 523
	Other countries	17	2	17	5	–	–
	Total	25 681	2 605	13 635	1 506	16 730	1 523

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Producers' shipments, and quantities used by producers.
p Preliminary; x Confidential; – Nil; . . Not available; . . . Amount too small to be expressed.
Note: Numbers may not add to totals due to rounding.

PRICES

Canada lime prices quoted in "Corpus Chemical Report":	December 1989	December 1990
	($ per tonne)	
Lime, carload and truckload f.o.b. Ontario plant		
High calcium quicklime, bulk	63.60	70.80
High calcium hydrated lime, bulk	66.40	80.40

f.o.b. Free on board.

TARIFFS

		Canada			United States
Item No.	Description	MFN	GPT	USA	Canada
2522.10	Quicklime	Free	Free	Free	Free
2522.20	Slaked lime	Free	Free	Free	Free
2522.30	Hydraulic lime	Free	Free	Free	Free

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States effective January 1, 1990.

despite increased effluent treatment in industrial and mining sectors; more efficient procedures are being developed, resulting in the reduction of the amount of lime required to treat the same quantities of liquid wastes. In lake neutralization, the prospect of using lime products appears very limited. The adoption of stringent air pollution standards in North America offers potential for growth in lime consumption. Coal-fired power stations will implement measures to cut their sulphur dioxide emissions by the year 2000 with technologies that may use lime. The choice between lime and limestone in wet scrubbing is still uncertain but many utilities in the United States have indicated their intention to use lime. In Canada, Ontario Hydro will be installing wet scrubbers using limestone at Lambton and Nanticoke, and in Nova Scotia, using limestone is also being considered. The extent to which lime will penetrate this huge market is still unknown, but it offers a tremendous sales potential to be realized in the medium term.

The demand for lime as a flux in steelmaking, currently the largest end-use, is expected to decline in the medium-to-long term as a result of technological changes in the industry such as the increasing use of continuous casting, growing energy efficiency, larger amounts of scrap used in basic oxygen furnaces, and improved feed-ore grades with lower silica content.

In the medium term, the lime market is projected to be stable in the established sectors while some important growth is anticipated in PCC for use as a filler and a coater in printing and writing papers. In North America, the PCC market is forecast to grow at an annual rate of 25%, to reach 2.0 Mt/y by 1995. Future trends call for an 85%-90% conversion to alkaline papermaking by 1994 in North America, and for higher filler loading in specialty papers, from 15%-20% for PCC to 30% by 1995.

The Canadian lime industry completed a major expansion phase during 1989/90 after going through some consolidation and restructuring in 1988. The industry remains fairly concentrated as fewer companies control more operations. The recession will likely affect the profitability of small operations that service regional and sectorial markets, such as the two newest plants that came on stream during 1990. Many new investors have continued to express their interest in getting into the lime industry; several projects were investigated during 1990 in British Columbia, Ontario, Quebec and Newfoundland. The current low rate of capacity utilization in combination with announced expansions will allow the Canadian lime industry to be well positioned to respond to any significant increases in the demand for lime during this decade.

Note: Information contained in this review was current as of mid-January 1991.

is also performed on some sandy soils to balance magnesium deficiencies.

Uses in the construction sector offer a potential growing market for lime in soil stabilization. Quicklime is used to react with fine-grained cohesive soil, such as plastic clays containing silica and alumina to form a dry, impervious, cemented and stable mass. It improves workability, strength and moisture stability and reduces swell-susceptibility. Clay subgrades may be stabilized for highways, airfields and parking lots. In Canada, very few projects utilizing lime for soil stabilization have been carried out by provincial public works departments during the last decade. Most agencies prefer adopting soil treatment measures instead of soil stabilization due to cost and performance considerations. Hydrated lime may also be used as an anti-stripping agent in hot asphalt mixtures. In 1989, the Ontario Ministry of Transportation completed field experiments using hydrated lime at a rate of 1% of total aggregate weight in asphalt mixtures. Tests demonstrated that hydrated lime improved the moisture resistance of asphalt mixes and reduced stripping. In a short period of time, field experiments showed comparable results with two conventional anti-stripping chemical agents while laboratory tests indicated a better performance with hydrated lime.

Miscellaneous uses of lime include sugar refining to help in the purification of crude sugar juices by removing acid compounds; in controlled atmospheric storage to extend the freshness of fruits and vegetables; in petroleum refining to neutralize sulphur compounds and sulphur dioxide emissions; and in the making of plaster, mortar, leather and rubber, paint, glass, dolomite refractories and calcium silicate bricks.

INTERNATIONAL DEVELOPMENTS

In 1990, world lime production was estimated at 134.9 Mt. The U.S.S.R., the largest producing country, accounted for 22%, followed by China (12%), the United States (11.7%), Japan (5.8%) and West Germany (5.6%). Canada ranked fifteenth with a 2% share.

United States

In 1990, the United States produced 15.78 Mt of lime, a 1.5% increase over 1989. Lime was produced in 116 plants across 32 states; Missouri, Ohio, Alabama, Pennsylvania and Texas accounted for half of all commercial sales. The captive market was estimated at 11% of total sales, with the remainder being sold on the merchant market. Shipments of quicklime and hydrated lime contributed to 85% and 15% of total sales respectively. As in 1989, sales were slow during the first quarter of 1990, then rose during the second quarter to peak in the third quarter; the fourth quarter registered a slight decline. The apparent consumption continued to grow steadily since 1986 and amounted to 15.9 Mt in 1990, compared to 15.72 Mt in 1989. The increase in consumption resulted mostly from higher sales in the chemical and industrial sectors, which accounted for 90% of lime consumed. Other end uses included construction with strong sales in 1990 (+9.8%), refractories (-4.4%) and agriculture (-24%). The average unit value for lime products rose slightly from US$46.68/short ton to US$50.00/short ton, f.o.b. plant. Imports decreased 20% to 58 000 t, and were from Canada (87%) and Mexico (13%).

OUTLOOK

The demand for lime in Canada is expected to show a modest increase during 1991. Sales in the steel, environmental control and chemical sectors are projected to remain firm. The resumption of normal operating levels in the steelmaking industry will likely increase demand compared to 1990, particularly in Ontario; however, this expectation is subject to the fate of The Algoma Steel Corporation, Limited. The pulp and paper sectors will likely experience some slowdowns in 1991, with lower operating rates compared to those prevailing during the last five years; the consumption of lime could decline slightly in Kraft and sulphate mills. However, the commissioning of new PCC units in Canada will offer strong sales opportunities to lime producers in Ontario and in Quebec.

Lime consumption in the environmental sector will remain stable in the short term

America, close to 85% of all coated paper mills have converted to the alkaline/neutral papermaking process in which PCC and Ultra-Fine Ground Calcium Carbonate (UFGCC) are used as fillers and coating agents. PCC contributes to enhance brightness and opacity in papers, and imparts low abrasivity and higher ink receptivity. Lime is used as a feedstock in the manufacture of PCC in a 0.6:1.0 ratio. Uncoated printing and writing papers use PCC as a filler and account for 60% of total PCC consumption in this sector, followed by coated papers (20%) and specialty papers and cardboards (20%). In papermaking, the maximum loading level for coater is 30% while for filler the current level ranges between 11% and 18%. Since the early 1980s, PCC consumption has increased at an annual rate of 20% in North America to reach 727 000 t in 1990, of which 94% was used in the paper sector, 3% in plastics and 3% in other manufactured products; the consumption of lime in the manufacture of PCC was estimated at about 435 000 t during 1990. By the end of 1990, close to 34 PCC plants were operational across North America with a total production capacity estimated at 1.65 Mt/y. In Canada, two plants produced PCC in 1990 at Dryden, Ontario, and at Prince Albert, Saskatchewan; three more plants are expected to come on stream by 1991.

In the mining sector, lime is used by the uranium industry to control hydrogen-ion concentration in the extraction process, to recover sodium carbonate and to neutralize waste sludges. Lime is also used for cyanidation and neutralization in the recovery of gold and silver by the flotation process. Chemical manufacturers require lime for the production of sodium carbonate (soda ash) and bicarbonate of soda; lime is also used to produce chloralkali, calcium carbide and calcium cyanimide.

The environmental control sector represents a growing end use for lime as more stringent regulations on air and water pollution are implemented. Lime is used in water pollution control to treat liquid wastes and industrial effluents, and to clarify and soften potable water. Mining companies treat acidic effluents with alkali such as lime, limestone, soda ash, ammonia and magnesium hydroxide in order to raise pH levels for neutralization and to precipitate metals. Caustic soda and soda ash are considered cost-effective for the treatment of water acidic drainage with low flow and low acidity over a short period of time; however, ammonia and hydrated lime perform better and are cheaper when treating high-flow, acidic effluents over a long period. The neutralization of lakes, acidified from the precipitation of sulphur dioxide and nitrogen dioxide emissions, has required much attention over the last two decades. The increasing acidification of lakes and streams in eastern North America is reported to affect aquatic organisms and vegetation. Effective interim actions include liming with limestone, calcite, quicklime, hydrated lime, dolomite, sodium bicarbonate, fly ash and industrial slags. However, research conducted in Ontario during the period 1981-88 demonstrated the cost-effectiveness of using pure limestone or calcite compared to other materials.

Air pollution control is a major developing market for lime in North America. In 1990, the United States adopted strict standards under the Clean Air Act calling for a 10 Mt/y reduction in the emissions of sulphur dioxide by the year 2000. Major coal-fired power stations, mostly located in the Ohio River Valley, will have to take measures to reduce their emissions from the burning of high sulphur coal, oil and lignite. Several methods could be utilized including the use of Flue Gas Desulphurization (FGD) units or scrubbers. Many options for scrubbing exist: wet scrubbing with lime or limestone; dry lime scrubbing; dry injection of sodium reagents–sodium bicarbonate, sodium sesquicarbonate, Trona and Nahcolite; dry limestone injection integrated with calcium oxide activation; and dry injection of hydrated lime. Wet scrubbing is considered as the main method using lime or limestone processes equally. The choice between lime and limestone depends on a variety of factors such as resources availability, solid wastes disposal programs, equipment costs, maintenance and operational costs, flue gas characteristics, utility type and size, and type of fuel. However, lime is an effective reagent (one tonne of lime removes one tonne of sulphur dioxide), being inexpensive and potentially recoverable.

In agriculture, lime has historically been used for neutralizing soil acidity. However, agricultural liming is now essentially done with pulverized limestone or aglime. Dolomitic liming increase capacity at its Freeport plant by another 15%-25%, if the market permits. The company is currently building a new 25 million kg/y vertical direct-chill caster.

As a result of a modernization program undertaken in the 1970s and productivity improvements in the 1980s, Dow's plant is generally regarded as a very competitive operation for magnesium metal production.

Production at the Magnesium Corporation of America (Magcorp) plant increased from the 1988 level of 33 000 t/y to 36 000 t/y by the end of 1990. The company, which uses an electrolytic process, employs more than 500 workers at its plant in Rowley, Utah, and its head office in Salt Lake City.

The magnesium chloride feedstock for the Magcorp plant is normally derived from the natural brines of Great Salt Lake. However, high water levels on the lake in 1986 caused US$20 million in damage to the solar ponding system. The company has been drawing brine since the end of 1989 from a new pond system in the west desert. MagCorp estimated that the new ponds have a 10-year to 15-year supply of brine.

Northwest Alloys, Inc., a subsidiary of the Aluminum Company of America (Alcoa), operates a magnesium plant in Addy, Washington, which uses the Magnetherm process whereby magnesium is produced by reducing dolomite with ferrosilicon. Capacity is about 33 000 t/y, although the latest reports suggest that the 1990 rate of production was somewhat higher. The company plans to increase capacity at its plant by making proprietary improvements in its processing methods.

Brazil's Companhia Brasileira de Magnesio (Brasmag) currently produces 6000 t/y of magnesium metal. On November 26, 1990, Brasmag filed for bankruptcy protection under Brazilian law, but the plant is expected to run normally under the control of its parent company, Rima Eletrometalurgia S/A. Under Brazilian law, companies under the Rima group will have two years to repay their debts. Future expansions at the Bocaiuva plant will therefore be delayed until a final settlement is reached.

Norsk Hydro AS operates a 60 000 t/y primary magnesium plant at Porsgrunn, Norway. The plant produces magnesium by the electrolysis of magnesium chloride derived from a seawater/dolomite process and from magnesium chloride brine imported from Germany. Following the start-up of production at its Bécancour plant, Norsk Hydro decided to temporarily reduce production at Porsgrunn beginning in 1990. The drop in production, which should not exceed 10 000 t/y, is part of the company's modernization and anti-pollution program. Norsk Hydro must comply with a rigorous plan set by the Norwegian State Pollution Control Authority (SFT) aimed at cutting dioxin effluents in half by the end of 1989, and eliminating them altogether by January 1, 1995. The SFT also asked Norsk Hydro to submit a plan to reduce atmospheric emissions.

Elkem a/s revived its plans to build a magnesium metal plant in Norway. Elkem was expected to finalize its feasibility study in 1990 on a 20 000-25 000 t/y plant using Brasmag technology. The company hopes to negotiate energy supply and a site for the plant with Norwegian officials. The project could be implemented in late 1991.

Pechiney Électrométallurgie operates a 15 000 t/y smelter in Marignac, France. During 1990, the company continued the rationalization of its magnesium division. Pechiney anticipated reducing its production costs by 15% and increasing capacity by 2000 t/y through reduction in the workforce, diminishing overhead costs, technological improvements, energy savings, etc. Pechiney also developed a new dolomite quarry at Bois des Teuses, 25 km from the Marignac plant, at a cost of 31 million FF. Pechiney uses its Magnetherm proprietary process.

Queensland Metal Corp. of Australia is looking for partners to build a 60 000 t/y magnesium metal plant adjacent to its magnesite deposit. Initially, the company is expecting to commission a 1000 t/y pilot plant in early 1991. Queensland Metal Corp. is anticipating to start production by the middle of the 1990s when the market in Japan is expected to grow considerably.

Magnesium

Anglo American Corporation of South Africa Ltd. and the Rembrandt Group subsidiary, Trans Hec, are conducting a feasibility study on a 10 000 t/y plant in Vredental in the western cape of South Africa.

Another project to produce magnesium metal is being built in India. Ispat Alloys of India will build a 4000 t/y operation near Agartala in the northeastern state of Tripura for about US$37.5 million. The facility will use a pyrometallurgical process from Mitsui & Co. Ltd. This area of India is rich in dolomite feed, while ferrosilicon will come from Ispat's facility in Balgopalpur. In April 1990, Tamil Nadu Industrial Development Corporation commissioned a 1200 t/y magnesium plant also in India.

Japan's production of magnesium reached 12 000 t in 1989, an increase of 20.5% over its 1988 total. Production increases by Japan Metals & Chemicals Co. Ltd. and Ube Industries Limited were responsible for this rise.

PRICES

In September 1990, magnesium stocks had increased by 11 500 t over the September 1989 level of 28 000 t.

In that context, Dow Chemicals Company announced a US20¢ cut in primary ingot and alloy prices from US$1.63/lb to US$1.43/lb. However, the official price for die-casting alloy AZ91D remained unchanged at US$1.43/lb.

The start-up of the Norsk Hydro and MAGCAN facilities was quoted as the reason for the price declines.

USES AND MARKETS

The main application of magnesium is as an alloying agent for aluminum, accounting for close to 53% of non-socialist consumption in 1989. Despite the 10% increase that occurred between 1987 and 1988, consumption for this application decreased by 2.9% between 1988 and 1989, to 130 400 t/y. It is predicted that magnesium consumption for this application will not grow over the next few years because of increased recycling of cans and a reduction in their thickness.

The second largest use of magnesium is as a deoxidizing and desulphurizing agent in the ferrous industry. The demand for magnesium in 1989 was 32 300 t, 12.9% higher than in 1988. This sector, which has grown an average of 15% per year over the past six years, should continue its rapid growth because of a considerable increase in demand in Europe.

The third largest use of magnesium is in structural applications, of which pressure die-cast products constitute the most important use. Consumption increased from 21 000 t in 1982 to 28 600 t in 1989, and should exceed 50 000 t/y within five years. During the next decade, this sector should show more growth than any other application of magnesium. Rapid growth in the die-casting sector is expected to be particularly important in the United States and Japan.

Magnesium die casting has a number of advantages over aluminum, such as its lower heat of solidification, which increases die-casting production capacity by approximately 25% and results in major process energy savings. In addition, magnesium dies are reported to last as much as two times longer than aluminum dies. Some aluminum parts which require several castings can be produced in magnesium with a single casting. Furthermore, some die casters note that even at a magnesium-aluminum price ratio of 1.7:1, some magnesium metal parts can be fabricated at the same cost as those made of aluminum.

Greater awareness of energy conservation and air pollution, owing primarily to recent studies of the greenhouse effect, has led the U.S. government to take steps aimed at reducing carbon dioxide emissions. In 1990, stricter Corporate Average Fuel Economy (CAFE) requirements by the U.S. government came into effect. The average consumption of new vehicles produced in the United States increased from 26 miles per gallon in 1989 to 27.5 miles per gallon in 1990. The CAFE requirements were enacted by Congress as part of the 1975 Energy Policy and Conservation Act. There are also plans to further improve new vehicle consumption requirements in the near future in order to reduce pollution in major urban centres in the United States.

According to some reports, the consumption levels for new vehicles will be reached through improved traction (50%), reduced weight (35%) and modifications related to friction and aerodynamics (15%). If the only means of reaching the new consumption levels were through reduced vehicle weight, 250 pounds would have to be eliminated to obtain one extra mile per gallon.

Other automobile manufacturers recently announced plans to make greater use of magnesium. Both the Toyota Motor Corporation and the Ford Motor Company, for example, plan to use magnesium for the valve covers in some of their models. The decision by General Motors Corporation to use magnesium for the steering columns on the Regal and Cavalier will increase magnesium consumption by 0.75 kg per vehicle.

Finally, as part of its program to improve vehicle safety, the Ford Motor Company has equipped some of its 1990 models with a pneumatic protective device (air bag). Approximately 2 kg of magnesium will be used to anchor the new device. According to the manufacturer of this device, Diemakers Inc., the use of magnesium instead of aluminum, zinc or steel will ensure weight savings in the order of 50% and reduce the number of parts by half. The use of magnesium also leads to lower costs and greater reliability. It is estimated that the consumption of magnesium for the device could reach 3000 t/y within three years. Other car manufacturers will undoubtedly follow suit in the next few years, thereby creating new opportunities for this application. Teams of specialists from the major magnesium producers are making consultants available to automobile manufacturers to suggest appropriate uses for the metal.

In Europe, Mercedez Benz started to use a 8.5 kg magnesium one-piece seat frame on some of its models. Another German company Audi will use a 4.2 kg magnesium part for dashboard bulkhead on its V8 sedan. The company anticipates using this part on other models.

The Japanese market, which consumed approximately 24 000 t in 1989 has a strong growth potential mainly in the die-casting sector where consumption is currently estimated at 2000 t/y. For instance, Nissan announced that by the turn of the century its cars could contain 40 kg of magnesium. Honda Motor Co. Ltd. offered magnesium, instead of aluminum, rims on its 1989 Preludes. The new 5.9 kg rim made this part more than 20% lighter.

Nippon Light Metals Company Ltd. manufacturers of the Honda Prelude magnesium wheel, recently reached an agreement with Diemakers Inc. to promote sales of Diemakers magnesium products to Japanese automobile manufacturers in Japan and the United States.

Aside from automotive applications, die-cast magnesium products are widely used in the manufacture of portable tools and sporting goods. The use of magnesium in electronic equipment, particularly computer housings and components, has grown substantially, and this trend is expected to continue. Magnesium is preferred for these applications not only because of its good strength-to-weight ratio, but also because it dissipates heat well, confines electro-magnetic fields, and dissipates radio frequency interference. Chicago White Metal Casting Inc. specializes in this type of casting and recently acquired equipment with a higher capacity and greater precision.

Magnesium is also used to produce nodular iron (16 900 t or 6.9%), of total Western World consumption, primarily ductile iron pipes and die-cast parts for use in automobiles and farm equipment, and as a reducing agent (9400 t or 3.8%) in the production of titanium, beryllium, zirconium, hafnium and uranium. Chemical applications (5500 t or 2.2%) include the manufacture of pharmaceutical products, perfumes and pyrotechnics. Electrochemical applications account for 3.3% of magnesium consumption for use in the manufacture of batteries and anodes for cathodic protection of gas pipelines and water heaters. Wrought products (2.5%) mainly include extruded products except anodes, sheets and plates; gravity casting (1%) includes the production of complex or large parts by sand casting or with other materials. Other applications together account for 2.8% of magnesium consumption.

Magnesium

RECYCLING

Anticipated growth of magnesium die-cast parts in the automotive sector should provide greater opportunities for magnesium recycling. Norsk Hydro Canada Inc. is the first company to have announced its intentions to collect magnesium scrap from its clients at its $7 million scrap remelting facility, scheduled to be in production at the end of 1991. Other companies, particularly in the United States, are expected to announce similar initiatives in the near future.

OUTLOOK

Within five years, Western World magnesium consumption should rise to more than 325 000 t/y, primarily because of the substantial increase expected in the die casting of automobile parts and the desulphurization of steel.

The magnesium industry, which has undergone tremendous change in recent years primarily as a result of plant rationalization and the construction of new plants, will remain in a period of transition.

Impact of the current recession could have considerable impact on some uses of magnesium, particularly in aluminum alloying, steel desulphurization and die-cast autoparts. However, consumption in the die-cast autoparts sector should continue to enjoy growth because, even if total car manufacturing decreases, the use of magnesium in this sector has such growth potential that there will likely be a net increase in consumption. The economic slowdown and increased production is expected to further affect magnesium prices. In addition, rationalizations could force the producers with the highest costs to cut their production or abandon the market.

If growth in consumption is to be sustained, magnesium will have to perform well, especially against aluminum in the automobile parts sector. A long-term magnesium-aluminum price ratio of 1.5:1 could lead to important breakthroughs for new applications.

Canada has a number of competitive advantages, including cheap and abundant energy, easy access to raw materials and proximity to the U.S. market, which could make it a key player in the industry.

Note: Information contained in this review was current as of mid-January 1991.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EEC MFN	Japan[1] MFN
81.04	Magnesium and articles thereof, including waste and scrap						
	Unwrought magnesium:						
8104.11	Containing at least 99.8% by weight of magnesium	4%	2.5%	2.8%	6.4%	5.3%	6.5%
8104.19	Other	4%	Free	2.8%	5.2%	5.3%	6.5%
8104.20	Waste and scrap	Free	Free	Free	Free	Free	3.2%
8104.30	Raspings, turnings and granules, graded according to size; powders						
8104.30.10.00	Raspings, turnings and granules; powders, alloyed	10.2%	6.5%	7.1%	5.2%	5.3%	7.2%
8104.30.20.00	Powders, not alloyed	4%	2.5%	2.8%	5.2%	5.3%	7.2%
8104.90	Other						
8104.90.10	Bars, rods, plates, sheets, strip, foil, tubes and pipes, alloyed	4%	Free	2.8%	2.8%	5.3%	7.2%
8104.90.90	Other	10.2%	6.5%	7.1%	2.8%	5.3%	7.2%
8104.90.90.10	Structural shapes	10.2%	6.5%	7.1%	2.8%	5.3%	7.2%
8104.90.90.90	Other	10.2%	6.5%	7.1%	2.8%	5.3%	7.2%

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States 1990; Official Journal of the European Communities, Vol. 33, No. L247, 1990, "Conventional" column; Customs Tariff Schedules of Japan, 1990.
[1] GATT rate is shown; lower tariff rates may apply circumstantially.

TABLE 1. CANADA, MAGNESIUM EXPORTS AND IMPORTS BY COMMODITIES AND COUNTRIES, 1989 AND 1990

Item No.		1989		Jan.-Sept. 1990p	
		(tonnes)	($000)	(tonnes)	($000)
Exports					
8104.11	Magnesium unwrought containing by weight at least 99.8% of magnesium				
	United States	159	624	10 454	35 967
	Netherlands	79	388	601	2 688
	United Kingdom	258	1 718	286	1 949
	Australia	312	1 870	240	1 473
	Switzerland	208	1 336	156	743
	Other countries	260	1 397	447	1 866
	Total	1 276	7 333	12 184	44 686
8104.19	Magnesium unwrought, n.e.s.				
	United States	123	650	777	2 736
	Australia	9	61	13	95
	Other countries	13	68	59	573
	Total	145	779	849	3 404
8104.20	Magnesium waste and scrap				
	United States	414	1 400	2 609	6 994
	South Korea	63	218	–	–
	Italy	6	11	–	–
	United Kingdom	–	–	12	25
	Total	483	1 630	2 621	7 019
8104.30	Magnesium raspings, turnings or granules graded according to size and powders				
	United States	482	2 750	399	2 501
	Ireland	82	559	167	1 213
	South Korea	30	166	60	353
	Other countries	32	213	...	1
	Total	626	3 688	627	4 070
8104.90	Magnesium and articles thereof, n.e.s.				
	United States	12	330	58	242
	Other countries	6	48	2	12
	Total	18	378	60	255
	Total Exports	2 548	13 808	16 341	59 434
Imports					
8104.11	Magnesium unwrought containing by weight at least 99.8% of magnesium				
	United States	4 984	17 444	4 121	13 886
	France	144	591	319	1 246
	Norway	198	752	330	1 121
	Other countries	5	24	2	7
	Total	5 331	18 811	4 771	16 261
8104.19	Magnesium unwrought n.e.s.				
	United States	5 110	16 691	2 713	8 453
	Norway	1 514	5 176	2 298	7 155
	United Kingdom	229	1 602	35	315
	France	160	662	–	–
	Other countries	5	15	20	61
	Total	7 018	24 147	5 066	15 986
8104.20	Magnesium waste and scrap				
	United States	80	210	37	106
	Total	80	210	37	106
8104.30.10	Magnesium raspings, turnings or granules, graded according to size and powders, alloyed				
	United States	2	13	43	170
	Total	2	13	43	170
8104.30.20	Magnesium powders, not alloyed				
	United States	17	83	309	1 254
	Total	17	83	309	1 254

TABLE 1 (cont'd)

Item No.		1989		Jan.-Sept. 1990p	
		(tonnes)	($000)	(tonnes)	($000)
Imports (cont'd)					
8104.90.10.10	Magnesium bars and rods				
	United States	46	284	71	218
	Other countries	18	74	1	5
	Total	64	358	71	223
8104.90.10.20	Magnesium plates, sheets, strip, foil, tubes and pipes				
	United States	99	1 341	115	1 073
	Other countries	–	–	1	7
	Total	99	1 341	116	1 080
8104.90.90.10	Magnesium structural shapes				
	United States	18	142	6	48
	Total	18	142	6	48
8104.90.90.90	Magnesium articles n.e.s.				
	United States	352	2 216	358	1 957
	Other countries	23	667	–	–
	Total	375	2 885	358	1 957
	Total Imports	13 004	47 990	10 777	37 085

Source: Statistics Canada.
p Preliminary; – Nil; . . . Amount too small to be expressed; n.e.s. Not elsewhere specified.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, CONSUMPTION[1] OF MAGNESIUM, 1983-89

	1983[4]	1984[4]	1985[4]	1986[4]	1987	1988[4]	1989p
				(tonnes)			
Castings and wrought products[2]	1 579	2 047	1 814	2 628	3 837	5 067	5 661
Aluminum alloys	3 878	4 841	4 813	4 907	4 508	7 810	7 836
Other uses[3]	1 200	1 455	1 316	1 191	1 124	1 189	1 910
Total	6 657r	8 343r	7 943r	8 726	9 469	14 066	15 407

[1] Available data as reported by consumers. [2] Die, permanent mould and sand castings, structural shapes, tubings, forgings, sheet and plate. [3] Cathodic protection, reducing agents, deoxidizers and other alloys. [4] Increase in number of companies being surveyed.
p Preliminary; r Revised.

TABLE 3. WORLD PRIMARY MAGNESIUM PRODUCTION, 1985-89

	1985	1986	1987	1988p	1989e
			(000 tonnes)		
Brazil	2 615	4 356	5 488	5 865	6 200
Canadae	7 200	5 100	8 800	7 600	7 200
Chinae	3 000r	3 000r	3 000r	3 200r	3 200
France	13 639	13 361	13 601	13 800	13 900
Italy	7 863	12 417r	7 626	5 436	2 770
Japan	8 456	8 116	8 180	9 012	11 385
Norway	54 704	56 522	56 907	50 300	49 827
U.S.S.R.e	87 000	89 000	90 000	91 000	91 000
United States	135 728	125 639	124 396	141 983	152 066
Yugoslavia	4 978	4 897	5 932	6 176	6 000
Total	325 183r	322 408r	323 930	334 372	343 548

Source: U.S. Bureau of Mines.
e Estimated; p Preliminary; r Revised.

TABLE 4. PRIMARY MAGNESIUM PRODUCTION BY WORLD ZONE[1], 1980-90

Period	**Area 1** United States and Canada	**Area 2** Latin America	**Area 3** Western Europe	**Area 5** Asia and Oceania	Total
			(000 tonnes)		
1980	163.0	–	64.4	9.2	236.6
1981	138.4	–	64.4	5.7	208.5
1982	97.8	–	52.8	5.8	156.4
1983	109.0	–	51.0	6.0	166.0
1984	152.8	1.0	71.6	6.7	232.1
1985	142.9	2.0	80.8	8.2	233.9
1986	130.7	3.7	81.4	8.1	233.9
1987	133.2	5.2	84.0	7.9	230.3
1988	149.6	5.8	76.2	9.6	241.2
1989	158.4	6.2	76.5	11.7	252.8
1990[2]	124.1	5.9	55.8	9.7	195.5

Source: International Magnesium Association.
[1] There is no production in **Area** 4 Africa and the Middle East. [2] Jan.-Sept.
– Nil.

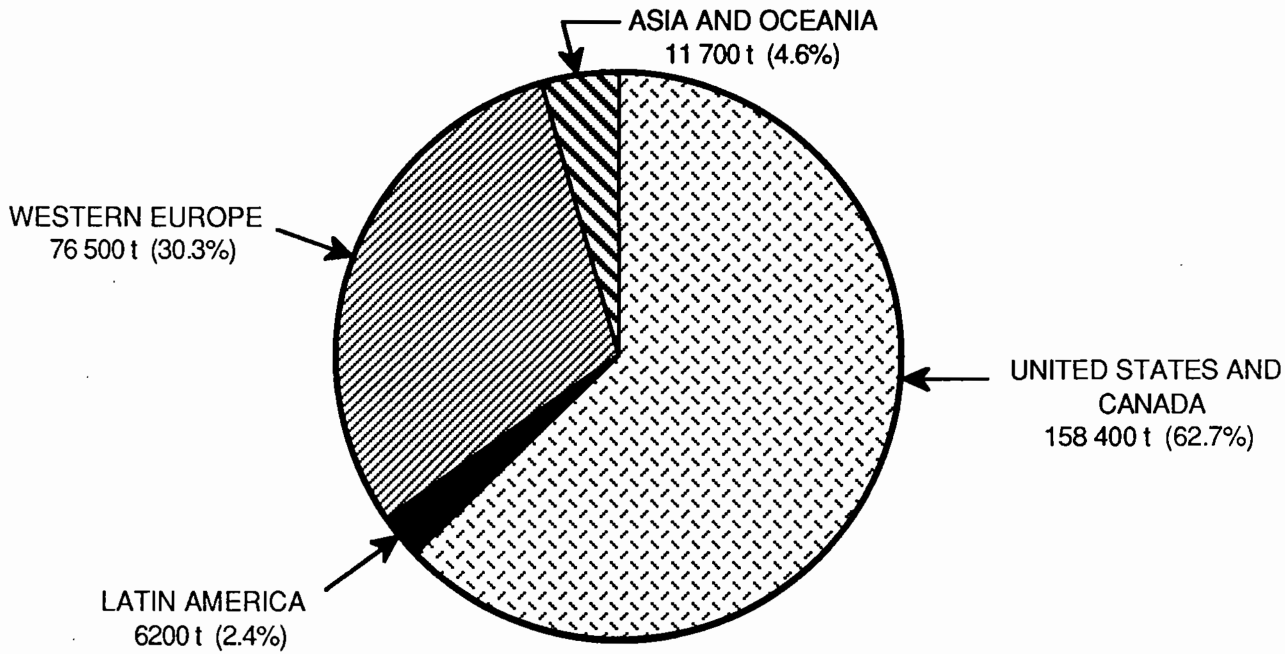
TABLE 5. PRIMARY MAGNESIUM SHIPMENTS BY WORLD ZONE, 1980-90

Period	**Area 1** United States and Canada	**Area 2** Latin America	**Area 3** Western Europe	**Area 4** Africa and Middle East	**Area 5** Asia and Oceania	**Area 6** Other	Total
				(000 tonnes)			
1980	111.0	17.0	66.0	2.0	23.0	–	219.0
1981	104.0	12.0	61.0	2.0	24.0	–	203.0
1982	85.5	8.3	60.6	1.3	17.7	–	173.7
1983	98.6	9.6	60.4	2.4	33.4	–	204.4
1984	110.1	8.0	66.8	1.6	29.5	–	216.0
1985	102.4	9.4	72.2	2.4	38.4	–	224.8
1986	103.3	11.3	73.6	3.2	35.0	–	226.4
1987	113.7	8.3	66.9	5.2	28.7	13.2	236.0
1988	125.0	11.7	70.6	3.8	33.8	6.2	251.2
1989	128.1	9.1	69.2	2.7	33.0	4.1	246.2
1990[1]	96.9	9.2	50.5	4.7	27.1	2.6	191.0

Source: International Magnesium Association.
[1] Jan.-Sept.
– Nil.

Figure 1

PERCENTAGE OF MAGNESIUM METAL
Production by World Zone, 1989

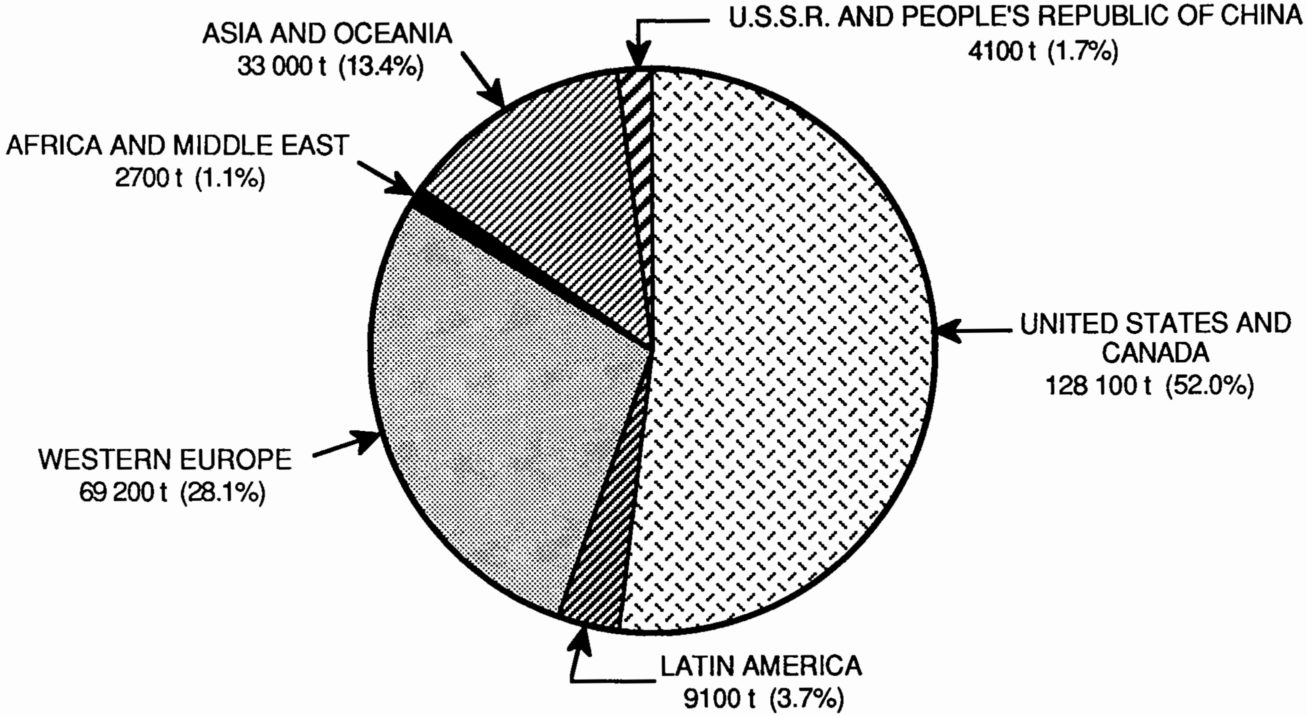


TOTAL WESTERN WORLD PRODUCTION : 252 800 t

SOURCE: INTERNATIONAL MAGNESIUM ASSOCIATION

Fig

PERCENTAGE OF MAGNESIUM METAL
Shipments by World Zone, 1989

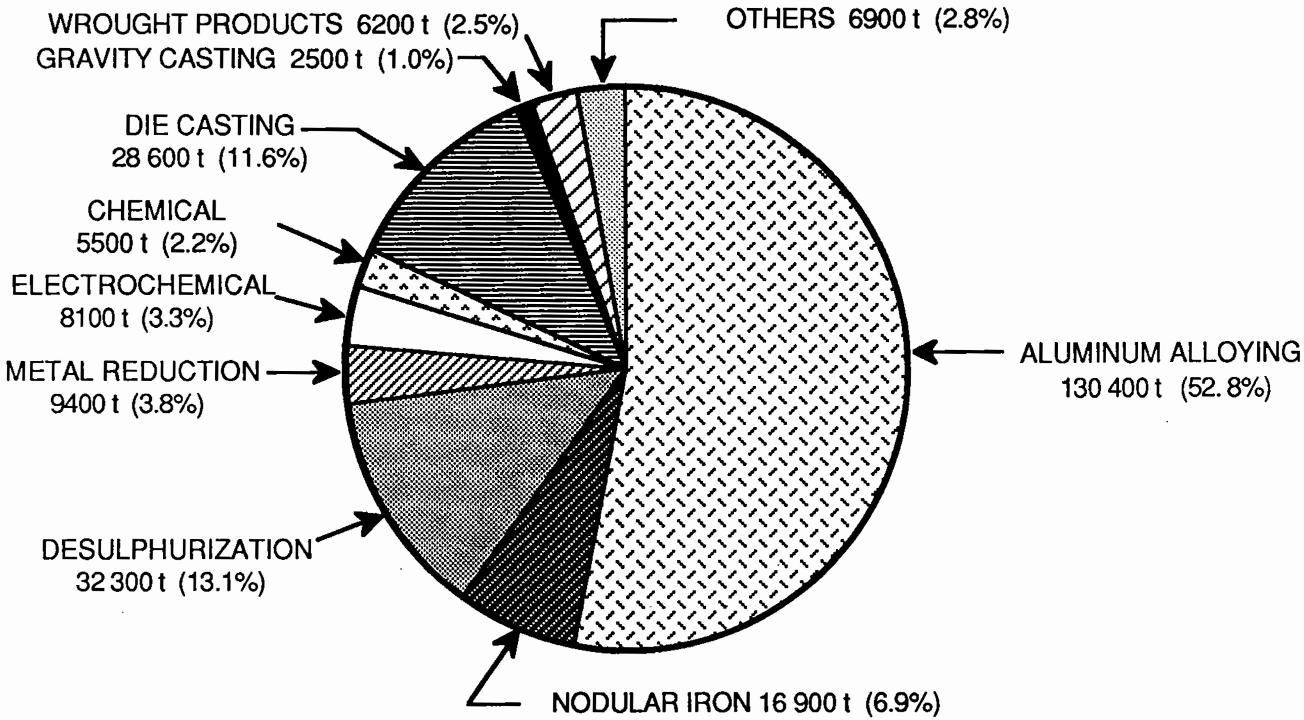


TOTAL SHIPMENTS : 246 200 t

SOURCE: INTERNATIONAL MAGNESIUM ASSOCIATION

Figure 3

PERCENTAGE OF MAGNESIUM SHIPMENTS
By Use in 1989



TOTAL SHIPMENTS : 246 200 t

SOURCE: INTERNATIONAL MAGNESIUM ASSOCIATION

Mercury

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Mercury (Hg), one of two elements that is liquid at ambient temperatures, is principally recovered from sulphide ores and recycled materials; mining of mercury deposits is conducted in some instances. The most common host geological formations are limestone, calcareous shale and sandstone, although nearly all mercury is recovered from the red sulphide ore known as cinnabar (HgS). Recovery from ore generally approaches 95% and usually exceeds 99.9% purity. Mercury-bearing ore is heated in furnaces to volatilize the mercury, releasing the sulphur as sulphur dioxide. A condenser collects the mercury as a liquid, with further purification being done by filtration, multiple distillation, chemical or air oxidation, or electrolytic refining. Mercury-bearing scrap, dusts and residues are treated by recyclers, particularly during periods of high mercury prices and high feed availability.

CANADIAN DEVELOPMENTS

Canada imported 32 442 kg of mercury metal in 1989 valued at $346 000. Estimates of imports for the period January to September 1990 are 39 146 kg valued at $397 000.

Canadian consumption of mercury metal for electrical apparatus, industrial and control instruments, and the electrolytic preparation of chlorine and caustic soda, was 27 364 kg in 1988, increasing 17.8% to 32 226 kg in 1989.

There has been no Canadian production of mercury since Cominco Ltd. suspended its mining operations at Pinchi Lake in 1975.

WORLD DEVELOPMENTS AND RESOURCES

According to 1989 production figures, the most important mercury-producing countries are the U.S.S.R. (2310 t), Spain (1500 t), China (850 t), Algeria (690 t) and the United States (460 t).

The U.S.S.R. is estimated to have the largest reserves of mercury, and has been the largest producer of mercury since the early 1970s. Although not much is known about the Soviet operations, it is known that mining operations are located in the Republic of Kirghizia near the border with China, and in the Ukraine.

Minas de Almaden y Arrayanes SA of Spain is the largest producer of mercury in the Western World and is also one of the oldest operating mines in the world; the Almaden mine has been in nearly continuous operation for more than 2000 years. Almaden operates an open-pit mine at El Entredicho, which was developed in 1981, and Las Cuevas, which came on stream in 1987 and is located 12 km north of Almaden. In 1987, the company announced a new find near Entredicho having an expected yield of more than 4000 tonnes. Because of declining prices and an inventory in the order of 60 000 flasks [1 flask = 34.473 kg], Almaden halted mining operations for nearly three months in late summer 1990, using this period to undertake secondary recovery of mercury from residues and to dispose of its wastes, some of which the company buys back from customers.

China is known to have mercury reserves in the provinces of Kweichow, Huna, Kwangsi, Liaoning and Shanxi, although not much other information is available.

Mercury production in the United States has been largely from the McDermitt mine in Nevada which closed in 1987, re-opened in 1988 and closed again in November 1990 due to low prices. Mercury is also obtained as a by-product from 14 gold mining operations in Nevada, California and Utah. A few companies in the eastern United States recover mercury from waste items such as dental amalgams, batteries and instruments. Mercury is also recovered from chlorine and caustic soda plants and from the U.S. Department of Energy's stocks of secondary mercury. However, because U.S. demand exceeds internal sources, the United States is a net importer of mercury, largely from Spain and China.

PROPERTIES AND USES

Mercury's liquid state at ambient temperature and its high electrical conductivity make it useful in various electrical applications. Uses for elemental and inorganic mercury compounds include: scientific instruments (e.g. barometers); electric equipment (e.g. meters, switches); in batteries as a mercury oxide cathode in an alkaline dry cell battery (because of its relatively flat discharge curve, its constant voltage and its reliability during temperature fluctuations); mercury vapour lamps for which demand is increasing because they are energy efficient; amalgams with copper, tin, silver or gold; and solders with lead and tin. In the chemical industry, mercury is used as a fluid cathode in the electrolytic production of chlorine and caustic soda, as a chemical reagent (e.g. as a catalyst in the production of vinyl chloride), in paints and pigments, in the extraction of gold and silver from ores, and in the preparation of some pharmaceuticals and disinfectants.

HEALTH AND SAFETY ISSUES AND REGULATORY DEVELOPMENTS

Awareness of the toxicity of mercury and mercuric salts has led to more stringent occupational exposure limits and tougher environmental regulations. Occupational exposure is via the inhalation of mercury vapour or absorption of mercury metal which becomes concentrated in the kidneys, liver and/or brain. Environmental awareness of mercury has been largely due to the publicity surrounding minamata disease, which was discovered in Japan in the late 1950s. Minamata disease is caused by methylmercury, an alkylmercury compound from inorganic mercury found in industrial effluent in Minamata, Japan. Elemental mercury and mercuric salts are easily ingested by fish and then concentrated up the food chain, ultimately impacting on humans.

In Europe, there are a number of European Communities directives on mercury relating to water, health and environmental protection, and mercury pollution is now deemed to be reasonably well controlled.

The U.S. Environmental Protection Agency banned the use of mercury in interior latex paints and limited the amount which could be used in exterior house paints on August 1, 1990, with the expected result being decreased demand.

Japan is considering ways to reduce overall consumption of mercury, even to the point of considering a ban. One option currently under consideration by the Ministry of International Trade and Industry (MITI) will force dry cell battery manufacturers to reduce the mercury content in both manganese and alkaline batteries.

PRICES

The price of mercury peaked in 1988 at US$335.52 per flask, declining to US$287.72 in 1989 and to US$249 in 1990. The price drop is related to declining demand as the Japanese eliminate mercury from batteries, and the fact that the United States has banned mercury from certain paints.

OUTLOOK

Because of the rising awareness of the toxicity of mercury, the market outlook is bleak with increasingly stringent regulations being promulgated and current users searching for unregulated substitutes. As supplies and reserves of mercury remain high, prices are not expected to rise in real terms.

Note: Information contained in this review was current as of mid-January 1991.

AVERAGE MERCURY PRICES

	1986	1987	1988	1989	1990
	(US$ per flask, 99.99% purity)				
January	265	217	351	282	290
February	245	208	353	316	290
March	248	240	346	312	285
April	269	273	345	295	285
May	270	313	345	295	282
June	262	307	361	295	270
July	233	296	370	283	254
August	196	313	364	270	241
September	173	342	334	261	220
October	197	355	297	268	200
November	215	350	285	286	191
December	220	332	276	290	181
Average	233	296	336	288	249

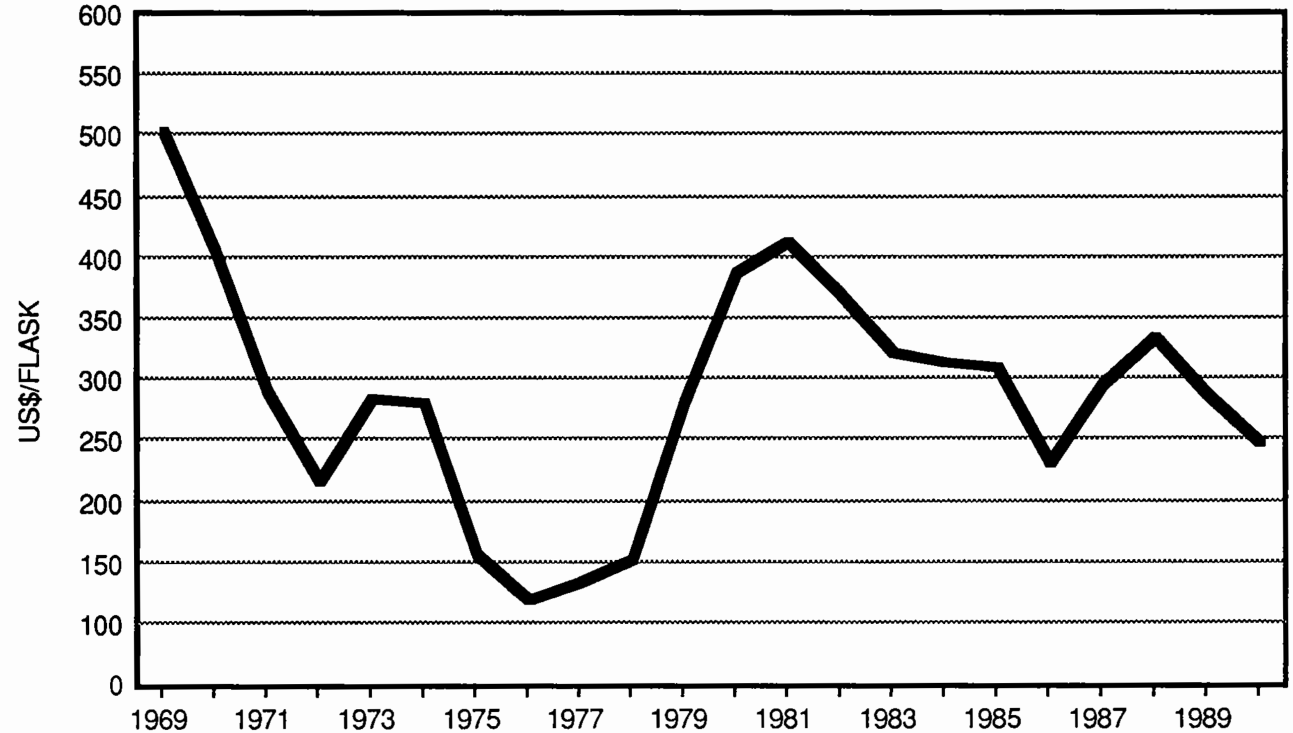
Source: Metals Week.

TABLE 1. CANADA, MERCURY TRADE 1986-90 AND CONSUMPTION, 1986-89

Item No.		1986		1987		1988		1989		Jan.-Sept. 1990	
		(kg)	($000)	(kg)	($000)	(kg)	($000)	(kg)	($000)	(kg)	($000)
Exports											
2805.40	Mercury										
	United States	..	..	..	..	28 697	302	–	–	8 381	48
	Other countries	..	..	..	..	20 004	7	14	2	541	13
	Total	..	..	..	..	48 701	309	14	2	8 922	61
Imports											
2617.90.00.20	Mercury ores and concentrates										
	United States	..	..	..	..	366	2	–	–	–	–
	Total	..	..	..	..	366	2	–	–	–	–
2805.40	Mercury										
	United States	52 000	500	33 000	346	36 245	421	32 442	346	39 079	397
	Other countries	25 000	261	–	–	–	–	–	–	67	...
	Total	77 000	761	33 000	346	36 245	421	32 442	346	39 146	397
2825.90.10.20	Mercury oxides										
	United States	..	..	..	..	22 518	212	13 729	222	770	15
	Spain	..	..	..	..	21 506	363	6 000	98	–	–
	Other countries	..	..	..	..	12	1	284	5	50	1
	Total	..	..	..	..	44 036	576	20 013	325	820	16
Consumption[1] (metal)											
Electrical apparatus, industrial and control instruments		38 130		23 555		16 084		18 104p			
Electrolytic preparation of chlorine and caustic soda and other uses		13 946		12 159		11 280		14 122p			
Total		52 076		35 714		27 364		32 226p			

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] As reported by consumers.
p Preliminary; – Nil; .. Not available; ... Amount too small to be reported.

AVERAGE ANNUAL PRICE OF MERCURY
1969-90



Sources: Metals Week; U.S. Bureau of Mines.

Mineral Aggregates

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The economy went into recession in 1990 following weaker growth and construction activity beginning in late 1989. Residential construction slowed throughout the current year and in September housing starts fell to their lowest level in five years.

Demand for mineral aggregates is mainly local or regional–reflecting trends in domestic construction–although international bulk shipping is becoming important in some areas. Over the past four years, the production of aggregates, including crushed stone and sand and gravel, has been in excess of 350 Mt/y. Related unit values have increased at average annual inflation rates, with selling prices varying considerably depending on proximity to consumers. Housing starts, a broad indicator of demand for most primary construction materials, were 222 562 in 1988, 215 382 in 1989, and then fell to about 182 000 in 1990. Total construction expenditures in 1990 were an estimated 15% lower than the $106 billion forecasted.

Recent federal/provincial government programs to assess aggregate resources and future market needs were concluded. Some of these were undertaken as part of Mineral Development Sub-Agreements under the Economic and Regional Development Agreements (ERDAs).

CANADIAN DEVELOPMENTS

Numerous constraints to increasing the reserves of aggregates persist because property owners generally oppose the opening of nearby quarries or pits. Increasingly, however, there is more awareness of the importance of this sector of the mining industry and its fundamental role in essentially all construction activity. Ontario's new Aggregate Resources Act, probably the most comprehensive Act of its kind in Canada, was proclaimed on January 1, 1990. Former legislation regarding extraction was mainly regulatory, lacking powers to enforce environmental, conservation or rehabilitation aspects of the industry.

With respect to resource evaluation, the Ontario Ministry of Natural Resources is involved with a number of economic assessment studies relating to supply-demand, costs, recycling and re-use. Goals are to assure that decision makers are aware of alternatives, the non-renewable resource aspect and the socio-economic aspects of longer haul distances. Several other provinces are involved with related, but less comprehensive, studies.

Sand and Gravel

Sand and gravel deposits are widespread and large producers have established plants as convenient as possible to major consuming centres. In addition to large aggregate operations usually associated with other construction-related activities such as ready-mix or asphalt plants, many small producers active on a seasonal or part-time basis serve local markets. Also, relatively large operations may operate intermittently, serving when required as suppliers to heavy construction companies. Provincial departments of Highways operate regional or divisional quarries supplying road-bed material for new and repair work. Clearly, exploitation by a wide range of groups has been an obstacle to capturing complete production and consumption data. In Ontario's case, the largest producing province, estimates indicate that the total production of aggregates from all sources–including designated areas as well as wayside sources, Ministry of Transportation sites, Crown lands and private lands–is 25%-30% higher than official statistics indicate.

Crushed Stone

Many of these stone-producing operations are part-time or seasonal; others are operated as subsidiaries of construction or manufacturing establishments not classified to the stone industry. Also, some are operated by municipal or provincial government departments producing stone for their own use, as referred to above. Quarries removing rock by drilling, blasting and crushing are generally associated with work by large construction companies, and not with smaller, more local needs often associated with gravel pits. Depending on costs and availability, crushed stone competes with gravel and crushed gravel as an aggregate in concrete and asphalt, and as railway ballast and road metal. In these applications, it is subject to the same physical- and chemical-testing procedures as the gravel and sand aggregates.

Steetley Quarry Products Inc. continued an expansion and modernization program at its Dundas quarry near Hamilton, Ontario. When completed, the program is expected to nearly double the current capacity of about 3 Mt/y. The largest quarry operator in Canada is Dufferin Aggregates, a subsidiary of St. Lawrence Cement Inc., operating near Milton, Ontario, and producing about 7.0 Mt/y.

The recent takeover of Gormley Aggregates Ltd. of Gormley, Ontario, by Lake Ontario Cement Limited (now Essroc Canada Inc., in turn owned by Société des Ciments Français) effectively doubles Ciment Français' aggregate production capacity in North America.

Lafarge Canada Inc., the largest producer of ready-mix concrete and aggregates in Canada, completed a new state-of-the-art aggregates plant at the Lafarge quarry on the east end of the island of Montreal.

Quarrying to supply high-quality construction aggregates or chemical stone has been successful on the east and west coasts where large-volume ocean transportation facilities serve to reduce unit transportation costs. Producers of high-calcium limestone on Texada Island in British Columbia have for many years provided raw material to cement and lime producers in Vancouver and the state of Washington. Also, granite aggregate from the Porcupine Mountain quarry at Auld's Cove, near Port Hawkesbury, Nova Scotia, has been transported by barge to serve some of Atlantic Canada, and in recent years 50 000-60 000 t loads have been shipped as far as Houston, Texas.

The Newfoundland Resources & Mining Company Limited, owned by Explaura Holdings PLC of the United Kingdom, opened its new crushed limestone operation at Lower Cove, near Stephenville on the Port-au-Port Peninsula in western Newfoundland. The $30 million plant and handling facility was designed mainly for shipping bulk quantities to the eastern seaboard. Approximately 500 000 t can be stockpiled for shipment at present, with capacity to produce about 4.3 Mt/y.

The Kelly Rock Limited project planned in 1989 by Municipal Ready Mix Ltd. of Sydney, Nova Scotia, was on hold pending environmental reviews. Considerable public concern developed and the review process is now expected to extend beyond the provincial Department of the Environment to involve federal authorities. Plans are to develop a major marine quarry situated on deep water at Kelly's Mountain, about 40 km north of Sydney, to produce 4-5 Mt/y of granite aggregates mainly for eastern seaboard markets.

WORLD DEVELOPMENTS

International investments, particularly by European companies in North America, slowed considerably in 1990. Relatively fewer opportunities, as well as growing interest in other areas including Eastern Europe, may have been factors influencing corporate strategies. Major companies involved in recent years include Tarmac plc, RMC Group plc, Redland plc, C.H. Beazer, English China Clays plc, Alfred McAlpine PLC, Blue Circle Industries Ltd., BTR Ltd., Hanson PLC, Consolidated Gold Fields PLC and Wimpey Construction Ltd.

Very large-scale, on-shore "marine" quarrying of normal stone aggregates to serve international markets has attracted considerable interest in Great Britain, Europe, the United States and Canada. The approach was pioneered in 1986 by Foster Yeoman Ltd. at its Glensanda quarry on the west coast of Scotland, followed recently by Vulcan Materials Co.'s joint venture on Mexico's Yucatan Peninsula.

Offshore dredging projects for aggregates have become more important because of strong demand and more on-land environmental and zoning constraints. This is particularly true in the United States, but also applies to Japan where seabed sands account for about 40% of total domestic production of fine aggregates needed for concrete.

Lightweight Aggregates

Elements of source, processing methods and end use are generally used to classify lightweight aggregates. Source rocks include pumice, scoria, volcanic cinders and tuff. Manufactured lightweight aggregates are bloated or expanded products commonly obtained by heating certain clays, shales and slates. Ultra-lightweights, produced mainly from perlite and vermiculite, are expanded or exfoliated by heating. Fly ash, resulting from the combustion of coal and coke, as well as slag from metallurgical processes, are classed as by-product aggregates.

Perlite: Perlite is a glassy volcanic rock containing 2%-5% of combined water and, when crushed and heated rapidly to 760°-1100°C, it expands in volume from 4 to 20 times. With attention to pre-blending of kiln feed and also to retention time in the kiln, expanded material can be manufactured to weigh as little as 30-60 kg/m^3.

The perlite processing plant in Surrey, British Columbia, operated by an associate of Aurun Mines Ltd., closed in 1990. Horticultural grades were produced from imported raw material and, for a time, used domestic raw material. With improved markets over a wider range of grades, there is optimism that local occurrences may be used in the future.

Imported perlite is expanded at numerous locations in Canada for use mainly in horticultural mixes and lightweight and fire-resistant construction products. Other uses relate to loose insulation and insulating media in concrete products. Imports of crude perlite are mainly from New Mexico and Colorado, with production from companies including Grefco, Inc., Manville Corporation, USG Corporation and United Perlite Corp.

Pumice: Numerous concrete product manufacturers, mainly including block producers, use pumice imported from Greece or the northwestern United States. In Canada, a major potential use for this durable and angular material is in highway asphalt overlay as a highly skid-resistant ingredient.

Vermiculite: Vermiculite refers to a small group of minerals, physically resembling the lamellar structure of the micas, that expand or exfoliate greatly when heated rapidly. Canadian consumption of vermiculite is mainly for horticultural uses with lesser amounts for insulation and other products.

The United States is the world's leading producer, with W.R. Grace and Company being the major supplier of vermiculite from operations at Libby, Montana and the Enoree region of South Carolina. Although the Libby mine closed in 1990, this is not expected to disrupt supplies to Canadian-based processing plants. Canada also imports crude vermiculite from the Republic of South Africa, where Palabora Mining Co. Ltd. (PMC) is the major producer. Vermiculite occurrences have been reported in British Columbia, and deposits near both Perth and Peterborough in Ontario have attracted attention in the past.

Clay, shale and slag: Common clays and shale are used throughout Canada for manufacturing lightweight aggregates. Although the Canadian industry began in the 1920s in Ontario, it did not evolve significantly until the 1950s when it grew in support of demand from the construction industry. Raw clay materials, usually quarried adjacent to plant sites, receive little beneficiation other than drying before going to the kiln where they are expanded. Shales are crushed and screened before burning. Slag, a porous, glassy, non-metallic by-product resulting from controlled cooling conditions at the end of the steel-making process, may be crushed and sized for many construction-related applications.

Ongoing research sponsored through the Canada Centre for Mineral and Energy Technology (CANMET), and relating to supplementary cementing materials, led to the successful use of blast furnace slag for manufacturing a slag cement. Reiss Lime Company of Canada, Limited is now producing this type of cement from a grinding plant at Spragge, Ontario, using granulated slag from The Algoma Steel Corporation, Limited's, Sault Ste. Marie plant. Plant capacity is 200 000 t/y of slag cement for complete or partial replacement of Portland cement, depending on requirements. The primary use at present is in mine backfill; however, construction-related uses are also being investigated.

PRICES

There are no standard prices for sand, gravel and crushed stone. In addition to supply-demand factors, prices are determined locally or regionally by production and transportation costs, by the degree of processing prior to final use, and also by the site-specific volume requirements.

USES

The principal uses for sand and gravel are for highway construction and concrete aggregate. Individual home construction triggers an overall need for about 300 t of aggregate per unit, while apartment construction requires only about 50 t per unit, according to a recent study by the Ontario Ministry of Natural Resources.

The construction industry utilizes more than 90% of total stone output as crushed stone, mainly as an aggregate in concrete and asphalt, in highway and railway construction, and as heavy riprap for facing wharves and breakwaters. Specifications vary greatly depending on intended uses, and many tests are required to determine the acceptability of aggregates for certain applications. Particle size distribution–as assessed by grading tests or sieve analysis–affects the uniformity and workability of concrete, the strength of the final product, the density and strength of an asphalt mix, and the durability, strength and stability of aggregates compacted as fill or base-course material. Also of importance are tests concerning organic impurities or other deleterious material, resistance of the aggregate to abrasion and to freeze-thaw cycles, the effects of thermal expansion, porosity and absorption, reactivity with associated materials, and surface texture.

Lightweight concrete used in commercial and institutional projects has facilitated construction of taller buildings and the use of longer clear spans in bridges and buildings. Other advantages of using lightweight aggregates relate to their thermal and acoustical properties, fire resistance, freeze-thaw and low water absorption characteristics, as well as their durability as it influences concrete products.

There are, as yet, no Canadian Standards Association specifications for the lightweight aggregates. Production and application are based on the American Society for Testing and Materials (ASTM) designations as follows: ASTM Designations C 332-676 (Lightweight Aggregates for Insulating Concrete); C 330-75a (Lightweight Aggregates for Structural Concrete); and C 331-69 (Lightweight Aggregates for Concrete Masonry Units).

OUTLOOK

The recession that began in the second quarter of 1990 deepened and affected most sectors of the economy. Housing starts dropped 16% to about 182 000 and are expected to decrease further in 1991.

The outlook for much of the construction sector remains uncertain; however, general activity outside of central Canada is expected to be strongest. Work associated with the petroleum industry, roads, natural gas pipelines and forestry projects in western Canada, along with Hibernia-related construction in Newfoundland, is expected to improve the general outlook in 1991/92.

The weak construction sector in the United States since March 1990 is expected to continue to reduce demand for a broad range of construction materials well into 1991. In particular, the northeastern United States was affected by weaker demand for aggregates beginning in the second quarter of 1990. The demand for crushed stone was affected the most, according to statistics from the U.S. Bureau of Mines.

Urban expansion has greatly increased demand for aggregates in support of major construction. Paradoxically, urban spread has not only tended to overrun operating pits and quarries, but it has also extended into areas containing potentially valuable reserves and resources. Clearly, municipal and regional zoning–given the advancements in land rehabilitation, reclamation and redevelopment–is expected to become more regulation-oriented to help ensure optimal sequential land use.

Sand and gravel will continue to be competitive with crushed stone in many areas and, in some applications, with lightweight aggregates. New reserves are expected to be located and assessed as part of the community planning or regional zoning process. Prices for aggregates will continue to rise with increasing land values, more sophisticated operating techniques and equipment, the depletion of more-accessible reserves and added rehabilitation expenditures.

Estimates have indicated that available sand and gravel supplies in some regions will be depleted by the 1990s, making outlying deposits necessary for the needs of the construction industry. Predicted shortages could encourage exploitation of offshore deposits and even underground mining in some regions.

Note: Information contained in this review was current as of mid-January 1991.

Mineral Aggregates

TABLE 1. CANADA, TOTAL PRODUCTION OF STONE, 1988-90

	1988		1989		1990p	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
By province[1]						
Newfoundland	1 127r	7 488r	862	5 199	1 156	6 155
Nova Scotia	6 567	34 453	6 732	33 718	5 298	28 698
New Brunswick	2 445	15 266	2 365	18 976	2 756	17 290
Quebec	46 450	234 775	42 584	230 455	41 923	248 116
Ontario	56 673r	309 031r	58 250	330 353	53 416	308 119
Manitoba	2 878r	12 567r	2 857	12 566	2 488	9 554
Saskatchewan	–	–	–	–	–	–
Alberta	298r	2 774r	374	3 619	345	3 914
British Columbia	3 571	21 264	3 421	22 922	3 641	22 478
Northwest Territories and Yukon	116r	374r	727	4 344	1 022	6 550
Total	120 126r	637 993r	118 172	662 151	112 046	650 874
By use[2]						
Dimensional stone			..	..	..	..
Rough	202	20 833	..	..	..	..
Monumental and ornamental stone (n.f.)	66	8 943	..	..	..	..
Other (flagstone, curbstone, paving blocks, etc.)	62	4 010	..	..	..	..
Chemical and metallurgical						
Cement plants, Canada	12 539	25 623	..	..	..	..
Cement plants, foreign	577	1 550	..	..	..	..
Lining, open-hearth furnaces	–	–	..	..	..	..
Flux in iron and steel furnaces	1 233	5 543	..	..	..	..
Flux in nonferrous smelters	53	1 161	..	..	..	..
Glass factories	198	3 734	..	..	..	..
Lime plants, Canada	2 346	14 141	..	..	..	..
Lime plants, foreign	477	2 130	..	..	..	..
Pulp and paper mills	226	1 932	..	..	..	..
Sugar refineries	33	230	..	..	..	..
Other chemical uses	1 452	9 828	..	..	..	..
Pulverized stone						
Whiting (substitute)	39	2 346	..	..	..	..
Asphalt filler	137	727	..	..	..	..
Dusting, coal mines	2	85	..	..	..	..
Agricultural purposes and fertilizer plants	1 142	14 804	..	..	..	..
Other uses	419	12 397	..	..	..	..
Crushed stone for						
Manufacture of artificial stone	57	1 072	..	..	..	..
Roofing granules	398	7 523	..	..	..	..
Poultry grit	40	966	..	..	..	..
Stucco dash	28	1 774	..	..	..	..
Terrazzo chips	9	571	..	..	..	..
Rock wool	–	–	..	..	..	..
Rubble and riprap	1 645	9 899	..	..	..	..
Concrete aggregate	10 179	56 136	..	..	..	..
Asphalt aggregate	8 268	43 545	..	..	..	..
Road metal	61 491	279 261	..	..	..	..
Railroad ballast	2 629	16 718	..	..	..	..
Other uses	29 065	130 275	..	..	..	..
Total	135 010	677 757	..	..	..	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Data exclude stone used in the Canadian cement and lime industries. [2] Data include stone used in the Canadian cement and lime industries.
p Preliminary; r Revised; .. Not available; – Nil; n.f. Not finished or dressed.
Note: Due to recent amendments incorporated here, data may not correspond with figures reported in Statistics Canada Cat. no. 26-202 "Canada's Mineral Production - Preliminary Estimates 1990". Totals may not add due to rounding.

TABLE 2. CANADA, PRODUCTION OF SAND AND GRAVEL BY PROVINCE, 1988-90[1]

	1988		1989		1990[p]	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
Newfoundland	5 374[r]	19 446[r]	4 241	18 039	4 093	17 445
Prince Edward Island	922	2 233[r]	826	2 214	1 323	3 312
Nova Scotia	9 483	27 726	6 585	22 049	6 012	18 862
New Brunswick	11 859[r]	18 251[r]	9 249	16 023	10 398	18 453
Quebec	37 680[r]	99 768[r]	36 025	107 586	29 633	86 795
Ontario	101 047[r]	339 024[r]	92 264	324 649	80 735	283 947
Manitoba	14 189	45 158	13 880	37 347	10 697	36 219
Saskatchewan	11 365[r]	32 764[r]	12 960	27 031	10 274	23 269
Alberta	42 391[r]	142 178[r]	41 959	145 072	40 460	131 498
British Columbia	48 658	123 233	52 469	156 580	52 517	158 705
Yukon and Northwest Territories	4 683	16 117[r]	4 390	17 488	3 927	15 624
Total	287 653[r]	865 900[r]	274 848	874 078	250 070	794 130

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Production values for silica have been included in sand and gravel.
[p] Preliminary; [r] Revised.
Note: Totals may not add due to rounding.

TABLE 3. AVAILABLE DATA ON CONSUMPTION OF SAND AND GRAVEL, BY PROVINCE, 1987 AND 1988

		Atlantic Provinces	Quebec	Ontario	Western Provinces[1]	Canada
				(000 tonnes)		
Roads	1987	16 735	21 379	50 819	86 746	175 678
	1988	20 733	19 705	53 373	90 749	184 560
Concrete aggregate	1987	2 175	5 709	19 231	12 190	39 304
	1988	2 191	7 109	18 042	10 807	38 149
Asphalt aggregate	1987	2 140	3 101	6 193	10 029	21 463
	1988	1 894	3 570	6 543	6 674	18 681
Railroad ballast	1987	110	. . .	284	2 171	2 565
	1988	9	256	458	1 511	2 234
Mortar sand	1987	100	452	2 235	377	3 165
	1988	97	602	2 231	297	3 227
Backfill for mines	1987	26	418	698	472	1 615
	1988	24	463	614	461	1 562
Other fill	1987	1 984	5 357	15 085	9 004	31 430
	1988	1 216	4 519	14 531	7 225	27 491
Other uses	1987	113	44	1 706	1 834	3 696
	1988	1 474	1 456	5 255	3 562	11 747
Total sand and gravel	1987	23 382	36 460	96 250	122 825	278 916
	1988	27 638	37 680	101 047	121 286	287 653

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] The western provinces include the Yukon and Northwest Territories.
. . . Amount too small to be expressed.
Note: Totals may not add due to rounding.

TABLE 4. CANADA, EXPORTS AND IMPORTS OF SAND AND GRAVEL AND CRUSHED STONE, 1988-90p

Item No.		1988		1989		Jan.-Sept. 1990p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Exports							
2505.90	Natural sands n.e.s., excluding metal-bearing sands						
	Bahamas	–	–	5	1	16 951	290
	United States	210 137	1 571	10 983	262	24 849	145
	Other countries	3 783	123	1 057	42	154	44
	Total	213 920	1 697	12 045	308	41 954	482
2517.10	Pebbles, gravel, broken or crushed stone used for aggregates, etc.						
	United States	1 622 963r	10 011r	975 194	8 419	865 291	5 237
	Other countries	130 841	1 456	48 686	1 004	21 603	351
	Total	1 753 804r	11 472r	1 023 880	9 428	886 894	5 588
2521.00	Limestone flux; limestone and other calcareous stone used for lime or cement						
	United States	1 106 772	5 912	928 680	5 864	1 004 403	5 118
	Other countries	169	83	43	9	3 114	21
	Total	1 106 941	5 997	928 723	5 874	1 007 517	5 140
Imports							
2505.90	Natural sands n.e.s., excluding metal-bearing sands						
	United States	475 180r	5 707r	800 375	7 998	253 883	3 581
	Other countries	178	14	374	42	167	15
	Total	475 359r	5 722r	800 749	8 042	254 050	3 598
2517.10	Pebbles, gravel, broken or crushed stone used for aggregates, etc.						
	United States	594 793r	3 546r	738 339	4 278	835 769	4 546
	Other countries	–	–	881	11	1 194	16
	Total	594 793r	3 546r	739 220	4 292	836 963	4 564
2521.00	Limestone flux; limestone and other calcareous stone used for lime or cement						
	United States	2 638 776r	9 525r	3 274 914	12 206	2 730 023	10 543
	Other countries	94	. .	190	. .	120	. .
	Total	2 638 872r	9 527r	3 274 240	12 209	2 730 143	10 543

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary; . . Not available; n.e.s. Not elsewhere specified; – Nil; r Revised.
Note: Totals may not add due to rounding.

TABLE 5. LIGHTWEIGHT AGGREGATE PRODUCERS IN CANADA, 1989

Company	Location	Commodity	Remarks
Atlantic Provinces			
Annapolis Valley Peat Moss Company Limited	Berwick, N.S.	Vermiculite	Processed for use in horticulture.
Avon Aggregates Ltd.	Minto, N.B.	Expanded shale	Processed for concrete products industry.
Fafard Peat Moss Company Ltd.	Shippagan, N.B.	Perlite	Processed for use in horticulture.
Fisons Horticulture Inc.	Maisonnette, N.B.	Perlite	Processed for use in horticulture.
Quebec			
Armstrong World Industries Canada Ltd.	Gatineau	Perlite	Processed for use in ceiling tile manufacture.
Perlite Industries Inc.	Ville St. Pierre	Perlite	Processed for use in horticulture and concrete products.
Premier Peat Moss Ltd.	Rivière du Loup	Perlite, Vermiculite	Processed for use in horticulture.
Ontario			
CGC Inc.	Hagersville	Perlite	Processed for use in gypsum plaster.
National Slag Limited	Hamilton	Slag	Used in concrete blocks and as slag cement.
W.R. Grace & Co. of Canada Ltd.	St. Thomas	Vermiculite	Vermiculite processed for use in horticulture and as loose insulation.
	Ajax	Vermiculite, Perlite	Perlite processed for use in gypsum plaster, in horticulture, refractories, as loose insulation, in friction materials and in fire-proofing.
Prairie Provinces			
Apex Aggregate	Saskatoon, Sask.	Expanded clay	Processed for concrete block manufacture.
Cindercrete Products Limited	Regina, Sask.	Expanded clay	Processed for concrete block manufacture.
Consolidated Concrete Limited	Calgary, Alta.	Expanded shale	Processed for concrete block manufacture.
CBR Cement Canada Limited	St. Albert, Alta.	Expanded clay	Processed for concrete block manufacture.
Fisons Horticulture Inc.	Elma, Man.	Perlite	Processed for use in horticulture.
Fisons Horticulture Inc.	Seba Beach, Alta.	Perlite	Processed for use in horticulture.
Kildonan Concrete Products Ltd.	Winnipeg, Man.	Expanded clay	Processed for concrete products industry.
W.R. Grace & Co. of Canada Ltd.	Winnipeg, Man.	Vermiculite, Perlite	Perlite processed for use in gypsum plaster and in horticulture.
	Edmonton, Alta.	Vermiculite, Perlite	Vermiculite processed for use in horticulture and as loose insulation.
British Columbia			
Ocean Construction Supplies Limited	Vancouver	Pumice	Purchased for concrete products industry.
W.R. Grace & Co. of Canada Ltd.	Vancouver	Vermiculite, Perlite	Mainly for horticulture

TABLE 6. CANADA, IMPORTS OF VERMICULITE, PERLITE AND PUMICE, 1988-90p

Item No.		1988		1989		Jan.-Sept. 1990p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
2513.11	Pumice stone: crude or in irregular pieces, including crushed pumice						
	United States	2 777	1 375	1 588	880	9 788	697
	Greece	23	15	4 565	237	4 660	278
	Turkey	10	7	429	174	1 744	250
	Other countries	207	93	355	207	27	9
	Total	3 017	1 493	6 936	1 501	16 217	1 234
2513.19	Pumice stone: other						
	United States	1 825	1 192	1 332	912	2 612	589
	Other countries	865	485	316	204	328	114
	Total	2 691	1 680	1 649	1 120	2 941	707
2530.10.10.10	Vermiculite, unexpanded						
	United States	14 510	2 591	19 286	3 118	12 430	1 917
	Other countries	7 115	1 021	9 919	1 423	3 000	460
	Total	21 625	3 612	29 204	4 542	15 430	2 377
2530.10.10.20	Perlite, unexpanded						
	United States	14 451r	1 786r	19 689	2 451	15 642	1 960
	Greece	1 549	116	4 084	304	4 707	337
	Other countries	154	22	–	–	–	–
	Total	16 154r	1 925r	23 733	2 755	20 348	2 298
3802.90.20	Activated perlite, excluding perlite ground to be employed in filtering						
	United States	1 768	854	616	302	134	57
	Total	1 768	854	616	302	134	57
6806.20.00.10	Exfoliated (expanded) vermiculite						
	United States	271	310r	233	611	358	1 036
	Total	271	310r	233	611	358	1 036
6806.20.00.20	Expanded perlite						
	United States	1 078r	777r	1 635	1 475	2 645	1 454
	Other countries	–	–	22	46	–	–
	Total	1 078r	777r	1 657	1 522	2 645	1 454

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary; – Nil; r Revised.
Note: Totals may not add due to rounding.

TABLE 7. CANADA, LIGHTWEIGHT AGGREGATES PRODUCED, SOLD AND USED, 1988 AND 1989

	1988				1989[2]			
	Produced		Sold and Used		Produced		Sold and Used	
	(m3)	($)	(m3)	($)	(m3)	($)	(m3)	($)
From domestic and/or imported raw materials								
Expanded clay, shale and slag[1]	651 001r	13 212 091r	639 981r	12 711 358r	706 700	14 304 356	595 687	12 200 478
From imported crude materials								
Expanded perlite and exfoliated vermiculite[1]	436 800	19 501 341	436 236	19 471 646	451 935	19 647 256	451 935	19 647 256
Total	1 087 801r	32 713 432r	1 076 217r	32 183 004r	1 158 635	33 951 612	1 047 622	31 847 734

Source: Company data. See Table 5 for list of establishments surveyed.
[1] Combined to avoid disclosing confidential company data. [2] Increase in number of companies being surveyed.
r Revised.

TABLE 8. CANADA, SALES OF EXPANDED SLAG, PERCENTAGE BY END-USE, 1987-89

Use	1987	1988	1989
Concrete block manufacture	85.9	85.9	85.9
Ready-mix concrete	8.5	8.5	8.5
Loose insulation	–	–	–
Precast concrete manufacture	5.6	5.6	5.6

Source: Company data. See Table 5 for list of establishments surveyed. Sales also imply quantities consumed for own use.
– Nil.

TABLE 9. CANADA, SALES OF EXPANDED CLAY AND SHALE, PERCENTAGE BY END-USE, 1987-89

Use	1987	1988	1989
Concrete block manufacture	79.2	86.3	75.0
Precast concrete manufacture	3.5	3.6	7.5
Ready-mix concrete	6.0	3.8	3.1
Horticulture and miscellaneous uses	11.3	6.3	14.4

Source: Company data. See Table 5 for list of establishments surveyed. Sales also imply quantities consumed for own use.

TABLE 10. CANADA, SALES OF EXPANDED PERLITE, PERCENTAGE BY END-USE, 1987-89

Use	1987	1988	1989
Insulation			
in gypsum products	8.2	2.7	1.7
in other construction materials	37.8	31.1	28.7
Horticulture and agriculture	42.4	56.1	58.9
Loose insulation and miscellaneous uses	11.6	10.1	10.7

Source: Company data. See Table 5 for list of establishments surveyed. Sales also imply quantities consumed for own use.

TABLE 11. CANADA, SALES OF EXPANDED VERMICULITE, PERCENTAGE BY END-USE, 1987-89

Use	1987	1988	1989
Loose insulation	13.0	12.6	14.2
Horticulture	47.0	61.5	56.1
Miscellaneous uses	40.0	25.9	29.7

Source: Company data. See Table 5 for list of establishments surveyed. Sales also imply quantities consumed for own use.

TABLE 12. CANADA, VALUE OF CONSTRUCTION BY TYPE,[1] 1988-90

	1988	1989	1990
		($ millions)	
Building construction[2]			
Residential	38 936	43 122	44 963
Industrial	3 842	4 264	4 001
Commercial	14 116	16 154	16 175
Institutional	4 540	4 954	5 441
Other building	2 452	2 781	3 315
Total	63 885	71 276	73 895
Engineering construction[2]			
Marine	504	523	677
Highways, airport runways	5 721	6 327	6 469
Waterworks, sewage systems	2 477	2 742	3 069
Dams, irrigation	398	492	560
Electric power	4 198	5 290	6 249
Railway, telephones	3 090	3 294	3 376
Gas and oil facilities	7 288	6 006	7 597
Other engineering	3 311	4 116	4 097
Total	26 986	28 790	32 093
Total construction	90 871	100 065	105 987

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Actual expenditures 1988; preliminary 1989; intentions 1990. [2] Includes total value of new and repair work purchased.

TABLE 13. CANADA, VALUE OF CONSTRUCTION BY PROVINCE,[1] 1988-90

	1988			1989			1990		
	Building Construction[2]	Engineering Construction[2]	Total	Building Construction[2]	Engineering Construction[2]	Total	Building Construction[2]	Engineering Construction[2]	Total
					($ millions)				
Newfoundland	919	627	1 546	1 024	578	1 602	1 063	739	1 802
Nova Scotia	1 698	716	2 415	1 836	748	2 585	1 852	875	2 727
New Brunswick	1 352	459	1 811	1 509	539	2 048	1 476	685	2 160
Prince Edward Island	261	91	352	254	96	350	263	105	368
Quebec	15 834	4 731	20 565	16 450	5 547	21 996	16 297	6 565	22 862
Ontario	27 528	7 203	34 731	31 667	7 741	39 408	32 065	8 108	40 173
Manitoba	2 076	1 062	3 138	2 209	1 198	3 407	2 353	1 390	3 742
Saskatchewan	1 958	1 803	3 761	1 954	1 617	3 572	2 152	2 003	4 156
Alberta	4 984	6 803	11 787	5 253	6 541	11 795	5 848	7 485	13 333
British Columbia, Yukon and Northwest Territories	7 274	3 490	10 764	9 119	4 184	13 303	10 526	4 138	4 664
Canada	63 885	26 986	90 871	71 276	28 790	100 065	73 895	32 093	105 987

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Actual expenditures 1988, preliminary actual 1989, intentions 1990. [2] Includes total value of new and repair work purchased.
Note: Totals may not add due to rounding.

Nickel 1990

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Consumption of nickel in the Western World in 1990 increased to a record high of an estimated 675 000 t, compared to 660 000 t in 1989. The increase was led by the stainless steel sector, particularly in western Europe. A shortage of stainless steel scrap also contributed to the increase in demand for primary nickel.

Despite some cutbacks announced by major producers early in the year in response to weak market conditions, production in the Western World was slightly higher in 1990 than in 1989. While estimates vary, Soviet exports of nickel metal to the Western World are considered to have increased by 10 000 t to 95 000 t in 1990. Cuban exports increased to 16 000 t from 11 000 t.

The nickel price on the London Metal Exchange (LME) averaged US$4.03/lb in 1990 compared to $6.04 in 1989 and $6.25 in 1988.

CANADIAN DEVELOPMENTS

Canadian mine production of nickel decreased slightly in 1990, with preliminary data indicating that production was 199 400 t compared to 200 900 t in 1989. Inco Limited and Falconbridge Limited reduced production, starting in the second quarter, in response to weak markets prevailing early in the year, but this reduction was partially offset by increased production at the Namew Lake mine near Flin Flon, Manitoba.

Inco commenced development of the McCreedy East mine near Sudbury at a cost of $179 million. The mine is expected to be in production in 1993, with full production being achieved in 1996. Peak production is expected to be about 18 000 t/y nickel and 9000 t/y copper. This mine is the first major new mine to be developed by Inco at Sudbury in more than 20 years. The operation will utilize the latest bulk-mining techniques and mining technology, and is expected to be Inco's most productive mine at Sudbury.

Inco announced that, in addition to the $108 million already committed for mine development at Thompson, Manitoba, another $287 million would be spent over the next few years on further development. The 1-D orebody is being developed, at a cost of $209 million, to connect up to the existing Thompson shafts. The Birchtree mine is scheduled to produce about 4100 t/d of ore when full production is achieved in 1997. The Thompson Open Pit South mine is also being developed.

Falconbridge proceeded with the development of the Craig mine at Sudbury at a cost of $280 million. The mine is scheduled to produce more than 20 000 t/y nickel when it is in full production in 1993. The mine will be a replacement for other depleting mines and no overall increase in production is planned.

Falconbridge continued with its $33 million underground development program at its Lindsley property, near Sudbury. A shaft is being sunk to 1390 m followed by a drifting and drilling program at the 1310-m level. Several potentially mineable ore zones have been identified. The program will be completed in 1991.

Sherritt Gordon Limited produced about 18 100 t of nickel in briquettes and powders at its Fort Saskatchewan, Alberta refinery, compared to 21 000 t in 1989. The refinery was closed in July and August due to a shortage of feed. The company's 10-year supply contract with Inco expired at the end of 1989 and, while the company was able to replace part of the Inco material, it was unable to secure a long-term source of supply by year-end. In the fourth quarter Sherritt treated, for the first time, some nickel matte from the U.S.S.R. This matte contained 1100 t of nickel.

Nickel

Early in 1990, Timmins Nickel Inc. reduced production at its small high-grade nickel mine near Timmins, Ontario, in response to weak nickel market conditions. As market conditions improved, the company increased production. Production commenced at the Langmuir No. 1 orebody and was completed by year-end. The nearby Carshaw mill of Marshall Minerals Corp. was leased and the company announced that this would reduce milling costs by about 25% and permit the expansion of production. The mine is 51% owned by Timmins Nickel, which is also the operator, and 49% by BHP-Utah Mines Ltd. Sherritt Gordon refines the concentrate under a 10-year contract.

Mining difficulties, which had affected production since its start-up, were resolved at the Namew Lake mine, which is owned 60% by Hudson Bay Mining and Smelting Co., Limited (HBMS) and 40% by Outokumpu Mines Ltd. Nameplate capacity is 9200 t/y nickel and 3500 t/y copper in concentrate. Production in 1990 was about 75% of capacity, which was about double the rate in 1989. Reserves, when the mine opened, had been reported at 2.6 Mt grading 2.44% nickel and 0.9% copper. Sherritt processes HBMS's share of the feed at Fort Saskatchewan while Inco processes Outokumpu's share at Thompson.

New Quebec Raglan Mines Limited completed 26 700 m of drilling on its property in the Ungava region of northern Quebec. The drilling program increased the estimated reserves by 30% to 16 Mt grading 3.13% nickel and 0.88% copper, with some values in platinum group metals. The company, which became a wholly-owned subsidiary of Falconbridge in 1989, had previously indicated that a sustained price of at least $4.00/lb would be necessary to bring the deposit into production.

WORLD DEVELOPMENTS

Producers generally operated at or near their effective capacities for most of the year. Consideration was given to development of some new projects or expansion of existing operations.

In Australia, Western Mining Corporation Limited announced plans to expand annual nickel production to approximately 65 000 t of nickel in matte, of which 42 000 t would be refined to metal at the Kwinana Nickel Refinery. The expansion is estimated to cost $270 million over a three-year period, but is subject to negotiations with the Western Australia state government.

Dominion Mining Limited of Australia announced plans to develop the Six Mile deposit at Yakabindie, Western Australia, at a cost of $225 million. Full production from the open-pit operation is expected to begin in 1993 at an annual rate of 20 000 t/y of contained metal.

In November, Outokumpu Metals and Resources Oy and Australian Consolidated Minerals Ltd. announced a construction delay at the Mount Keith project in Western Australia. It was reported that the delay was required to allow for the completion of the government approval process and to finalize financial arrangements. Once operational, the project is expected to annually produce 6.6 Mt of ore grading 0.063% nickel, which will be milled to produce 140 000 t of concentrate containing 28 000 t of nickel. It is expected that 18 000 t of concentrate will be shipped to Finland for processing with the remaining concentrate to be sold on world markets.

In Indonesia, the US$80 million expansion project at P.T. International Nickel Indonesia fell behind schedule as a result of technical difficulties and construction delays. The complex is expected to have a capacity of 47 600 t/y nickel in matte in early 1991. During 1990, Inco issued 50 million shares of P.T. International Nickel Indonesia through a share offering on the Djakarta stock exchange, reducing Inco's ownership of the company to 58%.

In New Caledonia, a 36-day strike that began in June at Société Métallurgique Le Nickel (SLN) resulted in an estimated production loss of 2400 t.

In the Philippines, attempts continued to restart the idle nickel complex of the former Nonoc Mining & Industrial Corporation. The Philnico Mining and Industrial Corp. purchased the refinery, port facilities and the exclusive mining rights to the island of Nonoc from the Philippine government, in October, for US$325 million and initiated some work to rehabilitate the facility. The refinery has been idle since 1986.

Metallurgical tests continued on Anglo American Corporation's Barbican property in Eastern Transvaal, South Africa. It is estimated that the property has the potential to produce 17 000 t/y of nickel. Production could begin in 1992.

In Zambia, a preliminary study was completed on the Munali nickel project by Apollo Mining. Current estimates of the geological reserves stand at 11.7 Mt grading 1.04% nickel and 0.15% copper. Planned production rates are expected to be 620 000 t/y of ore yielding 3300 t/y nickel over 13 years.

The Greek ferronickel producer Hellenic Mining and Metallurgical Company of Larymna S.A. (Larco) and the ferrochrome producer Hellenic Ferro-Alloy are among 28 companies that are being sold to private interests by the Greek government as part of a privatization plan. Larco is expected to have produced 16 000 t of nickel in 1990, approximately the same amount as in 1989.

Cuban production decreased to between 40 000 t and 42 000 t from 48 000 t in 1989 due to the closure in August of the nickel complex at Punta Gorda as a result of fuel shortages. During the shutdown, a program was instituted to improve the energy efficiency of the Punta Gorda complex and it is expected that the plant will reopen in April 1991. Also in 1990, the German government announced that it will cancel the agreement negotiated by the former East German government to supply 80% of the equipment to a new smelter at Las Camariocas.

Outokumpu Oy of Finland signed an agreement in principle with the U.S.S.R. to modernize the Pechenganikel and Monchegorsk nickel complexes in the Kola Peninsula. The project is expected to begin in 1991 and to be completed by the end of 1994 at a total cost of US$800 million. Finland is to provide half the capital requirements, Norway 25%, and the remainder is to be divided between the U.S.S.R., Germany and Sweden.

The United States and the U.S.S.R. reached an agreement in June 1990 to allow the importation of Soviet nickel into the United States on condition that the nickel is certified to be of Soviet origin.

Mining at the Glenbrook Nickel Co. property in Riddle, Oregon started in November. The deposit contains ore grading 1.2% nickel, with sufficient reserves to maintain production for three years.

CONSUMPTION AND USES

Resistance to corrosion, high strength over a wide temperature range, pleasing appearance and suitability as an alloying agent are characteristics of nickel which make it useful in a wide range of applications. After stainless steels, which account for about 65% of total nickel consumption, the major uses are nickel-based alloys, electroplating, alloy steels, foundry products and copper-based alloys. Nickel is extensively used as an alloying agent and is a component in some 3000 different alloys which are used in more than 250 000 end-use applications.

Nickel is used in chemical and food processing, nuclear power plants, aerospace equipment, motor vehicles, oil and gas pipelines, electrical equipment, machinery, batteries, catalysts and many other applications.

Nickel-containing stainless steel tanks are used for road, rail and sea transport of various liquids including dairy products, petrochemicals and toxic chemicals. These stainless steels are used for their resistance to corrosion, strength and ease of cleaning. Their ability to handle a wide variety of liquids adds to the tanks' capability for backhaul loads.

In recent years, some Japanese and European auto manufacturers have been using a zinc-nickel coated steel for various body panels and some structural parts. Zinc-nickel coatings can provide five to six times more resistance to road salt corrosion than ordinary galvanized steel. Bethlehem Steel Corporation acquired the licence from Nippon Kokan KK of Japan for the manufacture in the United States of the coating, which contains about 13% nickel with the remainder zinc. Commercial production of the coating started in 1989 from a plant in Walbridge, Ohio.

During 1990, it was reported that a new nickel-hydrogen battery had been developed. While more than 30% more expensive than existing nickel-cadmium batteries, the new battery provides significantly more power. While the new battery is potentially more environmentally acceptable, the discovery of a new energy-efficient recycling process which can recover 99% of the cadmium and 60% of the nickel from spent nickel-cadmium batteries may limit market penetration of the new product.

The major nickel markets of the United States, Japan and western Europe continue to account for close to 90% of the demand for nickel in the Western World, but the newly industrialized countries, particularly in the Pacific Rim region, are increasing their share of the market and this trend is expected to continue in the future. While the United States is a major nickel consumer, it is interesting to note that per capita consumption of stainless steel is only one half that in many Asian and European markets.

It is anticipated that the major growth areas for nickel will be in nickel stainless steels and new high-performance alloys, as well as in electroplating applications. In addition, it is expected that nickel will be used increasingly in the electronics industry.

MARKETS AND PRICES

Nickel prices, which averaged US$3.21/lb in January and $3.17 in February, began to strengthen in March on the basis of lower inventory levels, due partly to reduced supplies of nickel stainless steel scrap, consumer restocking and some speculative buying. With a recovery of the stainless steel sector, market conditions continued to strengthen through the second and third quarters. However, the nickel market weakened in the fourth quarter due to the delivery of large quantities of Soviet nickel into western Europe combined with the effects of a deepening recession, particularly in North America. The price of nickel averaged $3.70/lb in December.

Nickel stocks on the LME increased from about 6800 t at the beginning of 1990 to over 9100 t in June. For the remainder of the year, there was an overall decline in LME stocks with levels falling to below 3000 t in December and again in January 1991. It was reported that Western producer stocks at the end of 1990 were at relatively low levels.

Although there was a decline in LME and producer stocks through the second half of 1990, this was offset by the reported increase in Soviet material held by metal traders.

The LME announced the establishment of Baltimore as the LME's first nickel delivery point in the United States. The warehouse was expected to open on February 1, 1991. In addition, the LME announced that it had approved the establishment of Bilbao, Spain as a good delivery point for all LME metals, also effective February 1, 1991.

INTERNATIONAL NICKEL STUDY GROUP (INSG)

The INSG was inaugurated in June 1990 in The Hague, Netherlands. Initial member countries were: Canada, Australia, France, Germany, the Netherlands, Indonesia, Sweden, Norway, Finland, Greece, Cuba, and Japan. These countries account for over 60% of world trade in nickel. Seven additional countries, including the United States and the U.S.S.R., attended as observers.

The primary objective of the INSG, which is patterned after the highly regarded International Lead and Zinc Study Group, will be to increase the transparency of the world nickel economy through the publication of statistics and various special studies. The INSG will also provide a forum for discussion of issues of concern to governments and industry.

Industry representatives are members of national delegations to the meetings of the INSG and their participation is critical to the success of the activities of the organization, including those of the Statistics Committee. The next annual meeting of the INSG will be April 10-12, 1991 in The Hague.

HEALTH AND ENVIRONMENT

Under a 1985 Ontario government regulation, Inco and Falconbridge must reduce their emissions of sulphur dioxide to 265 000 t and 100 000 t, respectively, by 1994. In 1985, the limit was 685 000 t for Inco and 154 000 t for Falconbridge.

Inco has commenced a major program at Sudbury to put the company in compliance with the regulation. The major part of the program involves changes to the smelter. The program includes two oxygen flash furnaces, a new sulphuric acid plant, an additional oxygen plant plus some other plant modifications.

The other component of the program is a mill modernization and rationalization program. The Clarabelle mill is being expanded to handle all of the Sudbury ores. A bulk nickel-copper concentrate will be produced which will facilitate increased rejection of pyrrhotite. A semi-autogenous grinding circuit and large flotation cells are being installed. As well as contributing to cleaning up the environment, the operating efficiency of the plant will also be substantially increased.

Construction at both the smelter and mill was put about two months behind schedule due to strikes in 1990. Inco stated that there will be a "significant increase" in the earlier projected $494 million capital cost of the project.

Falconbridge is spending $38 million on research, development and capital projects related to increasing pyrrhotite rejection and greater roasting to be able to conform to the regulation. While actual emissions of sulphur dioxide in 1990 were below the required 1994 level, the company was producing below capacity. The company is conducting research on methods to reduce emissions to 75 000 t/y, at capacity production, by 1998. Increased pyrrhotite rejection is the focus of the research.

An issue of increasing concern to the nickel industry is the institution by various countries of stiffer regulations on exposure to nickel, some of which may be unduly restrictive or overly broad in scope. Unnecessary expenses can result for nickel producers and consumers and, as well, certain markets can be adversely affected.

In an effort to increase the scientific knowledge available concerning the health risks associated with exposure to nickel and nickel compounds, an epidemiological study was sponsored by the U.S. Environmental Protection Agency, the European Economic Commission, the federal departments of National Health and Welfare and Energy, Mines and Resources, the Ontario Ministry of Labour and the Nickel Producers Environmental Research Association. The study, chaired by Sir Richard Doll and published in 1990, concluded that exposure to high concentrations of certain nickel compounds can result in increased lung and nasal cancers in humans. The study showed that there is no evidence that nickel metal is a carcinogen.

OUTLOOK

In 1991, it is expected that nickel demand will be slightly lower than in 1990 due to a slowdown in many of the economies of the major OECD countries, including the United States. Producers are expected to continue to operate at or near their effective capacities and, barring any important supply disruptions, there is expected to be some rebuilding of producer stocks in 1991.

The weakness in demand, along with continuing high levels of production, will keep prices under pressure. An average price within the range of US$3.50-$4.00 is possible. If prices were to go below US$3.50/lb and sustained at this level for very long, it is expected that there would be a re-evaluation of production targets by some producers.

In the medium to longer term, it is expected that a price between $3.75/lb and $4.75/lb in constant dollars will be a sustainable price. A price much above this level would result in substantial new capacity, and possible substitution, while a price below this level would not insure adequate new supplies.

In Canada, nickel production is expected to increase marginally over the next several years. Canada will remain a highly cost-competitive producer, particularly given the effects of the cost reduction programs which were put in place in the 1980s. In 1991, however, production costs are expected to increase for Inco due to the mining of lower grade ore. At Sudbury, nickel ore grades are expected to fall below 1.2% in 1991.

Note: Information contained in this review was current as of mid-January 1991.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EEC MFN	Japan[1] MFN
2604.00	Nickel ores and concentrates	Free	Free	Free	Free	Free	Free
7501.10	Nickel mattes	Free	Free	Free	Free	Free	Free
7501.20	Nickel oxide sinters and other intermediate products of nickel metallurgy	Free	Free	Free	Free	Free	Free-81 yen/kg[2]
75.02	Unwrought nickel						
7502.10	Nickel not alloyed	Free	Free	Free	Free	Free	81 yen/kg
7502.20	Nickel alloys	Free	Free	Free	Free	Free	Free-9%[3]
7503.00	Nickel waste and scrap	Free	Free	Free	Free	Free	Free
7504.00	Nickel powders and flakes						
7504.00.10	Powders containing by weight 60% or more nickel	Free	Free	Free	Free	0.5%	Free
7504.00.20	Powders containing by weight less than 60% of nickel; flakes	10.2%	6 .5%	4.0%	Free	0.5%	65 yen/kg-6%

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, effective January 1, 1990; Official Journal of the European Communities, Vol. 33, No.247, 1990 "Conventional" column; Customs Tariff Schedules of Japan, 1990.

[1] GATT rate is shown; lower tariff rates may apply circumstantially. [2] Free except for nickel oxide sinters containing by weight not less than 88% nickel which is 81 yen/kg, and nickel oxide containing by weight not more than 1.5% copper which is 7.2%. [3] Tariff rate of 9% applies to nickel alloys other than those containing by weight less than 50% of nickel and not less than 10% of cobalt.

Nickel

TABLE 1. CANADA, NICKEL PRODUCTION AND TRADE, 1989 AND 1990

Item No.		1989		1990p	
		(tonnes)	($000)	(tonnes)	($000)
Production[1]					
	All forms				
	Ontario	130 632	2 010 119	128 402	1 316 618
	Manitoba	64 922	1 032 160	68 203	707 335
	Total	195 554	3 042 278	196 606	2 023 952
Exports[2]				(Jan.-Sept.)	
2604.00.00	Nickel ores and concentrates, nickel content				
	United States	15	58	–	–
	Japan	2	37	–	–
	South Korea	2	30	–	–
	India	1	17	–	–
	Chile	1	19	–	–
	Total	21	163	–	–
7501.10	Nickel mattes				
	Norway	35 939	460 328	26 961	285 896
	United Kingdom	26 455	184 745	25 364	176 854
	United States	122	2 138	–	–
	Switzerland	6	117	–	–
	Total	62 522	647 329	52 325	462 750
7502.20	Nickel, unwrought, alloyed				
	Belgium	663	12 282	544	7 210
	United States	1 194	9 857	675	7 195
	Other countries	274	2 171	183	2 406
	Total	2 131	24 318	1 402	16 816
7503.00	Nickel waste and scrap				
	United States	5 321	60 517	3 454	25 664
	Netherlands	337	1 696	576	1 917
	United Kingdom	773	3 626	173	316
	Japan	112	310	15	124
	Austria	193	30	30	6
	Other countries	249	953	308	1 846
	Total	6 985	67 135	4 556	29 875
7504.00	Nickel powders and flakes				
	United States	6 897	96 158	5 161	61 901
	Japan	1 557	22 066	1 699	19 139
	Netherlands	198	3 314	278	2 864
	Belgium	51	467	99	1 290
	United Kingdom	57	776	51	1 138
	Mexico	78	713	108	1 043
	People's Republic of China	135	1 182	65	783
	Other countries	267	3 212	222	2 808
	Total	9 240	127 888	7 683	90 966
7505.12	Bars, rods and profiles of nickel alloy				
	United States	157	2 206	2	35
	Japan	–	–	. . .	17
	Total	157	2 206	2	53
7508.00	Articles of nickel, n.e.s.				
	South Africa	. .	10 711	. .	7 354
	Netherlands	. .	3 407	. .	5 549
	United States	. .	16 052	. .	403
	Other countries	. .	1 815	. .	1 579
	Total	. .	31 985	. .	14 885
Imports[3]					
2604.00.00.20	Nickel ores and concentrates, nickel content				
	Norway	–	–	24	468
	Finland	1 097	7 392	–	–
	United States	. . .	1	. . .	2
	Total	1 097	7 393	24	470

TABLE 1 (cont'd)

Item No.		1989		Jan.-Sept. 1990p	
		(tonnes)	($000)	(tonnes)	($000)
Imports[3] (cont'd)					
7501.00	Nickel mattes, nickel oxide sinters and other intermediate products of nickel metallurgy				
	U.S.S.R.	–	–	2 250	17 175
	Australia	351	2 448	2 359	15 751
	United States	3 528	9 336	3 976	6 479
	United Kingdom	663	3 110	1 244	3 695
	Poland	474	1 454	–	–
	Other countries	911	3 485	206	403
	Total	5 928	19 835	10 036	43 503
7502.10	Nickel unwrought, not alloyed				
	Norway	1 890	30 133	1 038	18 925
	U.S.S.R.	1 203	20 206	630	5 971
	Other countries	253	3 958	554	6 044
	Total	3 346	54 297	2 222	30 940
7502.20	Nickel unwrought, alloyed				
	United States	187	1 638	90	876
	Norway	254	4 337	30	352
	West Germany	...	2	...	8
	France	–	–	...	3
	Total	440	5 979	121	1 241
7503.00	Nickel waste and scrap				
	United States	12 141	36 712	5 870	14 852
	Finland	–	–	59	602
	Norway	184	1 362	310	403
	United Kingdom	274	777	241	305
	West Germany	208	365	80	211
	Belgium	203	280	5	7
	Australia	154	686	–	–
	Other countries	316	623	207	422
	Total	13 480	40 805	6 772	16 802
7504.00	Nickel powder and flakes				
	United States	76	1 342	6 897	68 480
	Japan	–	–	1 567	13 475
	Other countries	15	299	774	9 244
	Total	91	1 641	9 238	91 199
7505.12	Bars, rods and profiles of nickel alloy				
	United States	441	8 604	370	4 728
	Other countries	31	664	20	532
	Total	472	9 268	390	5 260
7508.00.10.00	Nickel anodes for electroplating				
	United States	44	340	24	148
	Other countries	3	21	1	7
	Total	47	362	25	155

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Refined nickel and nickel in oxides and salts produced, plus recoverable nickel in matte and concentrates exported. [2] Item Nos. 7501.20 (nickel oxide sinters and other intermediate products of nickel metallurgy) and 7502.10 (nickel unwrought, not alloyed) suppressed due to confidentiality. [3] Imports from "other countries" may include re-imports from Canada.
p Preliminary; – Nil; .. Not available or not applicable; ... Amount too small to be expressed; n.e.s. Not elsewhere specified.
Note: Totals may not add due to rounding.

TABLE 2. CANADA, NICKEL PRODUCTION AND CONSUMPTION, 1970, 1975 AND 1980-90

	Production[1]	Consumption[2]
	(tonnes)	
1970	277 490	10 699
1975	242 180	11 308
1980	184 802	9 676
1981	160 247	8 603
1982	88 581	6 723
1983	125 022	5 010
1984	173 725	7 502
1985	169 971	7 206
1986	163 640	8 865
1987	193 391	9 732
1988	216 589	9 250
1989	200 899	10 423
1990p	199 434	..

Source: Energy, Mines and Resources Canada.
[1] Refined nickel and nickel in oxides and salts produced, plus recoverable nickel in matte and concentrates exported. Data for 1987 to 1990 is nickel contained in concentrates produced. [2] Consumption of metallic nickel, all forms (refined metal, and in ferronickel oxides and salts) as reported by consumers on the EMR survey "Consumption of Nickel."
p Preliminary; .. Not available.

TABLE 3. CANADIAN PROCESSING CAPACITY, 1990

	Inco Limited		Falconbridge Limited	Sherritt Gordon Limited
	Sudbury	Thompson	Sudbury	Fort Saskatchewan
			(t/y of contained nickel)	
Smelter	110 000[a]	81 600	45 000	n.a.
Refinery	56 700	49 900	n.a.	25 000

[a] Capacity is constrained to this level by an Ontario government regulation on SO_2 emission limits.
n.a. Not applicable.

TABLE 4. WORLD MINE PRODUCTION OF NICKEL, 1988 AND 1989

	1988	1989
	(tonnes)	
U.S.S.R.	280 000	280 000
Canada	216 600	200 900
New Caledonia	71 200	96 200
Australia	62 600	65 000
Indonesia	59 800	59 600
Cuba	43 900	46 500
South Africa	34 800	34 000
Botswana	22 500	19 800
People's Republic of China	26 000	27 500
Dominican Republic	29 300	31 300
Other	92 900	102 600
Total	939 600	963 400

Sources: World Bureau of Metal Statistics; Energy, Mines and Resources Canada.

TABLE 5. WORLD CONSUMPTION OF NICKEL, 1988 AND 1989

	1988	1989
	(tonnes)	
U.S.S.R.	170 000	170 000
Japan	161 700	163 000
United States	135 300	127 300
Federal Republic of Germany	90 900	89 100
France	39 600	40 000
Italy	28 600	30 500
United Kingdom	33 000	29 500
People's Republic of China	27 500	29 500
Sweden	20 000	18 400
India	15 000	14 800
Other	184 700	198 500
Total	866 300	870 600

Sources: World Bureau of Metal Statistics; Energy, Mines and Resources Canada.

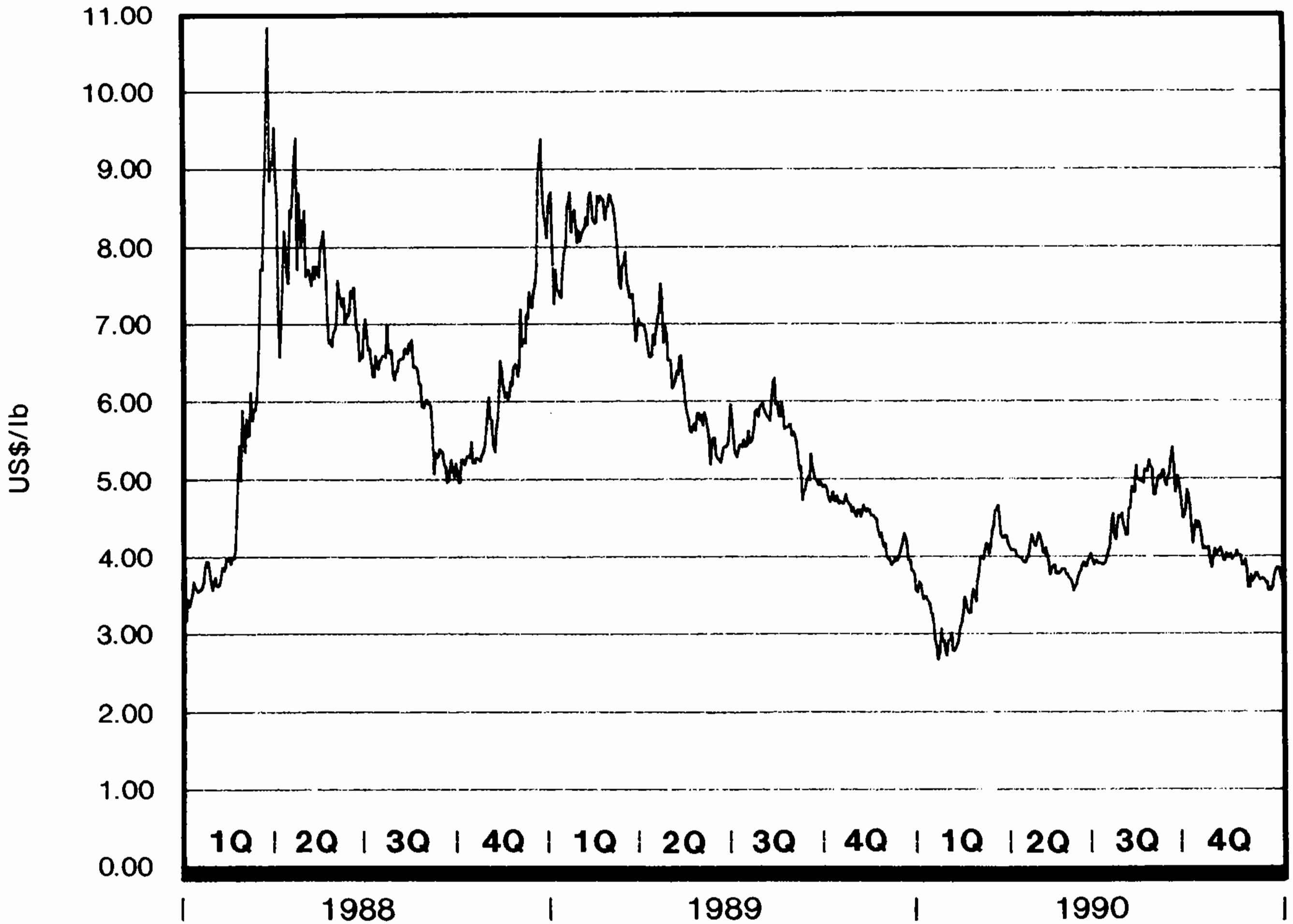
TABLE 6. AVERAGE ANNUAL NICKEL PRICES, 1980-90

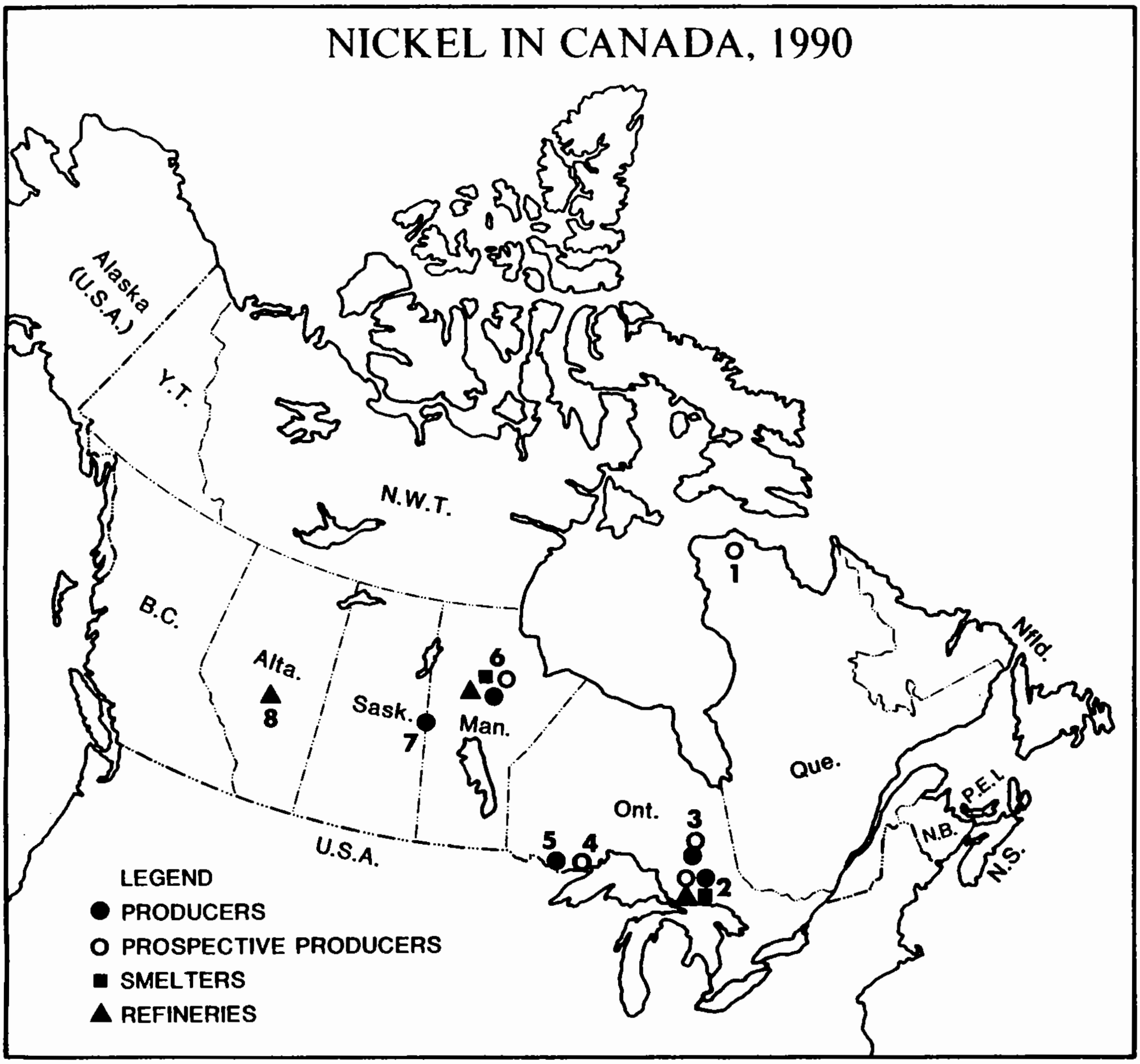
	London Metal Exchange - Spot
	(US$/lb)
1980	2.96
1981	2.71
1982	2.18
1983	2.12
1984	2.16
1985	2.22
1986	1.76
1987	2.19
1988	6.25
1989	6.04
1990	4.03

TABLE 7. AVERAGE MONTHLY NICKEL PRICES, 1989 AND 1990

	1989	1990
	(US$/lb)	
January	8.06	3.21
February	8.42	3.17
March	7.80	4.21
April	6.94	4.06
May	6.12	3.95
June	5.56	3.82
July	5.58	4.23
August	5.86	4.98
September	5.10	4.93
October	4.74	4.16
November	4.45	3.90
December	4.00	3.70

LONDON METAL EXCHANGE NICKEL PRICES




NICKEL IN CANADA, 1990
Alaska (U.S.A.)
Y.T.
N.W.T.
B.C.
Alta.
Sask.
Man.
Ont.
Que.
Nfld.
N.B.
P.E.I.
N.S.
U.S.A.
1
2
3
4
5
6
7
8
LEGEND
PRODUCERS
PROSPECTIVE PRODUCERS
SMELTERS
REFINERIES

Producers, prospective producers, smelters and refineries

(numbers refer to locations on map above)

Producers

2. Falconbridge Limited
   (Fraser, Lockerby, Onaping, Strathcona)
   Inco Limited
   (Copper Cliff North, Copper Cliff South, Crean Hill, Creighton, Frood, Levack, Little Stobie, McCreedy, West, Stobie and Whistle)
3. Timmins Nickel Inc.
   (Redstone, Langmuir)
5. Inco Limited
   (Shebandowan mine)
6. Inco Limited
   (Thompson, Birchtree, Thompson Open Pit North and South mines)
7. Hudson Bay Mining and Smelting Co., Limited (Namew Lake)

Prospective Producers

1. New Quebec Raglan Mines Limited
2. Falconbridge Limited (Craig, Lindsley)
   Inco Limited (Clarabelle, Coleman, Garson, Crean Hill, Murray, Totten)
3. Teck Corporation
   (Moncalm Township)
4. Great Lakes Nickel Limited
   (Pardee Township)
6. Inco Limited
   (Soab North, Soab South and Pipe No. 1)

Smelters

2. Falconbridge Limited (Falconbridge)
   Inco Limited (Sudbury)
   Inco Limited (Thompson)

Refineries

2. Inco Limited (Sudbury)
6. Inco Limited (Thompson)
8. Sherritt Gordon Limited
   (Fort Saskatchewan)

Peat

1990

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Peat is an intermediate matter resulting from the biochemical decomposition of plants. In its raw material form, it is ligneous, fibrous and elastic. It has a pH of 2.8-4.0 and an ash content of 0.5%-2.5%. Peat is composed of organic residues accumulated from the anaerobic decomposition of plant matters, and is found in peat bogs, swamps and marshes. Its main properties are its high water-retaining capacity, low density, high resistance to decomposition, low heat conductivity and high porosity. It can hold up to twenty times its weight in liquids and gas. Peat is divided into two principal types according to its botanical composition and degree of decomposition. Horticultural peat is relatively undecomposed, with a von Post value of H1-H5. It has a high fibre content, is light yellowish brown in colour and contains few colloids. Fuel peat is highly decomposed, with a von Post value of H6-H10. It is blackish in colour and contains colloid residues. Peat moss is the term applied to commercial peat used in horticulture.

The total area of peatlands in Canada is estimated at 111 328 000 hectares (ha), covering close to 12% of the country's land surface. Approximately 60% of all Canadian peatlands are perennially frozen. Indicated peat resources total approximately 3 004 996 million m^3, equivalent to 338 000 Mt of dry peat. Measured resources are estimated at 1092 Mt.

Peat production in Canada is limited to a short harvesting season–from May to September–due to weather conditions which hinder drainage and drying of the peat.

Canada mainly produces sphagnum peat, which is used in horticulture and agriculture. It is harvested primarily in eastern and southeastern Quebec, in northeastern and eastern New Brunswick, and in western Canada near Edmonton, Alberta; Carrot River, Saskatchewan; and Giroux and Elma, Manitoba. Sphagnum moss production also occurs in Nova Scotia, Prince Edward Island and Newfoundland.

PRODUCTION AND TRADE IN CANADA

In 1990, Canadian peat production was estimated at 745 842 t, a 6% decline from the previous year. Production in New Brunswick, Nova Scotia and Manitoba registered some gains while output in Quebec, Saskatchewan, Newfoundland and Alberta declined. No production was reported in Ontario and British Columbia. Quebec contributed to half of the decline, followed by Alberta (35%) and Saskatchewan (15%). In eastern Canada, the harvesting season started late, i.e. in the third week of May in Quebec and in mid-June in New Brunswick, and lasted up to the end of September. Weather conditions during June and July were favourable for harvesting in eastern Canada. In Quebec, peat production dropped 24% compared to last year as a result of a combination of factors that included unfavourable weather conditions in August, lower operating rates at several plants and temporary closures at a few operations in the Abitibi, Rivière-du-Loup and Côte Nord regions. In New Brunswick, strong winds and violent storms occurred at the end of July causing major losses of harvested peat that was stocked on bogs; however, peat production was reported to be better along the coast than inland. Both August and September offered intermittent sun and showers that allowed producers to recover some of the losses incurred earlier. In western Canada, the harvesting period lasted longer, from mid-April to October; some showers occurred in June and July. Peat production decreased 14% and accounted for 24.4% of total Canadian peat output.

Shipments in 1990 declined 8% from the previous year to 748 801 t, valued at \$89.4 million. Quebec accounted for 40%, followed by New Brunswick (32%), Alberta (14.5%) and Manitoba. Major declines occurred in Alberta (-29%) and Quebec (-14%), while significant sales increases were reported in New Brunswick (+13%) and Manitoba (+11%). Sales from Nova Scotia and Newfoundland remained stable. The average unit value decreased for the third consecutive year, reaching $119.57/t, a small 2.4% decline over 1989.

The peat market in 1990 was affected by two major factors from the supply side: the carry-over of large inventories in Quebec and the lower-than-expected harvest during the year. Both factors resulted in a stable level of sales influenced by a small increase in prices. In Quebec, sales showed a sustained performance during the first and second quarters of 1990, increasing 5% compared to the same period in 1989; however, shipments during the second half of 1990 were modest. In New Brunswick, sales were strong during the year and most producers have already committed all their 1990 production; transfers of peat volumes were necessary amongst New Brunswick peat producers in order to meet the requirements of some major accounts. Supplies of sphagnum peat from this province are expected to become scarce during the winter of 1990/91. In January 1990, inventories were reported high in Quebec at close to 6 million bales of 170 dm^3 and normal in New Brunswick with 3.1 million bales. The high level of stocks in Quebec in combination with a low level of sales during the winter of 1989/90 resulted in downward pressures on prices. Producers and suppliers resisted these pressures during the first half of 1990 and succeeded in implementing a small 4%-5% increase in prices in the fall of 1990. At the start of the harvesting season, inventories were still high in Quebec, at about 2.9 million bales, while they were marginal in New Brunswick at 0.85 million bales, except for those of one producer. Stocks in eastern Canada remained stable in June and July as most sales were directly supplied from production. It is expected that stocks in Quebec will decline 1 million bales (-17%) by the end of 1990 compared to last year, totalling 5 million bales. Sales from western Canadian producers remained steady despite production shortfalls due to technical problems.

Most Canadian peat production was used in horticulture, nurseries and landscaping, and by mushroom growers. Domestic consumption of peat was estimated at 12% of total shipments, the remainder being exported. Shipments comprised peat in bulk, bales and value-added products such as pots and mixes.

In 1989, exports of peat declined 25% to 512 378 t, valued at $106.3 million. Canada exported to about 35 countries of which the United States accounted for 89%, followed by Japan at 10% and the Netherlands at 0.6%. Exports to the United States declined 25% while sales to Japan continued to increase. Higher sales were registered in Africa, Scandinavia, the Middle East and the Antilles. Lower sales occurred in Oceania and Western Europe. In the first nine months of 1990, Canadian exports amounted to 475 248 t. The unit value of exports reached $209.67/t, mostly due to increases in the value of shipments to Japan and the United States. Sales to the United States originated mostly from Quebec (51%), followed by western Canada (35%) and Atlantic Canada (14%). Shipments were reported strong during the first half at a rate of 4000 t/m to 6300 t/m, but remained static during the third quarter of 1990 at 3300 t/m. Sales to Japan were mostly from New Brunswick (72%), followed by Nova Scotia and Quebec. Western Canada accounted for 6%. Shipments to Japan were strong during the second and third quarters of 1990; monthly shipments averaged 4000 t/m early in 1990 and rose to 8500 t/m in September. Exports to the Netherlands and South Africa were all from Quebec while exports to Israel and South Korea were from New Brunswick. Exports to Australia were mostly from Quebec (66%) and New Brunswick (33%).

DEVELOPMENTS IN CANADA

In 1990, close to 75 operations were involved in the production and manufacture of sphagnum peat moss in Canada. The Canadian peat industry provided 1400 jobs on an annual basis during 1990, compared to 1580 jobs in 1989. Over the last ten years, the peat industry has employed an average of 1430 workers per year.

In Atlantic Canada, Encon Enterprise Inc. of Calgary carried out field tests for the production of oil, char and gas from the pyrolysis of peat; experiments were conducted during the summer of 1990 with a mobile pilot plant near Bishop's Falls, Newfoundland. The company ultimately hopes to produce activated carbons from peat on a commercial basis. Late in 1990, Hi-Point Industries, Division of Genesis Pipeline Canada Ltd., was affected by a fire that destroyed its plant located at Bishop's Falls, Newfoundland; the company plans to reconstruct a small temporary plant to resume production of peat-based oil-absorbent products in early 1991. In New Brunswick, Premier CDN Entreprises Ltd. of Rivière-du-Loup, Quebec, encountered delays in its development of a peat bog near Bull Pasture; delays were related to the filing of an environmental impact analysis. Jiffy Products (N.B.) Ltd. of Shippagan was granted an exploitation lease for a peat bog near Ste. Rose; no production is expected in the short-to-medium term since the bog is considered as peat reserves. Lameque Quality Group Ltd. of Lamèque did not operate Canadian Supreme Products Ltd. of Rivière-du-Portage for a second consecutive year; the company is planning to open into production two new peat bogs in Nova Scotia. Fisons Horticulture Inc. expanded its peat mixing and bagging facilities at Shippagan. Several producers in New Brunswick conducted field work to expand production acreages within the next two years: Berger Mix Inc. at Baie-du-Vin, Fafard Peat Moss Company Ltd. at Burnt Church and Saint-Paul, and Miramichi Peat Moss Ltd. near Ste. Marguerite. The Peat Research and Development Centre Inc. (PRDC) received a \$1.4 million grant from the federal and provincial governments to create a trust fund to ensure the long-term viability of the PRDC. The New Brunswick Department of Natural Resources and Energy has initiated two peat-related studies that deal with dusting from airborne peat matters associated with peat production, and with harvested bog reclamation.

In central Canada, Lindeidt Peat Inc. of Marathon Township, Ontario, was sold in June to McKinnon Prospecting Co. of Timmins; no production was reported in 1990. Two private companies applied separately to the Ontario Ministry of the Environment to obtain exploitation permits for peat production near Cochrane, Ontario. Atkins & Durbrow (N.B.) Ltd. of Wainfleet closed down its peat operation after a fire destroyed the facilities in the fall of 1990. In Quebec, Premier CDN Entreprises Ltd. of Rivière-du-Loup did not operate its peat production units in St-Ulric, Rivière-du-Loup and St-Alexandre during 1990; four other divisions, including Verbois and Sept-Îles, operated intermittently in 1990. These temporary closures were part of a corporate strategy to limit production in order to reduce substantial inventories. Premier CDN Entreprises Ltd., in a joint venture with the Centre de recherche industrielle du Québec (CRIQ) and the Centre québécois de valorisation de la biomasse (CQVB), carried out laboratory tests to develop peat-based biofilters for treating liquid wastes from small- and medium-sized municipalities; in subsequent work, experiments are to be conducted on a larger scale at one municipality. Premier Peat Moss Ltd. expanded its Pointe-Lebel facilities in the Lac-St-Jean area; the \$1.7 million project will permit the company to produce coarse peat products and to automate its packaging system. Fafard & Brothers Ltd. shut down its operation at Senneterre in the Abitibi region due to production problems; the company intends to experiment with block cutting during 1992. Fafard encountered some technical problems at its Ste. Marguerite operation where wet bulk peat is extracted to supply Produits Desbiens Inc.; by mid-August, the operation ran on a five-day-per-week schedule. Tourbières Lambert Inc. closed its production at Les Escoumins and ran its operation in St-Paul-du-Nord at a low rate. Lambert acquired huge peat reserves near St-Léon and St-Nazaire in the Lac-St-Jean area. Johnson & Johnson Inc. started the production of peat-based personal absorbents during 1990 for retail commercialization due early in February 1991.

In western Canada, Premier West Peat Moss Ltd. of Giroux, Manitoba, operated at high capacity with the resumption of activities at the plant that had been affected by a fire in 1989. In Saskatchewan, Premier Sask. Inc. suffered damages from a fire that destroyed both its processing and packaging units in March; no peat manufacture was carried out during 1990 since all peat harvested was trucked to the company's plant at Olds, Alberta. Reconstruction of the facilities in Carrot River was undertaken late in 1990 for completion due in early 1991. Fisons Horticulture Inc. conducted modernization work at Elma, while the company's operation in Seba Beach, Alberta, was damaged by a fire that occurred in the drying units in February 1990; normal operation resumed during April 1990. Trade-tech Industries Ltd. closed its operation at New Brook, Alberta, for an undetermined period.

INTERNATIONAL DEVELOPMENTS

World Production

In 1990, world peat production was estimated at 194.7 Mt, a small 2% increase over 1989. In 1989, close to 194.2 Mt were produced of which about 87% was for use in agriculture. The U.S.S.R. was the world's largest producer of agricultural peat with a 97% share, followed by West Germany (1.07%), Canada (0.5%) and the United States (0.4%). Fuel peat production accounted for 13.3% of total world output and was mainly produced in the U.S.S.R. (66%), Ireland (21%) and Finland (12%). World resources of peat were estimated at 1.9 trillion tonnes with the U.S.S.R. accounting for 40% and Canada for 27%.

United States

In 1990, the United States ranked as the fourth largest world producer of agricultural peat. Peat production declined 2% to 671 000 t, valued at US$17 million-$18 million. Close to 80 operations were active in 22 states and about 20 plants were idle. Seven states (Florida, Michigan, Illinois, Indiana, Minnesota, New Jersey and Wisconsin) accounted for 85% of total U.S. peat production. Reed-sedge peat remained the most produced type of peat with a 65% contribution, followed by humus peat (18%), sphagnum peat moss (13%) and hypnum moss (4%). Apparent consumption of all types of peat rose marginally in 1990 to 1.27 Mt of which sphagnum peat moss accounted for 50%. Sphagnum peat was produced in 12 operations and production amounted to 85 000 t in 1989, or 12.5% of total peat output in the United States. The domestic consumption of sphagnum moss registered a small 3% increase in 1990, with sales estimated at 635 000 t, of which imports accounted for 88.6%. Canada exported close to 562 400 t, a 17% increase over 1989. These imports were largely responsible for offsetting the decline registered in industry stocks withdrawals. The net import reliance over apparent consumption rose 1% to 47%, the highest level achieved since 1986. Domestic prices on a f.o.b. basis remained stable at US$21.00/t. Imported peat prices were quoted at US$140.59/t, c.i.f., compared to US$119.74/t in 1989. The U.S. market demonstrated some stability in 1990 as both supply and demand remained static. The domestic horticultural industry has experienced a steady decline since 1987 resulting in the temporary or permanent closure of approximately 20 operations that produced reed-sedge and humus peat in Florida, North Carolina, Ohio and Pennsylvania. The U.S. Bureau of Mines forecasts that U.S. peat production will increase 16% from 740 000 t in 1990 to 840 000 t in 1995. Primary demand for peat is expected to increase 5.5%/y to reach 1.5 Mt/y in 1995; this tonnage excludes close to 450 000 t/y of peat for use in power generation plants.

Japan

Japan remained the second largest importer of Canadian peat moss, accounting for 10% of Canada's exports in 1989. In 1989, Canadian export sales to Japan were valued at $12.6 million. The unit value of exports continued to fluctuate; during the last decade, it ranged between $204/t and $241/t, but reached $253/t in 1990, a 14% increase over 1989. In the first nine months of 1990, Japan imported a total of 69 000 t of peat, valued at $27 million on a c.i.f. basis. Sales rose 35% compared to the same period last year. During 1989, Japan imported 60 347 t from thirteen countries. Canada remained the major supplier with a 92% share, followed by West Germany (4%), Taiwan (0.8%) and the U.S.S.R. (0.8%). Delivered prices (c.i.f. basis) averaged US$372/t in 1989. January to October 1990 prices were reported at $344/t compared to $372/t during the same period last year.

The major end use for sphagnum peat moss is industrial landscaping accounting for half of total consumption, followed by rice nursery bedding (20%) and greenhouse usage (20%). The remaining 10% includes horticulture and golf courses. Peat usage is reported to be growing in industrial landscaping and greenhouse food manufacture, while declines have been registered in rice nurseries. Peat sales for industrial uses are mostly handled by large buyers while, for other usages, distributors and wholesalers handle peat purchases. The household market is supplied by retailers. Japan is mostly supplied with imported peat in six-cubic-foot bales (170 dm_3) shipped in containers. Most Canadian sales are from Atlantic Canada with Halifax, Nova Scotia as the port of clearance.

In 1990, the Japanese peat market continued to demonstrate strong growth, with an annual rate of 30% for the last 10 years. In 1989, sales rose 15%, while in 1990 sales increased 38%. The peat market is forecast to remain firm and to show steady growth for the next five years. Demand for specialty peat products such as peat mixes and peat blends is expected to increase. It is projected that Japan will continue to rely heavily on Canada as the main source of peat products. However, intensifying competition among Canadian suppliers and increasing freight charges and currency rates will likely soften the pricing structure and may result in lower profitability than expected for Canadian producers. A peat export consortium could alleviate these constraints.

Ireland

Ireland was the second largest world producer with 3% of total production. In 1989/90, peat production decreased 10% to 7.56 Mt of which 95% was for fuel usage. Bord na Mona, a state-owned corporation, contributed 82% of total Irish output. Ireland produced milled peat, sod peat and milled moss peat. Milled peat is peat in powder or crumb form and is used for the production of peat briquettes and by local power stations. Sod peat or machine turf peat is extruded peat used for general and domestic fuel usage. In 1989/90, milled peat production declined 9% to 5.8 Mt over 1989; moss peat output amounted to 190 000 t. The peat harvesting period lasted from May to August. The peat industry employs close to 3000 persons in Ireland.

Half of Bord na Mona production is sold on the open market while the rest, mainly milled peat, is shipped to the Electricity Supply Board (ESB). In 1990, close to 370 000 t of briquettes were manufactured from milled peat. In Ireland, fuel peat accounted for about 15% of its total primary energy output. Sales of horticultural peat and sod peat totalled 240 000 t and 150 000 t respectively. Close to 90% of horticultural peat production was exported to more than 27 countries. The major destinations for exports were the United Kingdom, France, the Netherlands, the Middle East, Africa and Central America.

Finland

Finland was the third largest peat producer in the world. In 1989, peat production rose 20% to 4.27 Mt of which milled fuel peat accounted for 83%, sod peat for 8% and horticultural peat for 9%. Most of the increase was attributed to higher output in fuel peat; however, production of horticultural peat reached a 16-year record level of 1.77 million m^3; the former record was registered in 1982 with an output of 1.75 million m^3. Two thirds of the total milled peat output was carried out with the Haku method, the remainder being harvested with mechanical collection wagons. Vapo Oy is a state-owned corporation which accounted for 85% of total Finnish peat production. Close to 30 plants were active in Finland.

The harvesting season is usually relatively short with 30-40 effective production days. Peat production lasts from May to October, but peaks in June and July. Close to 45 400 ha were in production in 1989, representing about 0.5% of the Finnish bog surface; close to 3600 ha were worked for the production of horticultural peat.

Over the last 16 years, fuel peat production has increased from 2.2 million m^3 to 18.0 million m^3. Milled and sod peat products are used as fuel, accounting for 3%-4% of the total energy consumption in Finland. Half of this volume is consumed by power plants while the remainder is for industry usage. The 1989 fuel peat production had an energy content equivalent to 1.52 Mt of oil. Since 1987, the use of fuel peat has continued to decline progressively, mostly due to lower-than-anticipated operating rates at some peat power plants.

Since 1975, the annual horticultural peat production averaged 1.09 million m^3/y, ranging between 0.62 million m^3/y and 1.77 million m^3/y. In 1989, the sales of horticultural peat rose 39% to 1.72 million m^3. For the last 15 years, peat sales have grown from 0.5 million m^3 to 1.72 million m^3, a 250% increase or a 14% annual growth rate in that period. The domestic market accounted for 85% of total sales for use in landscaping, horticulture, farmland conditioning and environmental protection. Exports amounted to 262 000 m^3, contributing to 15% of total sales.

USES

Sphagnum peat is extracted from peatlands and dried. After the fibres are removed, it is pressed into bales. It is marketed in three forms. In its natural state, peat is sold in bulk form within a 100-km radius of production centres. When packaged in bags or bales, peat is compressed using a ratio of 2:1. The most common bale sizes are 170 dm^3 (6 ft^3), 113 dm^3 (4 ft^3), and 56 dm^3 (2 ft^3). Peat is mixed with fertilizers and other products, such as vermiculite and perlite, to form a substrate, and with limestone, soil and fertilizers to form potting soil.

Because of the range of its physical and chemical properties, peat has many uses. It is used in its natural state in agriculture and horticulture to loosen up clay soils, to maintain moisture in sandy soils and to add organic matter and fertilizers to depleted soils. Peat is also used as a horse, cattle and poultry litter to absorb liquids and odours. Peat is used in the production of artificial mixtures such as potting soil, seed carriers, peat-perlite and peat-vermiculite mixes, fertilizers and composts. It is also used in the production of peat pots for sprouting plants.

Peat has several industrial applications. It can be used in the production of paper towels, chemical products, metallurgical coke and activated carbon (charcoal). Peat is also used to purify industrial and domestic effluents. Its cellular structure, absorbing properties and high capacity for ionic exchange, form the basis for its use as a natural filter. Peat can reduce the acidity of drainage from old mines and remove iron oxides from waste and drainage water. Peat has also been used as an oil spillage absorbent and in certain medical applications.

Fuel peat is recognized as an alternate source of energy. This form of biomass is widely used as fuel in several European countries, such as Ireland and Finland, and in the U.S.S.R. The calorific value of dry Canadian peat is approximately 4700-5100 kcal/kg, compared with oil at 9900-10 000 kcal/kg and coal at 4800-5800 kcal/kg. Peat, as a fuel, is fired in furnaces to produce the steam needed to drive turbines generating electricity. Fuel peat can be processed to produce coke, synthetic natural gas and methanol. Fuel peat has a high degree of humification, a high bulk density, a high calorific value, a low ash content and a low percentage of pollutants such as sulphur and mercury.

OUTLOOK

The peat industry in Canada is expected to continue its rationalization and the implementation of major measures to ensure its profitability. The temporary or permanent closure of marginal operations will allow producers to focus their resources toward research and development. Canadian producers will adopt more technologies developed abroad and apply them to local conditions. Scandinavian, Irish and German technologies are increasingly used in Canada.

The number of producing centres is declining due to closures in isolated regions or at depleted peatlands; shutdowns are expected in the Abitibi, Rivière-du-Loup and Côte-Nord regions in Quebec. Activities are expected to resume in Saskatchewan and Newfoundland, and potentially in Ontario.

The demand for peat will be stable in 1991 due to the recession. However, due to limited supplies, producers will likely achieve a price increase in the order of 4%-5% in the spring of 1991. An 8% fuel charge was implemented late in 1990 and may continue during 1991 in the wake of potential disruptions in oil markets. The professional market is projected to remain firm in 1991, despite the stiff competition that sphagnum moss faces from lower-priced non-sphagnum peat substitutes. The retail market may show some improvement as the merits of using peat moss are more widely recognized in the United States as a result of the promotion campaign sponsored by the Canadian Sphagnum Peat Moss Association since 1989.

In the early 1990s, the peat industry is tending to become more sensitive to concerns over protection of the environment. The industry has approached these concerns on two fronts: first, the use of peat moss as a solution toward environmental problems; and second, a pro-active determination to ensure environmentally sound peat production. For the last two decades, the world peat industry has conducted many studies and experiments to demonstrate the benefits of using peat moss for the treatment of industrial waste waters and sewage. Peat moss also offers interesting properties that could be key to the control and the prevention of acid mine drainage. Peat moss is also an excellent feedstock for the manufacture of activated carbons whose consumption is expected to boom in water and gas treatments. The prospect of using peat-based biofilters or filtering systems for industrial and municipal wastes offers huge sales opportunities to peat producers. In Canada, the peat producers have taken a positive stance on wetlands depletion which is a very sensitive issue in the United States, Western Europe and Scandinavia. In 1990, the Canadian Sphagnum Peat Moss Association, whose members account for 90% of total Canadian peat output, developed a preservation and reclamation policy for peatlands. The policy aims at protecting the peatland eco-systems and recommends methods for operating and managing a peat bog which include preparation techniques and reclamation measures.

The future calls for new uses for peat products. New enhanced peat products in horticulture will include fertilized peat matts, peat pellets and peat boards. Industrial usages for peat may be developed for the manufacture of nitrogenous fertilizers, formic acid, hydrogen peroxide, ethanol and carbons.

Peat is increasingly perceived as a low sulphur fuel alternative for power generation. Several projects have been announced in the United States following the commissioning of a US$55 million plant in Maine during 1990. Five other plants are expected to come on stream before 1995 in central Florida. In Canada, many projects are under study in Nova Scotia, Newfoundland, Ontario, Saskatchewan and Alberta.

The U.S. Bureau of Mines has forecast that world peat consumption will grow at an annual rate of 0.7% to reach 223.0 Mt/y by 1995; close to 191.8 Mt/y will be for use in agriculture, with the remainder being used for fuel usage. In 1995, world production capacity is projected at 225.0 Mt/y.

Note: Information contained in this review was current as of mid-January 1991.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2703.00	Peat (including peat litter) whether or not agglomerated	10.2%	6.5%	4.7%	Free
6815.20	Articles of peat	6.8%	4.5%	4.7%	Free

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States effective January 1, 1990.

TABLE 1. PRICES[1] IN UNITED STATES, BY TYPE OF PEAT, 1989

Type	Domestic Bulk	Domestic Packaged or Bales	Domestic Average	Imported[2] Total
		(U.S. dollars per short ton)		
Sphagnum moss	14.30	76.24	30.32	132.02
Hypnum moss	21.86	62.48	40.81	n.a.
Reed-Sedge	24.32	22.59	23.27	n.a.
Humus	11.07	20.96	14.03	n.a.
Other	10.00	4.89	6.35	n.a.

Source: U.S. Bureau of Mines, "Peat," 1989.
[1] Prices are f.o.b. plant. [2] Average customs values.
n.a. Not applicable.

TABLE 2. WORLD PRODUCTION OF PEAT, BY COUNTRY, 1985-89

Country	1985	1986	1987	1988p	1989e
			(000 tonnes)		
Agricultural use[1]					
U.S.S.R.[e,r]	158 725	163 260	163 260	163 260	163 260
West Germany	1 515	2 015	2 000	2 000	1 815
Canada	645	740	610	735	810
United States	750	830	865	765	685
Netherlands[e]	455	400	400	400	400
Ireland[r]	320	325	370	355	365
Finland	340	350	350	350	350
France[e]	200	220	210	200	200
Poland[e]	200	195	250	200	200
Hungary[e]	70	70	70	70	70
Sweden	40	60	60	60	60
Denmark	40	45	50	50	50
Norway	30	30	30	30	30
Spain	55	50	50	55	25
Israel	20	20	20	20	20
Other	40	30	30	20	55
Total	163 445	168 640	168 675	168 570	168 395
Fuel use					
U.S.S.R.[e]	15 965	19 500	11 430	17 500	16 960
Ireland	2 670	4 710	6 135	5 440	5 440
Finland	3 140	3 175	3 175	3 175	3 175
West Germany	280	245	240	200	180
Total	20 055	27 630	20 990	26 315	25 755
World total	183 500	196 270	189 655	194 885	194 150

Sources: U.S. Bureau of Mines, "Peat," 1989; Energy, Mines and Resources Canada.
[1] Agricultural use figures have been highly revised for U.S.S.R. and for Ireland.
[p] Preliminary; [r] Revised; [e] Estimated.

TABLE 3. CANADA, PEAT SHIPMENTS BY PROVINCE, 1986-90

Province	1986		1987		1988		1989		1990p	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
Newfoundland	2	149	1	45	2	53	1	77	2	96
Prince Edward Island	–	–	–	–	–	x	x	x	x	x
Nova Scotia	x	x	x	x	x	x	x	x	x	x
New Brunswick	228	21 351	211	20 405	241	25 428	251	24 910	275	28 273
Quebec	334	30 059	274	25 731	317	30 313	335	41 516	297	35 839
Ontario	x	x	x	x	x	x	x	x	–	–
Manitoba	x	x	x	x	x	x	x	x	x	x
Saskatchewan	x	x	x	x	x	x	x	x	x	x
Alberta	72	13 930	78	15 221	78	15 150	93	18 626	64	13 129
British Columbia	x	x	–	–	–	–	–	–	–	–
Total	738	80 152	662	75 484	736	82 832	812	99 666	749	89 535

Source: Energy, Mines and Resources Canada.
p Preliminary; – Nil; x Confidential.

TABLE 4. CANADIAN DOMESTIC EXPORTS OF PEAT, BY COUNTRY, 1986-90

Province	1986		1987		1988		1989		Jan.-Sept. 1990p	
	Tonnage	Value	Tonnage	Value	Tonnage	Value	Tonnage	Value	Tonnage	Value
		($000)		($000)		($000)		($000)		($000)
Angola	–	–	–	–	–	–	7	6	–	–
Anguilla	–	–	–	–	1	2	30	21	–	–
Australia	61	32	480	251	2 723	1 403	1 938	645	942	244
Austria	–	–	–	–	171	77	–	–	–	–
Barbados	–	–	104	11	5	6	5	5	15	6
Belgium	–	–	–	–	497	147	32	20	135	25
Bermuda	40	15	52	13	66	33	56	11	20	7
China, People's Republic of	–	–	–	–	25	3	24	6	90	20
Costa Rica	11	3	–	–	16	6	–	–	–	–
Cuba	1	2	–	–	–	–	–	–	–	–
Denmark	–	–	53	26	27	69	75	145	115	344
Dominican Republic	35	15	14	2	14	6	68	11	54	10
Egypt	–	–	27	15	404	162r	–	–	–	–
France	–	–	9	5	19	27	24	62	24	35
Finland	–	–	7	1	–	–	–	–	–	–
Germany, West	35	14	10	4	502	182	79	14	7	11
Greece	–	–	64	33	1 220	425	–	–	–	–
Greenland	38	7	18	7	–	–	–	–	–	–
Guadeloupe	–	–	–	–	–	–	13	6	–	–
Haiti	143	121	49	33	49	51	76	67	135	143
Hong Kong	116	18	237	55	65r	9	86	18	37	19
Iceland	–	–	–	–	9	2	50	9	9	2
India	–	–	–	–	–	–	27	16	–	–
Ireland	–	–	11	3	9	2	–	–	–	–
Israel	–	–	63	16	417	101	167	39	342	62
Italy	–	–	17	5	277	71	16	47	250	26
Japan	31 552	7 240	35 008	7 659	52 691	11 020	56 226	12 640	49 992	13 373
Jordan	–	–	–	–	–	–	243	115	199	84
Korea, South	50	12	67	16	154	44	269	88	385	94
Kuwait	–	–	40	27	–	–	62	29	–	–
Leeward-Windward Islands	12	6	22	10	–	–	–	–	–	–
Mexico	–	–	–	–	77	16	16	5	36	15
Namibia	–	–	–	–	21	4	–	–	–	–
Netherlands	17	5	204	45	2 718	539	4 571	149	623	125
Netherland Antilles	–	–	–	–	13	6	17	4	–	–
New Caledonia	–	–	–	–	–	–	2	3	–	–
Niger	–	–	–	–	139	31	–	–	–	–
Norway	–	–	11	2	47	18	–	–	–	–
Puerto Rico	2 138	553	1 736	536	2 018	617r	2 672	489	–	–
St. Kitts-Nevis	–	–	–	–	19	4	–	–	–	–
St. Lucia	–	–	–	–	73	38	5	2	–	–
St. Pierre and Miquelon	209	38	–	–	–	–	–	–	–	–
Saudi Arabia	576	217	299	55	5 593	1 572	1 975	579	41	11
Singapore	16	7	64	26	–	–	–	–	12	1
South Africa	299	59	300	68	393	119	709	252	1 465	383
Spain	–	–	–	–	100	11	50	14	4	6
Switzerland	–	–	–	–	56	50	8	23	7	13
Taiwan	–	–	108	37	166	70	135	40	309	121
Trinidad-Tobago	46	15	29	19	15	6	32	28	51	38
United Kingdom	–	–	3 426	960	510	158	7	10	61	31
United States	499 608	101 574	434 813	93 279	618 678	86 556	460 606	90 669	419 879	84 377
Uruguay	–	–	–	–	–	–	–	–	8	4
Total	535 003	109 953	477 342	103 219	689 997r	103 682r	512 378	106 303	475 248	99 647

Sources: Statistics Canada; Energy, Mines and Resources Canada.
p Preliminary; – Nil; r Revised.
Note: Totals may not add due to rounding.

TABLE 5. PRIMARY DESTINATIONS FOR CANADIAN PEAT DELIVERIES FROM MAJOR PRODUCING REGIONS IN 1988

	Canadian Producing Region		
Destinations	Western Canada[1]	Central Canada[2]	Atlantic Canada[3]
		(tonnes)	
Western Canada[1]	20 008	0	148
Central Canada[2]	0	76 261	43 441
Atlantic Canada[3]	0	204	17 578
Subtotal, Canada	20 008	76 465	61 167
United States	124 825	237 810	187 467
Japan	1 168	5 969	17 186
Other	0	0	4 295
Subtotal, exports	125 993	243 779	208 948
Total	146 001	320 244	270 115

Source: Energy, Mines and Resources Canada.
[1] British Columbia, Alberta, Saskatchewan and Manitoba. [2] Ontario and Quebec. [3] New Brunswick, Prince Edward Island, Nova Scotia and Newfoundland.

TABLE 6. PEAT RESOURCES OF CANADA

	Peatland Areas		Indicated Volume of Peat (Oven Dry)
	Ha x 10^3	% of Total Canadian Peatlands	Tonnes x 10^6
Newfoundland-Labrador	6 429	6	24 945
Prince Edward Island	8	...	30
New Brunswick	120	...	466
Nova Scotia	158	...	613
Quebec	11 713	11	40 057
Ontario	22 555	20	77 138
Manitoba	20 664	19	58 893
Saskatchewan	9 309	8	26 532
Alberta	12 673	11	36 118
British Columbia	1 289	1	4 410
Northwest Territories	25 111	23	65 841
Yukon Territory	1 298	1	2 960
Total	111 328	100	338 003

Source: "Peat Resources of Canada," C. Tarnocai, Agriculture Canada, NRCC 24140, 1984.
... Amount too small to be expressed; Ha Hectare.

Platinum Metals

1990

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The platinum group metals (PGM) refer to six closely related metals: platinum, palladium, rhodium, ruthenium, iridium and osmium. These metals, among the scarcest of all metallic elements, commonly occur together in nature.

In 1990, industrial demand for platinum in the non-socialist world was estimated to have increased by more than 7% over 1989 levels. The largest gains were recorded in the automobile catalyst market, despite a slowdown in the U.S. automotive industry. These gains were partially offset by a decline in investment demand.

The average price of platinum declined from US$510/oz in 1989 to $471 in 1990. The price of palladium fell from $145 to $114 in 1990.

Rhodium prices skyrocketed to US$7000/oz in July 1990 in response to production problems in South Africa and reduced supplies from the U.S.S.R. The strong growth of rhodium consumption for three-way automobile catalysts in recent years is expected to continue in the 1990s as new automobile emission regulations are introduced or existing regulations are strengthened.

CANADIAN DEVELOPMENTS

The production of PGM in Canada in 1990 is estimated to have increased to 11 209 kg from 9870 kg in 1989. While the bulk of Canadian production is derived from the operations of Inco Limited and Falconbridge Limited at Sudbury, Ontario, small amounts are also produced from Inco's operations at Thompson, Manitoba, and the Namew Lake mine of Hudson Bay Mining and Smelting Co., Limited (HBMS) and Outokumpu Mines Ltd. at Flin Flon, Manitoba.

The Lac-des-Îles palladium/platinum property of Madeleine Mines Ltd. in northwestern Ontario started production in December at a rate of 3000 t/d. The company expects the operation to have an annual output of 4665 kg of PGM, 625 kg of gold, 900 t of copper, and 900 t of nickel. Estimated reserves at the Roby zone are more than 20 Mt grading 6.4 g/t PGM, with a platinum-to-palladium ratio varying between 1:4 and 1:8.

There was a significant drop in PGM exploration in Canada in 1990. Factors contributing to the decline included the reduced availability of risk capital and lower prices for both platinum and palladium.

WORLD DEVELOPMENTS

The major world producers of the platinum group metals are the Republic of South Africa (48%), the U.S.S.R. (45%), Canada (4.5%) and the United States (2%). Other producers include Finland, Yugoslavia, Ethiopia, Zimbabwe, Japan (from imported nickel and copper ores and intermediates), the People's Republic of China, Colombia and Australia. In 1989, world production, excluding China, reached 283 t, compared to 282 t in 1988.

At the end of 1990, there were six PGM producers in the Republic of South Africa: Rustenburg Platinum Holdings Limited, controlled by Johannesburg Consolidated Investment Company, Limited (JCI); Lebowa Platinum Mines Limited, with linkages to both Rustenburg and JCI; Impala Platinum Holdings Ltd., controlled by General Mining Union Corporation Limited (Gencor); Western Platinum Limited and Eastern Platinum Limited, owned by Lonrho Plc; and Barplats Mines Limited, controlled by Rand Mines Limited.

Rustenburg, the largest South African producer, operates three mines on the western rim of the Bushveld complex, namely the Rustenburg Section, the Union Section and the Amandelbult Section, and also manages another, the Atok mine, in the extreme northeast of the Bushveld complex on behalf of its affiliate, Lebowa Platinum Mines Limited. Capacity of the Rustenburg operations, including Lebowa, is estimated at about 40 500 kg/y of platinum.

Lebowa Platinum Mines Limited's Atok operation, which stopped mining in November 1990 after a labour dispute, resumed normal operation by year-end. Prior to the work stoppage at Lebowa's Atok mine, the company was proceeding with an expansion to increase capacity from 2000-3000 kg/y of platinum to over 4000 kg/y by mid-1992.

The first phase of the Rustenburg expansion program was due on stream in October. This phase will result in the mining of an additional 30 000 t/m of the UG2 reef at the Union Section. A program to increase output by 140 000 t/m from the Amandelbult Section is scheduled for completion by mid-1992.

At the end of September 1990, Rustenburg and Lebowa jointly announced their decision to proceed with the development of a mine on the Platreef near Potgietersrus. At an estimated capital cost of 789 million rands (R), the mine will reach full production of 200 000 t/y by 1994.

It is estimated that these three expansions will increase output of refined platinum by 6000 kg by the middle of the decade.

Rustenburg has also decided to go ahead with a US$500 million PGM mine in the Platreef area of Lebowa. The new mine is expected to be one of the lowest cost producers in the world. With the Platreef expansion, Rustenburg's production is expected to increase between 20% and 30% over the next four years.

It is estimated that Rustenburg accounts for about one third of the 9500 kg of rhodium produced in the world each year.

Impala Platinum Holdings Ltd., the second largest PGM producer in the Republic of South Africa, operates four mines which are northwest and adjoin the Rustenburg Section mine. Impala's annual platinum capacity is estimated at about 34 000 kg/y.

In order to maintain its market share, Impala plans to increase annual production capacity to 42 000 kg over the next five years. The increase is expected to come from enhanced mining and metallurgical efficiencies (1000 kg) at the existing operations and 4500 kg through expansions of mining at UG2. Some 2000 kg will be contributed by the development of a new mine on the Messina properties in the northeastern Bushveld complex, in which Impala has a 55% interest. The first output from Messina is expected in late 1993. The final feasibility study of the Messina project was approved by Impala's Board of Directors in January 1991. The Messina property is located on the northeastern rim of the Bushveld complex in Lebowa. Ore reserves at this site are estimated at 26 Mt grading 5.9 g/t PGM plus gold for the Merensky reef, and 33.8 Mt grading 6.7 g/t PGM for the UG2 reef.

At the end of 1990, the first phase of the new Karee mine, operated by Impala's subsidiary, Gazelle Platinum Limited, was in the process of being commissioned. The mine will have an initial capacity of about 3000 kg/y of platinum, increasing to approximately 4500 kg/y by 1994.

Western Platinum Limited, with one mine near Marikana, east of the Rustenburg Section, is the third largest South African producer. The company's platinum capacity is estimated at about 5000 kg/y, although an expansion to approximately 8500 kg/y is planned. During 1990, Western's affiliate, Eastern Platinum Limited, began production at its new platinum metals mine in Bophuthatswana. This operation, which will have planned capacity of about 5000 kg/y of platinum, is expected to be fully on stream in 1991.

In January 1990, it was announced that Impala would merge its Karee mine with Western Platinum Limited. As a result of the transaction, Impala will acquire a 25% interest in Western Platinum Limited as well as a 27% share of future earnings of both the merged assets and Eastern Platinum Limited.

In the first quarter of 1989, Barplats Mines Limited brought its Crocodile River mine (formerly the Lefkochrysos property) into production. The Crocodile River mine has since experienced a series of mining, metallurgical and engineering problems which have seriously affected output. Barplats did not achieve its first stage milling capacity of 160 000 t/y of UG2 ore until August 1990. The supply of platinum from that operation should total 1900 kg in 1990.

Barplats also continued work during 1989 on the development of its Kennedy's Vale property (formerly called Rhodium Reefs). It is expected that this mine will come on stream in 1995 at an annual production rate of between 4000 and 5500 kg of platinum.

Matte from the company's Crocodile River processing plant reached an output level of about 5300 kg/y of platinum in the first quarter of 1990, with production scheduled to increase to 8300 kg/y by the end of 1992.

During 1990, Northam Platinum Limited, controlled by Gold Fields of South Africa Ltd., continued development work on a new high-grade, but deep, PGM mine on the southeastern boundary of Rustenburg's Amandelbult Section mine. It is expected that production will begin at the end of 1991, with the operation scheduled to reach its full design capacity of 7000 kg/y in 1994.

Johnson Matthey Limited purchased a plant near Germiston, east of Johannesburg, which it plans to refurbish for C$15 million to produce auto catalysts. The plant will have a capacity to produce 2 million units per year once it comes on stream in 1991. Johnson Matthey will also relocate the manufacturing of its fabricated metal and chemical products from its Wadeville plant to the new site.

In Zimbabwe, PGM exploration continued during 1990 on the Hartley Complex of the Great Dyke. In November, Delta Gold NL completed a feasibility study of its Hartley platinum project, 65 km south of Harare. The proposed development would have an output of about 6000 kg/y of PGM plus gold, nickel, copper and cobalt, and could come on stream in 1992. The cost of the project is estimated at US$193 million. Also on the Hartley Complex, there were several other exploration projects during 1989 involving Rio Tinto Zimbabwe Ltd. and Anglo American Corp. Zimbabwe Ltd.

The Stillwater Mining Company, jointly owned by Chevron Resources Company and Manville Corporation, is the only primary PGM producer in the United States. Manville Corporation announced in 1990 its intention to sell its 50% stake in the Stillwater property. The mine, which came on stream in 1987, was scheduled to produce 7300 kg of combined platinum and palladium in 1990, after the completion of a major expansion. The company is also considering the development of a second mine 30 km to the west of the current operation.

Stillwater commissioned a 15-20 t/d smelter in July 1990 in Columbus, Montana, in an attempt to reduce costs and shorten the period of time between actual production and the receipt of payment for mine output. The US$6 million smelter was built about 60 km from the mine site due to environmental factors. The company experienced some difficulties in commissioning the smelter and this caused a two-week shutdown in August. Matte is shipped to Métallurgie Hoboken-Overpelt SA of Belgium for refining.

U.S.-based Salomon Inc. and the Soviet state company, Almazjuvelirexport (Almaz), formed Salmaz PGM Inc., a joint venture company which will market platinum group metals from the U.S.S.R. Marketing is expected to begin in early 1991.

The Soviets, through Almaz and the Ministry of Automobile Industry, are seeking joint venture partners to establish auto catalyst plants in the U.S.S.R. Regulations to reduce air emissions by automobiles in the U.S.S.R. are expected to be in place by 1993.

In Australia, platinum exploration continued at a large number of sites during 1990. Some of the more promising areas include Yarawindah Brook, Munni and Panton Sill. Other promising areas include Coronation Hill in the Northern Territory and Fifield in New South Wales.

In eastern Greenland, Platinova Resources Ltd. and Corona Corporation continued exploration work on the Skaergaard intrusion, where promising indications of significant gold and platinum mineralization have been reported. Corona Corporation withdrew from the project because some drilling results from the Skaergaard intrusion did not meet the company's criteria. Corona was to have earned a 50% interest in the project by funding $25 million in exploration and project costs. Platinova Resources will continue with its original plan to drill test the Edward Holm intrusion where grades are expected to be much higher than Skaergaard.

RECYCLING

The recovery of PGM from secondary sources, such as used industrial catalysts, electronic scrap and jewellery, constitutes an important source of these metals. The U.S. Bureau of Mines reported that the United States produced 51 t of secondary PGM in 1989, including 25 t of platinum and 23 t of palladium.

Spent automobile catalysts represent a growing and potentially significant source of PGM. Johnson Matthey Public Limited Company estimated that the recycling of these catalysts would yield about 4500 kg of platinum and 2333 kg of palladium in 1989.

CONSUMPTION AND USES

Platinum group metals are used in a wide variety of applications in pure form, and in a host of alloys combining different PGM alone or with other metals. The diversity of uses reflects their varied and unique attributes which include: chemical inertness and corrosion resistance, the ability to catalyze chemical reactions, high melting points, high strength at elevated temperatures, stable thermo-electric properties, good durability, low coefficient of thermal expansion, excellent reflectivity, stable electrical contact resistance and good high-temperature oxidation resistance. Platinum and palladium are the most common PGM found in nature. Platinum's principal uses are in catalysts designed to control automobile exhaust emissions and in jewellery, while the main uses of palladium are in the electrical and electronics industries and also in dental alloys.

While the other PGM are less important in absolute terms, rhodium, iridium and ruthenium have key industrial applications. The most important uses of rhodium are in automobile catalysts and as an alloying agent with platinum, while iridium is used in electrochemical and catalytic applications. The principal uses of ruthenium are electrochemical and electronic in nature. Osmium is used in the chemical and medical fields.

One of the largest uses of PGM is in the production of automobile catalysts. There are two distinct types of auto catalysts, an oxidation type which controls carbon monoxide and hydrocarbons, and the so-called three-way type, which controls emissions of carbon monoxide, hydrocarbons and nitrous oxides. Oxidation catalysts can contain either platinum or palladium, although most use a combination of the two metals. Three-way catalysts require platinum and rhodium. The use of oxidation catalysts has diminished as new environmental regulations governing nitrous oxides have come into effect, but some automobile manufacturers utilize an oxidation catalyst in conjunction with a three-way catalyst. PGM catalytic units are currently the major technology being utilized to reduce hydrocarbon and nitrous oxide emissions in automotive exhaust gases. Although research is continuing on other systems, including the lean-burn engine concept, these are not yet considered to be viable alternatives.

A typical emission catalyst in 1990 contained approximately 1.77 g of platinum, 0.47 g of palladium and 0.2 g of rhodium, for a total of 2.44 g of PGM.

In June 1989, the European Communities (EC) adopted new U.S. 1983-type emission standards for all gasoline-powered automobiles under 1.4 litres. These new regulations, which will take effect on January 1, 1993, go significantly beyond the levels agreed upon in 1988. In addition, it is also likely that current standards applicable to larger cars will also be made more stringent. By 1994, demand for platinum used in auto catalysts in the EC is expected to double to 18 000 kg/y.

Johnson Matthey PLC commissioned a catalytic converter plant in Brussels which will produce 5 million converters per year. The company plans to eventually double the capacity to 10 million units per year, depending on the market situation in Europe. In view of these developments, together with the likelihood that stricter California-type standards will be adopted in the United States and that emission regulations will be introduced in other countries such as Brazil, Mexico and Venezuela, the demand for platinum and rhodium will experience significant growth in the next decade.

In April 1989, the Canadian government announced its intention to tighten automobile emission controls. These will include reductions of up to 30% for nitrogen oxides and volatile organic compounds. Carbon dioxide emission levels will likely be held at current levels until 1995, and then reduced by 20% over the period to the year 2005.

Even before the full implementation of emission standards in Europe, the demand for converter-equipped automobiles had increased dramatically as a result of growing concern by both individuals and governments over the environmental effects of pollution. In an attempt to speed up the conversion to automobiles with catalytic converters, a number of European governments had offered various incentives to the purchasers of automobiles with pollution control devices.

The use of platinum in jewellery constitutes the second largest use for the metal. In 1990, it was expected that platinum demand in this sector would increase by 1400 kg, due in part to the relative stability of bullion prices. Japan continued to be the largest market for platinum jewellery with 1990 consumption representing about 86% of the Western World total.

In the petroleum refining industry, PGM, particularly platinum, are used as reforming agents to increase the octane rating of gasolines. This use has become more important in recent years as more stringent environmental regulations have restricted the amount of lead additives in gasoline. These additives are known to reduce the effectiveness of PGM auto catalysts. Also in the refining industry, PGM catalysts are used in hydrocracking and isomerization applications.

Other important industrial applications of platinum are in the glass industry for the production of glass fibres, in the chemical sector where platinum gauze is used as a catalyst in the production of nitric acid, and in the electrical industry and the biomedical sector.

One potential use, which could represent a major new market for platinum, is in the manufacture of phosphoric acid fuel cells. There are several potentially promising applications for this technology, including stationary power generation systems. While development work for such systems is still continuing, proponents claim significant advantages over traditional systems in terms of potential energy efficiency and cleanliness of operation.

In December 1989, Nippon Mining Company Limited established a commercial production technology for a platinum-iron magnet. This magnet is suitable for ultraclean environments because it does not generate gas or dust. The price of the magnet was quoted at US$214/g.

Investment demand has been a large but somewhat erratic market for platinum in recent years. Investment demand fell from about 5000 kg in 1989 to an estimated 3600 kg in 1990. The Royal Canadian Mint reported that sales of the platinum "Maple Leaf" coin in 1989 totalled 467 kg compared to almost 2000 kg during 1988.

One of the largest markets for palladium is in the electronics industry, where it is used in the manufacture of multi-layer ceramic capacitors, thick-film hybrid integrated circuits, resistor networks and electrical contacts. Another important application, and the fastest growing market for palladium, is in the field of dentistry where it is used in dental alloys and orthodontic and prothodontic devices. Much of this growth has resulted from the substitution of palladium for higher-priced gold.

A proposal to mint 350 000 commemorative palladium coins in the United States was abandoned, largely due to comments that the coinage would be too difficult to produce. In 1989, the U.S.S.R. announced that it would produce 30 000 legal tender palladium bullion coins.

Although the claim that cold fusion could provide both a low-cost form of power generation and also a significant market for palladium has been dulled by significant skepticism within the scientific community, research is continuing.

Stanford University recently reported that during the electro-chemical insertion of deuterium into palladium, heat was produced in an amount equivalent to about 8.5 watts/cm^3 of metal. This compares to 50 watts/cm^3 of core in a large nuclear power plant.

MARKETS, PRICES AND STOCKS

The average price of platinum in 1990 was US$472/oz compared to $510/oz in 1989 and $531/oz in 1988. In London, the average platinum monthly prices in the first eight months reached a peak of $516/oz in February and a low of $478/oz in April and July. Relative strength in prices was caused by projected growth in automotive catalyst markets. However, average monthly prices started to decline from the September level of $463/oz to between $420/oz and $425/oz between October and December in response to recessionary pressures. Relatively high interest rates and poor economic perspectives were expected to dampen growth expectations in the major end-use markets of the metal, such as automobile catalysts and jewellery. The Middle East crisis had little effect on platinum prices except for a short period in August 1990.

The average price of palladium in 1990 was US$115/oz, which was a substantial decline over the prices of $145/oz and $124/oz in 1989 and 1988, respectively. Palladium prices in 1990 behaved in the same manner as platinum prices with relative strength in the first part of the year, followed by a subsequent decline. Average monthly prices peaked in January at US$135/oz, fell to $115/oz in August, and by December had fallen to an average price of $90/oz.

Rhodium prices were US$2000/oz at the beginning of the year but then increased dramatically and peaked at US$7000/oz in July as a result of acute physical shortages. The shortfall was caused by rapidly increasing demand combined with production difficulties in the Republic of South Africa and reduced U.S.S.R. rhodium sales. The price gradually decreased to about $5300/oz by year-end.

New York dealer prices for ruthenium during 1990 were relatively stable in a range of US$61-$67/oz. On the other hand, iridium prices decreased slightly from a range between $315/oz and $330/oz to $308/oz and $320/oz, while osmium fell from between $500/oz and $550/oz to between $450/oz and $500/oz.

In 1990, the Tokyo Commodity Exchange (TOCOM) was considering the establishment of a palladium futures contract. However, industry representatives, such as Japan Gold Metal Association, are against the plans of TOCOM and the Japanese Ministry of Industry and International Trade (MITI) because it would increase platinum price fluctuations.

In its "Platinum 1990 Interim Review" published in November 1990, Johnson Matthey Public Limited Company estimated a supply surplus of about 2200 kg of platinum in 1990 compared to a shortfall of almost 1700 kg in 1989. For palladium, Johnson Matthey forecasted a supply surplus of approximately 1000 kg in 1990 compared to a deficit of 3000 kg in 1989.

OUTLOOK

A significant amount of new PGM capacity, particularly in the Republic of South Africa, is expected to come on stream over the next five years. However, the strong demand growth from the automobile catalyst sector is likely to result in some upward pressure on prices. In Europe alone, the demand for platinum in catalysts is expected to increase from about 9300 kg in 1989 to over 18 000 kg in 1994.

The actual level of PGM prices is dependent on a number of factors, the most important of which are political in nature. Despite recent encouraging political developments within the Republic of South Africa, significant uncertainty remains with regard to the future stability of that country. Moreover, fundamental political changes within South Africa could contribute to an escalation of mining and processing costs, and ultimately to international prices, for the platinum group metals. Political developments in the U.S.S.R.

can also have an impact on the availability of supplies and price levels.

In addition to the impact of political change and uncertainty, the level of PGM prices is also dependent on strength of demand from existing applications. In view of their high cost, consumers will continue to search for low-cost alternatives.

Despite the problems associated with the collection and processing of PGM scrap, it is expected that there will be a significant increase in the amount of material recovered from recycling in the next decade. In the long term, the availability of recycled material will limit price escalation.

Note: Information contained in this review was current as of mid-January 1991.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EEC MFN	Japan[1] MFN
26.16	Precious metal ores and concentrates						
2616.90.00.30	Platinum group	Free	Free	Free	Free	Free	Free
71.10	Platinum, unwrought or in semi-manufactured forms, or in powder form						
	Platinum						
7110.11	Unwrought or in powder form	Free	Free	Free	Free	Free	Free
7110.19	Other	Free	Free	Free	Free	0.9%-4%	Free-4%
	Palladium						
7110.21	Unwrought or in powder form	Free	Free	Free	Free	Free	Free
7110.29	Other	Free	Free	Free	Free	2%	Free-4%
	Rhodium						
7110.31	Unwrought or in powder form	Free	Free	Free	Free	Free	Free
7110.39	Other	Free	Free	Free	Free	2%	Free-4%
	Iridium, osmium and ruthenium						
7110.41	Unwrought or in powder form	Free	Free	Free	Free	Free	Free
7110.49	Other	Free	Free	Free	Free	2%	Free-3.7%
71.12	Waste and scrap of precious metal or of metal clad with precious metal						
7112.20	Of platinum, including metal clad with platinum but excluding sweepings containing other precious metals	Free	Free	Free	Free	Free	Free
71.15	Other articles of precious metal or of metal clad with precious metal						
7115.90.10.20	Crucibles of platinum	Free	Free	Free	4.8%	4.4%-5.1%	3.7%
7115.90.90.90	Other	Free	Free	Free	4.8%	4.4%-5.1%	3.7%

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States 1990; Official Journal of the European Communities, Vol. 33, No. L247, 1990, "Conventional" column; Customs Tariff Schedules of Japan, 1990.

[1] GATT rate is shown; lower tariff rates may apply circumstantially.

TABLE 1. PLATINUM METALS, PRODUCTION AND TRADE, 1989 AND 1990

Item No.		1989		1990p	
		(kilograms)	($000)	(kilograms)	($000)
Production[1]					
	Platinum, palladium, rhodium, ruthenium, iridium	9 870	141 730	11 209	205 553
				(Jan.-Sept.)	
Exports					
2604.00	Nickel ores and concentrates				
2604.00.83	Platinum metals group content	–	–	–	–
26.16	Precious metal ores and concentrates				
2616.90.83	Platinum metals group content				
	United Kingdom	10 129	113 896	7 191	89 413
	West Germany	12	367	–	–
	United States	8	216	76	514
	Total	10 148	114 479	7 267	89 928
7110.11	Platinum unwrought or in powder form				
	Japan	1 896	45 554	410	9 210
	United States	804	15 638	97	902
	West Germany	78	1 500	–	–
	Other countries	95	2 271	62	1 124
	Total	2 873	64 964	569	11 238
7110.19	Platinum in other semi-manufactured forms				
	Australia	1 811	30 904	566	11 819
	Hong Kong	248	3 899	244	4 547
	People's Republic of China	–	–	114	2 276
	Other countries	77	70	97	2 042
	Total	2 136	34 876	1 021	20 686
7110.21	Palladium unwrought or in powder form				
	United Kingdom	2 906	16 772	2 662	12 960
	United States	1 156	6 553	424	2 054
	France	311	1 854	187	866
	Other countries	–	–	1	2
	Total	4 373	25 180	3 274	15 883
7110.29	Palladium in other semi-manufactured forms				
	United States	–	–	237	1 153
	United Kingdom	175	926	–	–
	People's Republic of China	98	487	40	282
	Singapore	–	–	17	5
	Other countries	–	–	94	430
	Total	273	1 414	387	1 872
7110.31	Rhodium unwrought or in powder form				
	United States	–	–	25	562
	Total	–	–	25	562
7112.20	Waste and scrap of platinum; including metal clad with platinum, except sweepings containing other precious metals				
	United States	526	32 806	466	10 819
	United Kingdom	155	6 140	–	–
	Other countries	23	2 933	–	–
	Total	703	41 880	466	10 819
Imports					
26.16	Precious metal ores and concentrates				
2616.90.00.30	Platinum group metal content				
	United States	334	3 345	44	1 086
	Total	334	3 345	44	1 086

TABLE 1 (cont'd)

Item No.		1989		Jan.-Sept. 1990p	
		(kilograms)	($000)	(kilograms)	($000)
Imports (cont'd)					
7110.11	Platinum unwrought or in powder form				
	South Africa	840	16 120	527	9 419
	United States	701	12 216	550	9 750
	West Germany	1 279	23 110	121	2 195
	U.S.S.R.	355	6 966	. . .	. . .
	Other countries	140	2 666	87	1 617
	Total	3 316	61 080	1 284	22 984
7110.19	Platinum in other semi-manufactured forms				
	U.S.S.R.	678	13 905	620	12 686
	United Kingdom	2	99	325	8 517
	United States	221	2 752	375	4 342
	South Africa	47	958	–	–
	Other countries	105	2 736	106	1 891
	Total	1 052	20 357	1 426	27 438
7110.21	Palladium unwrought or in powder form				
	United Kingdom	–	–	256	1 136
	United States	128	878	81	533
	South Africa	124	571	–	–
	Other countries	42	321	65	260
	Total	295	1 772	401	1 931
7110.29	Palladium in other semi-manufactured forms				
	United States	885	9 042	504	3 982
	South Africa	156	821	–	–
	Other countries	105	656	185	985
	Total	1 145	10 521	689	4 967
7110.31	Rhodium unwrought or in powder form				
	U.S.S.R.	33	1 243	96	9 891
	United States	48	2 206	105	8 640
	South Africa	79	3 928	48	8 607
	Other countries	50	2 404	26	3 306
	Total	210	9 783	276	30 446
7110.39	Rhodium in other semi-manufactured forms				
	U.S.S.R.	–	–	14	1 871
	United States	14	547	. . .	14
	Other countries	5	191	–	–
	Total	19	739	14	1 886
7110.41	Iridium, osium and ruthenium unwrought or in powder form				
	United States	1	10	1	10
	South Africa	1	1	1	1
	Total	1	11	1	11
7110.49	Iridium, osmium and ruthenium in other semi-manufactured forms				
	United States	9	98	12	162
	Other countries	. . .	. . .	–	–
	Total	9	99	12	162
7112.20	Waste and scrap of platinum, including metal clad with platinum but excluding sweepings containing other precious metals				
	United States	816 564	7 944	687 281	6 792
	Mexico	53 337	901	533	2 587
	Costa Rica	557	186	54 581	225
	Other countries	154	3 023	125	2 188
	Total	870 612	12 056	742 520	11 794

TABLE 1 (cont'd)

Item No.		1989		Jan.-Sept. 1990p	
		(kilograms)	($000)	(kilograms)	($000)
Imports (cont'd)					
71.15	Other articles of precious metal or of metal clad with precious metal				
7115.90	Other				
7115.90.10.20	Crucibles of platinum				
	United States	713	19 825	318	10 316
	Other countries	32	871	3	119
	Total	745	20 697	321	10 435
7115.90.90	Other				
7115.90.90.30	Of platinum				
	United States	70	414	23	412
	Total	70	414	23	412

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Platinum metals, content of concentrates, residues and matte shipped for export.
p Preliminary; -- Nil; . . . Amount too small to be expressed.
Note: Numbers may not add to totals due to rounding.

TABLE 2. WORLD PRODUCTION OF PLATINUM GROUP METALS, 1985-89

	1985	1986	1987	1988	1989p
			(kilograms)		
Europe					
Finland					
Palladium	35	96	89	106	100
Platinum	35	120	120	54	60
Yugoslavia[e]					
Palladium	95	85	132	142	140
Platinum	3	33	24	23	22
Total	168	334	365	325	322
Africa					
Ethiopia[e]					
Placer platinum	2	2	1	1	2
South Africa					
Platinum group metals	115 000	123 900	131 300	133 300	135 800
Zimbabwe					
Palladium	30	35	29	46	35
Platinum	19	26	18	28	20
Total	115 051	123 263	131 348	133 375	135 857
Asia					
Japan					
Palladium	1 359	1 453	1 417	1 170	846
Platinum	691	663	753	647	999
Total	2 050	2 116	2 170	1 817	1 845
America					
Canada					
Platinum group metals	10 534	12 190	10 930	12 541	9 870
Colombia					
Placer platinum	362	447	638	810	964
United States					
Palladium			2 330	3 730	4 850
Platinum	w	w	780	1 240	1 430
Total	10 896	12 637	14 678	18 321	7 114
Australia					
Palladium	476	428	490	410	400
Platinum	95	115	130	105	100
Total	571	543	622	515	500
Eastern countries					
U.S.S.R.[e]					
Placer platinum and platinum group metals	118 200	121 300	124 400	127 500	127 500
World total	247 036	260 193	273 581	281 853	283 138

Source: Energy, Mines and Resources Canada.
p Preliminary; e Estimated; w Withheld to avoid disclosing company proprietary data; excluded from "Total."

TABLE 3. PLATINUM SUPPLY AND DEMAND, WESTERN WORLD, 1987-90

	1987	1988	1989	1990e
		(kilograms)		
Supply				
South Africa	78 380	80 246	81 490	88 021
Canada	4 354	4 510	6 065	6 220
Others	1 244	2 955	1 866	1 866
	83 978	87 710	89 421	96 108
U.S.S.R. sales	12 441	13 685	17 107	18 040
Total	96 419	101 396	106 528	114 148
Demand				
Western Europe	17 418	16 951	18 817	20 528
Japan	51 320	59 095	51 942	53 186
North America	27 993	26 904	27 837	26 904
Rest of Western World	5 599	9 642	8 398	11 353
	102 329	112 593	106 994	111 971
Western sales to COMECON/China	993	1 244	1 244	–
Movements in stocks	(6 843)	(12 441)	(1 711)	2 177
Total	96 419	101 396	106 527	114 148

Source: Johnson Matthey Public Limited Company.
( ) Brackets refer to reduction; e Estimated; – Nil or not separately available.
Note: Data converted from ounces; totals may not add due to rounding.

TABLE 4. PALLADIUM SUPPLY AND DEMAND, WESTERN WORLD, 1987-90

	1987	1988	1989	1990e
		(kilograms)		
Supply				
South Africa	33 902	34 369	35 768	38 879
Canada	5 910	5 288	11 664	12 286
Others	2 799	8 398	1 866	2 177
	42 611	48 054	49 298	53 342
U.S.S.R. sales	55 674	55 052	51 320	51 631
Total	98 285	103 106	100 618	104 973
Demand				
Western Europe	17 107	18 817	18 195	17 884
Japan	44 477	47 743	47 121	47 277
North America	32 192	31 725	33 280	32 814
Rest of Western World	5 288	5 132	4 976	6 065
	99 063	103 417	103 572	104 040
Movements in stocks	(778)	311	(2 955)	933
Total	98 285	103 106	100 617	104 973

Source: Johnson Matthey Public Limited Company.
( ) Brackets refer to reduction; e Estimated.
Note: Data converted from ounces; totals may not add due to rounding.

TABLE 5. PLATINUM CONSUMPTION BY APPLICATION, 1987-90

	1987	1988	1989	1990e
	(kilograms)			
Western World				
Auto catalyst (net)	35 457	36 857	40 123	41 679
Chemical	6 065	4 976	4 977	6 376
Electrical	5 599	5 754	6 065	6 221
Glass	3 732	4 043	4 354	4 043
Investment	15 240	19 595	4 977	3 577
Jewellery	30 792	36 702	40 589	41 989
Petroleum refining	1 711	1 555	2 333	4 354
Other	3 732	3 732	3 577	3 733
Total	102 329	112 593	106 995	111 972
Japan				
Auto catalyst (net)	9 175	9 486	10 420	11 664
Chemical	467	467	467	778
Electrical	1 400	1 400	1 555	1 555
Glass	1 400	1 400	1 244	1 244
Investment	10 420	12 908	2 022	933
Jewellery	27 993	32 969	35 768	36 235
Petroleum refining	–	–	–	311
Other	467	467	467	467
Total	51 320	59 096	51 943	53 187
North America				
Auto catalyst (net)	18 351	17 262	17 884	16 485
Chemical	1 711	1 711	1 711	1 866
Electrical	2 022	2 022	2 333	2 333
Glass	778	778	933	933
Investment	2 644	2 644	1 555	1 089
Jewellery	467	467	622	622
Petroleum refining	467	467	1 244	1 866
Other	1 555	1 555	1 555	1 711
Total	27 993	26 904	27 837	26 905
Rest of Western World including Europe				
Auto catalyst (net)	7 931	9 486	11 819	13 530
Chemical	3 888	2 799	2 799	3 732
Electrical	2 177	2 333	2 177	2 333
Glass	1 555	1 866	2 177	1 866
Investment	2 177	4 043	1 400	1 555
Jewellery	2 333	3 266	4 199	5 132
Petroleum refining	1 244	1 089	1 089	2 177
Other	1 711	1 711	1 555	1 555
Total	23 016	26 593	27 215	31 880

Source: Johnson Matthey Public Limited Company.
– Nil or not separately available; e Estimated.
Note: Data converted from ounces; totals may not add due to rounding.

TABLE 6. PALLADIUM CONSUMPTION BY APPLICATION, 1987-90

	1987	1988	1989	1990e
	(kilograms)			
Western World				
Auto catalyst (net)	6 843	5 754	5 754	6 221
Dental	29 703	30 947	30 947	31 259
Electrical	48 987	53 031	51 475	51 475
Jewellery	5 132	5 599	5 599	5 754
Other	8 398	8 087	9 797	9 331
Total	99 063	103 417	103 572	104 040
Japan				
Auto catalyst (net)	2 488	2 177	2 177	2 177
Dental	9 020	9 331	9 642	9 953
Electrical	28 615	31 725	30 481	30 170
Jewellery	2 488	3 266	3 421	3 421
Other	1 866	1 244	1 400	1 555
Total	44 477	47 743	47 121	47 276
North America				
Auto catalyst (net)	3 732	3 266	3 266	3 732
Chemical	12 130	12 130	12 286	12 286
Electrical	12 441	12 597	12 752	13 063
Jewellery	311	311	156	156
Other	3 577	3 421	4 821	3 577
Total	32 191	31 725	33 281	32 814
Rest of Western World including Europe				
Auto catalyst (net)	622	311	311	311
Dental	8 553	9 486	9 020	9 020
Electrical	7 931	8 709	8 242	8 242
Jewellery	2 333	2 022	2 022	2 177
Other	2 955	3 421	3 577	4 199
Total	22 394	23 949	23 172	23 949

Source: Johnson Matthey Public Limited Company.
e Estimated.
Note: Data converted from ounces; totals may not add due to rounding.

TABLE 7. AVERAGE PRICES FOR PLATINUM AND PALLADIUM

		Platinum		Palladium	
		NY Dealer	London	NY Dealer	London
		(US$/oz)			
1990	December	420	421	89	90
	November	422	421	94	94
	October	425	424	96	96
	September	460	463	104	106
	August	491	492	115	116
	July	479	479	117	117
	June	482	481	116	116
	May	488	488	120	120
	April	479	478	127	127
	March	497	497	131	130
	February	516	516	135	136
	January	498	498	136	138
1989	December	502	506	137	138
	November	504	510	138	139
	October	483	486	137	137
	September	477	477	137	138
	August	483	485	134	135
	July	500	502	150	151
	June	494	497	152	153
	May	515	517	152	154
	April	538	538	166	154
	March	534	538	145	147
	February	530	532	141	141
	January	528	527	135	135
1988	December	567	570	131	132
	November	567	576	125	126
	October	522	526	121	122
	September	506	512	120	121
	August	529	533	123	124
	July	543	549	124	126
	June	576	580	127	128
	May	545	549	122	123
	April	523	527	122	123
	March	491	496	121	122
	February	452	459	119	120
	January	492	494	124	124
Average	1988	525	531	123	124
	1987	553	556	130	131
	1986	462	465	116	117
	1985	291	..	106	..
	1984	357	..	148	..
	1983	424	..	136	..
	1982	327	..	67	..
	1981	446	..	95	..
	1980	677	..	201	..
	1979	445	..	120	..
	1978	216	..	63	..

Source: Metals Week.
.. Not available.

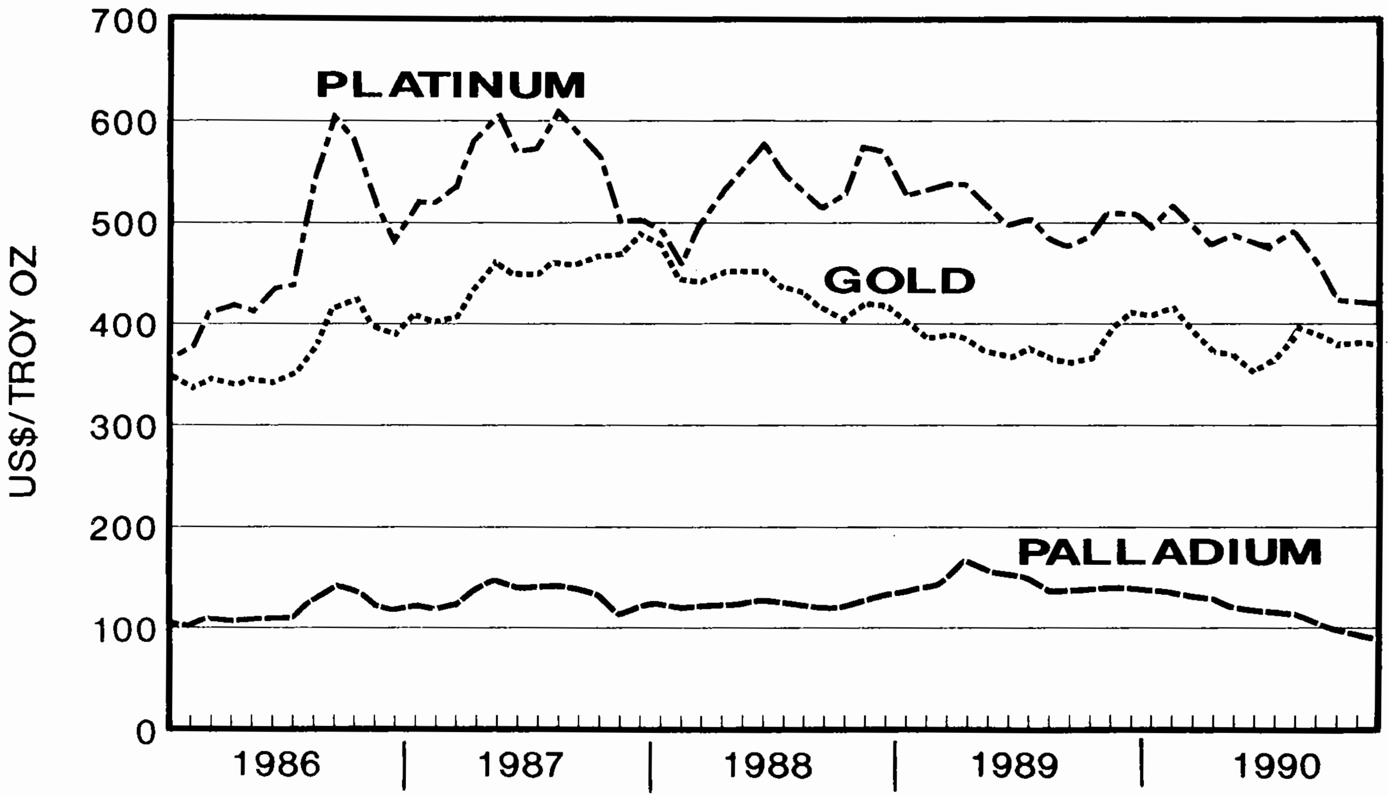
TABLE 8. RHODIUM SUPPLY AND DEMAND, WESTERN WORLD, 1985-90

	1985	1986	1987	1988	1989	1990e
			(kilograms)			
Supply						
South Africa	5 132	5 443	6 065	6 127	5 661	6 407
North America	467	467	560	622	467	529
Others	–	–	–	–	–	–
	5 599	5 910	6 625	6 749	6 128	6 936
U.S.S.R.	1 400	2 644	3 110	3 110	4 043	4 665
Total Supply	6 999	8 554	9 735	9 859	10 171	11 601
Demand						
By Region						
Western Europe	1 369	1 524	2 053	2 333	2 799	2 799
Japan	1 524	2 799	2 582	2 861	3 141	3 732
North America	4 169	3 452	3 950	3 421	3 328	4 510
Rest of Western World	529	560	622	840	902	964
	7 591	8 335	9 207	9 455	10 170	12 005
Movements in stocks	591	218	529	404	31	(404)
Total Demand	7 000	8 553	9 736	9 859	10 741	11 601
Demand						
By Application						
Autocatalyst: gross	4 199	5 847	7 029	7 216	8 211	10 264
recovery	(–)	(–)	(93)	(218)	(218)	(342)
Chemical	1 400	684	653	995	995	840
Electrical	529	498	373	342	373	311
Glass	529	373	404	435	124	249
Other	933	933	840	684	684	684
Total	7 590	8 335	9 206	9 454	10 169	12 006

Source: Johnson Matthey Public Limited Company.
( ) Brackets refer to reduction; – Nil or not separately available; e Estimated.

LONDON PRECIOUS METAL PRICES, 1986–90

(Monthly averages)



Potash

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SUMMARY

World production of potash in 1990 is estimated at 27.7 Mt in K_2O equivalent compared to 29.3 Mt in 1989. This is the second consecutive annual decline, caused principally by events in the Council for Mutual Economic Assistance (COMECON) block and China. Canadian mine production declined from 7.33 Mt to 7.0 Mt K_2O while mine shipments were steady at about 7.15 Mt in 1989 and 1990. Total Canadian sales, however, increased to 7.19 Mt K_2O in 1990. There was a decrease in mine-site inventories of about 70 000 t. The production decline was registered in Saskatchewan, while production in New Brunswick, which accounted for 14% of the total, increased marginally.

In 1990, the global potash potential oversupply was still persisting and the overall capacity utilization was around 80%, principally because Canadian mines operated at a very low level of 59%, the lowest level in the past decade. Slightly lower production levels were voluntarily maintained by German and French producers. Production in the U.S.S.R. declined substantially for the second year in a row due to serious dislocations in overall COMECON demand and further deterioration in the transportation and distribution systems.

In the United States, potash fertilizer demand remained steady, but below best expected levels, as it appeared that farmers reduced rates of potash application per acre. Total U.S. demand held at about 4.7 Mt K_2O. New-Potex Ltd., a potash export association created by New Mexico producers at the beginning of 1990, fell apart and ceased operations at the end of October.

The average unit value of potash shipped by Canadian producers was C$129.33/t K_2O (f.o.b. mines) in 1990 compared to C$145.07/t in 1989. This is a revision from the C$134.60/t reported by companies as a preliminary figure last year.

The average unit value of potash exported calculated by Statistics Canada, on the basis of port of exit (e.g. Vancouver or Saint John) or a border crossing to the United States, was $180.5/t K_2O in 1990 (based on nine-month exports) compared to $184.09/t in 1989.

The Canadian potash industry reported a net profit after taxes and interests of $190 million in 1989 compared to a profit of $208 million in 1988. Profits in 1990 are expected to be significantly lower, after which a steady improvement is forecast on a long-term basis.

CANADIAN DEVELOPMENTS

Saskatchewan

Saskatchewan produced about 86% of Canadian potash in 1990. The industry employed 3332 persons in 1990 compared to 3393 in 1989. This included Canadian-based employees of Canpotex Limited. Short interruptions in employment were required in some of the mines as they shut down for a few weeks to a cumulative period of four months in 1990 to keep inventories at acceptable levels in a period of oversupply.

A new provincial potash tax system was introduced as of January 1, 1990. This system replaced the Potash Resource Payment Agreement (PRPA) which had been in force since 1979. Under the new tax regime, all potash companies are subject to a base payment of $11/t K_2O of product sold, plus a graduated profit tax varying from 15%-50%. Crown royalties and freehold royalties are deductible against the base payment. The base payment is also recognized as a credit towards profit taxes payable; it can be carried forward for five years. Each year the base payment and profit tax rates will be adjusted for inflation. The base payment will be \$11.36/t K_2O as of January 1, 1991. Research and development and market development expenses are also eligible for tax credits.

For periods varying from three to nine weeks in the spring, summer and fall of 1990, all conventional mines in Saskatchewan were closed for maintenance, vacation and limited layoffs for inventory control. Potash Corporation of Saskatchewan Inc. (PCS Inc.) also closed its mines for most of December and early January 1991, while other firms closed for the Christmas season.

At the end of 1990, Canadian potash production capacity was nominally at 11.8 Mt/y K_2O. It is generally acknowledged, however, that the effective capacity is closer to 11.0 Mt/y as some additional capital would be required for underground machinery as well as for the surface installations to operate near the nominal level. Of the total capacity, New Brunswick accounts for 1 160 000 t/y K_2O. At the end of 1990, PCS Inc. accounted for 47.6% of Canadian capacity or 52.8% of Saskatchewan's capacity.

PCS Inc., which had a net income of \$83.4 million in 1989, is expected to show a profit of only about \$25 million in 1990 as a result of lower prices and lower sales volume. The average potash price was down about 8% from that of 1989 and the sales tonnage was down principally because of the discontinuance of sales to the Potash Company of America. The stronger-than-expected Canadian dollar also had a negative effect on income. Throughout 1990, PCS Inc. pursued a policy of strict inventory controls shutting three out of four of its mines for several weeks in July and August. Rocanville and Lanigan were closed from December 2, 1990 to January 6, 1991, and Allan will be closed from December 2, 1990 to February 3, 1991. Thus, by year-end, PCS Inc.'s total inventories declined by about 200 000 t. During the first quarter, PCS Inc. successfully negotiated a three-year collective agreement with unions at three mines and a three-year agreement was signed at the fourth mine, Rocanville, during the third quarter.

All PCS Inc. mines achieved greater efficiency and work-related accidents were very low. This was particularly important in 1990 when low capacity utilization kept unit operating costs high. The Rocanville and Allan mines were awarded the prestigious John T. Ryan award for their outstanding safety records. The Rocanville mine is now rated as the lowest cost potash production facility in the world.

In July, PCS Inc. acquired all of the shares of Saskterra Fertilizers Ltd. from Husky Oil Ltd. for \$47 million plus working capital. Thus, PCS Inc. now has 100% ownership of the Allan mine which it previously held on a 60%-40% partnership basis with Saskterra. Saskterra tonnage previously sold independently will now be sold through Canpotex Limited which sells potash on "offshore" international markets for all Saskatchewan producers. Canpotex consented to an additional special allocation of 500 000 t/y to PCS Sales for the next five years. The acquisition of Saskterra Fertilizers Ltd. was financed by the issue of 3 669 000 special warrants at \$136.25 each. Each warrant was exchangeable into one PCS Inc. common share at no additional costs. Before the end of the third quarter, all warrants were exercised. As of December 18, 1990, a total of 38 669 000 PCS Inc. shares were outstanding. This number includes the 11 111 111 shares allocated to holders of convertible bonds.

Excluding the Saskterra mining concessions, PCS Inc. controls the right to 575 000 acres in Saskatchewan, on which it estimates recoverable reserves to be approximately 4.3 billion t at an average grade of 22.8% K_2O. The total yield of such ore is estimated at 1.4 billion t of product (KCl). Ore accessible from current shafts will allow production for about 100 years. With the addition of 385 000 t of capacity from Saskterra, the company has 5 620 000 t K_2O of annual installed capacity (9.23 Mt KCl at 60.9% K_2O equivalent).

For the first three quarters of 1990, PCS Inc. produced 2.47 Mt KCl and sold 2.66 Mt. Estimated production for the year is 3.45 Mt.

At year-end, total employment at PCS Inc. was: Rocanville, 337; Lanigan, 316; Allan, 306; Cory, 118; Esterhazy, 2; Head Office, 163; for a total of 1242 compared to 1256 at the end of

1989. The Head Office number includes 58 persons in sales of which 27 reside in the United States.

Besides potassium chloride, PCS Inc. produces modest quantities of calcium chloride brine at its Cory mine and industrial grade potassium sulphate at the Big Quill Lake mine. The plant has a capacity of 10 t/d and operated at an average level slightly above 50%.

International Minerals & Chemical Corporation (Canada) Limited (IMCC), which is wholly owned by IMC Fertilizer Group, Inc., operates two mines near Esterhazy, Saskatchewan, K1 and K2, which are connected underground. In 1990, IMCC produced about 2.6 Mt KCl of which over 500 000 t was for PCS Inc.'s account. Employment at the mines was 913 of which 142 were additional employees dedicated to water inflow-related problems. During 1990, K2 operated on a 10/4 (10 days out of 14) schedule throughout the year and K1 switched to 10/4 in the spring. As a consequence, maintenance and inventory control shutdowns were limited to 3 weeks in the summer and 1.5 weeks at Christmas. Improvements were completed to the crystallizer circuits.

The K2 mine is still experiencing water inflow problems which started in December 1985. Chemical grouting, introduced in 1987, is ongoing and is the preferred method of keeping the water inflow at a level of around 2000 gallons per minute. Backfilling through surface bore holes to stabilize the ground in the inflow area is still practised from time to time as required. From December 1985 through June 30, 1990, the company expended C$251 million on water control. Litigation is still in progress over the insurance payments which may reach a court hearing late in 1991. The policy limit is C$250 million but the company contends that special circumstances allow it to claim in excess of the above limit.

IMCC completed some additional exploration drilling for potash in the areas east and west of the mines. It also completed two shaft pilot holes in 1990 and will drill a third in 1991 with the objective of keeping the company's options open on the eventual development of a new mine.

Potash Company of America (PCA), division of Rio Algom Limited, extracts potash by solution from a mine that was flooded in 1987. The potash extraction scheme required the drilling of intake wells and a cluster of outlet wells to pump out potash-rich brine. Surface precipitation takes place in a series of ponds that cover more than 130 acres. Potassium chloride precipitates preferentially as the brine cools in the ponds from October to April. Experience indicated that the rate of potash dilution in the mine dropped significantly with the return of cold brine. By mid-November 1990, the company installed 10 gas-fired brine heaters (of 30 000 BTUs/hr each). These raise the temperature of the salt-rich brine by about 20°C which is closer to optimum levels. In addition, a 17 x 1 metre vertical heat exchange unit is being installed for operation before the end of January 1991 which will allow for a further increase in brine temperature. In 1990, the mine produced about 360 000 t of KCl. The year-end performance indicates that a substantially higher output may be expected in 1991. Employment at year-end 1990 was 126.

Central Canada Potash (CCP), a division of Noranda Minerals Inc., produced 1 109 000 t KCl in 1990, about 8% more than in 1989. Shipments were slightly higher resulting in a reduction of inventories. A computerization program for the surface plant was completed and a dust-collecting system was installed in the compaction plant. The mine was closed for two weeks' vacation in July and two weeks' maintenance in September. It was also closed for the Christmas season from December 24, 1990 to January 2, 1991. Employment at year-end was 376.

Cominco Ltd. produced 1 085 000 t of potash (KCl) in 1990 in its Vanscoy mine, compared to 963 000 t in 1989. The company maintained production on a seven-day-per-week schedule throughout the year except for a three-week maintenance shutdown in the summer. The transition to full production at a new mining block was completed and the company is now in a position to operate at full capacity as market conditions require it. Coarse and granular premium products account for about three quarters of the company's production. Employment was 338 near year-end.

Potash

Kalium Canada, Ltd., also known as Kalium Chemicals (trade name), operates a large solution mine at Belle-Plaine, west of Regina. During 1990, the company operated below optimum capacity for marketing reasons. It produced approximately 0.96 Mt K_2O, about the same as in 1989. Sales were higher and inventories declined. The plant has two lines of crystallizers which are operated concurrently except during maintenance and inventory control shutdown, which took place in June and November, for an equivalent of four weeks' downtime. Early in 1990, small amounts of waste salt were returned underground experimentally. The company established the technical capability of returning 100% of its waste salt underground when conditions will require it. Employment at the end of 1990 was 321.

Saskterra Fertilizers Ltd., which was controlled by Husky Oil Ltd., sold its 40% share in the Allan potash mine to PCS Inc. in June 1990. During the first six months of the year, Saskterra's potash production was 196 000 t KCl.

New Brunswick

Potash Company of America (PCA), which has a solution mine in Saskatchewan, also operates the Penobsquis underground mine just east of Sussex, New Brunswick. The orebody at this mine is steeply dipping, requiring mechanized cut and fill mining. The mine operated throughout the year without problems, near full capacity utilization. It has a closed system, i.e. all waste salt and brine have to be returned underground. Production in 1990 was about 640 000 t KCl, an improvement over 1989. The mine was closed for two weeks in July for maintenance. It operates on a seven-day-per-week schedule. The company had 346 employees at year-end. The capacity of the Penobsquis mine could be expanded in the future as market conditions improve.

PCA (New Brunswick) exports practically all of its potash through a potash terminal at Saint John, which it operates on behalf of the two New Brunswick potash producers. The terminal has a state-of-the-art loading facility for ships up to 40 000 dwt (deadweight tons) capacity. It has a permanent employment of about 20. A longshoremen strike early in 1990 closed the port for about two weeks but this had no adverse effects on exports in 1990.

Denison-Potacan Potash Company (DPPC) produced 972 000 t of potash (KCl) in 1990 at the Cloverhill mine located 20 km southeast of Sussex, New Brunswick (also referred to in the press as the Cassidy Lake mine). The complex orebody requires both drill and blast methods and the extraction with continuous mining machines which is carried out in a proportion of about 55% to 45%. Since the beginning of the year, the company changed its method of returning waste salt underground from dry to slurried salt. This system now works satisfactorily and towards the end of 1990 about 90% of the waste salt was returned underground and the remainder stored temporarily on the surface. For the full year of 1990, 70% of waste salt was returned underground compared to only 40% in 1989. The excess brine disposal pipeline to the Bay of Fundy performed without problems throughout 1990. A strike closed operations between January 15 and February 5. The summer shutdown was avoided as the company was able to ship more than its production, thereby lowering its inventories. There was a five-day maintenance shutdown in late October and a two-day Christmas season shutdown. Employment at year-end was 580 of which 509 were on DPPC payroll and the rest on contract. A year-long mine safety inquiry by Commissioner Michael Hewitt was completed and a report released in late December 1990, which is currently under study by management and the union. Safety measures were optimized after the last fatality in 1989 and appear to be working well. Denison Mines Limited decided to sell its 60% interest in DPPC to outside interests.

Manitoba

Canamax Resources Inc. sold its share (51%) of the Manitoba Potash Corporation (MPC) to the French company, Entreprise minière et chimique (EMC). EMC controls 50% of Potacan Limited, which in turn controls 40% of DPPC in New Brunswick. The Manitoba government retained its 49% share. EMC stated that the purchase was made to secure economic potash reserves for the future. The development of this deposit, situated near

Russell at the Manitoba-Saskatchewan border, has been delayed by a worldwide oversupply of potash which is likely to persist until 1995. Nevertheless, the situation will change and Manitoba is likely to be a potash producer before the end of this decade. An engineering feasibility study was completed and it will take five to six years to achieve production once a decision is made to proceed. EMC is a major potash producer in France where reserves are likely to be depleted towards the turn of the century.

INTERNATIONAL DEVELOPMENTS

For two successive years there was a substantial decline in the world production of potash to an estimated 27.7 Mt K_2O in 1990. Production was 29.3 Mt in 1989 and 31.5 Mt in the peak year of 1988. There was a small improvement in demand in North America and Western Europe while some countries of Southeast Asia recorded significant gains. The principal cause for the decline was a collapse in demand in Eastern Europe, including the U.S.S.R.

Canada continued to act as the principal residual supplier, its mines operating at levels varying from 50% to 90% of capacity. Small voluntary adjustments to production were made in France and West Germany. Events in East Germany brought to light the highly inefficient system of potash production and resulted in a major decline in production. Production in the U.S.S.R. was reduced mainly in response to much lower domestic demand, as well as the inefficient storage, distribution and transportation systems.

The European Economic Commission (EEC) agreed to investigate the dumping complaint brought by the European Potash Producers Association (APEP) in June 1990 against potash from the U.S.S.R. If found guilty, the U.S.S.R. exporters will be subject to retroactive dumping duties. The EEC may also impose import quotas on Soviet potash for a number of years.

The Taquari-Vassouras mine in the Sergipe District of Brazil ceased production in October 1990. For several years, this mine was producing only small quantities of potash and was a major economic drain on PETROMISA and its parent company PETROBRAS Mineraçuo S.A. Between $700 million and $800 million was spent on this enterprise. For 1990, production was estimated at about 100 000 t K_2O. It is unlikely that this mine will ever be replaced as one of its principal problems was the absence of good grade, continuous reserves of ore.

In China, potash production is derived from brines in the Qinghai Basin in the Qinghai province situated about 4000 km west of Beijing. Two plants operated in 1990. The old Qinghai Potash Plant (QPP1), which has an annual capacity of about 55 000-60 000 t of 90% KCl product, and the new Qinghai Potash Plant No. 2 (QPP2), which has a designed capacity of 200 000 t/y KCl. QPP1 operated as expected, near capacity, while QPP2 produced only between 40 000 t and 50 000 t of KCl product with variations of grade from 75% to 90% KCl. In total, Chinese potash production in 1990 was between 50 000 t and 55 000 t K_2O. The QPP2 plant, which started operation in May 1989, still experiences technical problems, some of which may not be resolved without modification and additional capital. It will take a few years before optimum capacity operation is achieved. Meanwhile, the product, which is mostly off-grade, is shipped to granulation plants in southeast China at highly subsidized production and transportation costs.

In Chile, Sociedad Mineral Salar de Atacama Ltda (MINSAL Ltda) has been studying the feasibility of extracting potash and other salts from brines in the Atacama desert for a number of years. The latest proposal was for a $360 million development with a capacity of 450 000 t/y KCl and 15 000 t/y K_2SO_4, as well as basic salts and 15 000 t/y of lithium salts. However, AMAX Chemical Corporation, which holds 65% in MINSAL Ltda, decided not to proceed to production. The company expects to find a buyer in 1991.

France's production increased by 100 000 t to 1.3 Mt K_2O in 1990 with two mines producing steadily throughout the year. Disposal of waste salt into the Rhine River was kept to regulated amounts with the excess temporarily stockpiled above-ground. Imports of Soviet potash increased significantly in the second half of 1989 and the first half of 1990, and French companies joined other EC members in a dumping complaint. Furthermore, pending resolution of the case, the French government posted a notice on August 12, 1990, requiring importers to apply for an import licence for potash of Soviet origin.

In the Federal Republic of Germany, production of potash was steady at 2.2 Mt K_2O. First-half production exceeded sales by about 50 000 t and Kali und Salz AG (K&S) had to resort to short temporary shutdowns of about three weeks in the second half for maintenance and inventory control. The company intends to continue a policy of limiting supply to conform with market conditions in 1991. There is a possibility that K&S will terminate operations at one mine during 1991.

Mines in East Germany, formerly the Democratic Republic of Germany, experienced a significant decline in production for the second year to about 2.6 Mt K_2O. Domestic demand for potash also declined drastically to about 300 000 t K_2O, as many state-run farms, beset by an unknown future, curtailed fertilizer purchases. A further drop in production is expected in 1991 but its extent is highly speculative. The East German potash industry was restructured under the holding company Mitteldeutsche KALI AG (MDK). It holds 100% equity in the following producing concerns: Zielotzer KALI AG, with one mine at Zielitz which is performing reasonably well at its capacity level of 900 000 t/y; Kalibetrieb Werra AG, with three interconnected mines; and Durndorf, Merkers and Unterbreizbach, with total capacity reduced to about 900 000 t/y after the cave-in at Merkers in 1989. The major uncertainty at KALI Werra is whether government funds will be made available to completely re-vamp the surface plants so that the dumping of waste salt into the Werra River (some 6 Mt/y in previous years) could be reduced or eliminated. K&S technology would probably be required. Kalibetrieb Süd Harz AG has six mines and at one time about 1.45 Mt/y capacity. There, the Volkenrode mine was closed in July 1990 and more mines may close in 1991. Some experts believe that, except for the Bischofferode mine, most others are not economic by Western standards. The time required to provide alternative employment may be the main reason for continuing production. By the mid-1990s, capacity at KALI Sudharz AG may be reduced to only one third of the former level. MDK also controls a number of other companies as well as KALI-Bergbau Handelsgesellschaft GmbH which is responsible for all potash sales. The company will no longer accept soft currency or continue to give longer term credit after December 31, 1990. There is an expectation that Kali-Bergbau will join the Vienna-based Kali Export Ges., which would then be responsible for all non-EC markets for East German potash.

In Israel, Dead Sea Works Ltd. (DSW) produced about 1 260 000 t K_2O in 1990 compared to 1 271 000 t in 1989. Work to add about 120 000 t of capacity by 1992 is in progress. A rehabilitation of some ponds affected by the growth of "salt mushrooms" was also in progress. Construction of an SOP (sulphate of potash) plant was continuing and pilot production in 1990 achieved fully satisfactory results.

Italian production of sulphate of potash (K_2SO_4) suffered a major decline when production had to be stopped at the mines in Sicily because of the shortage of process water to its refineries. A new pipeline is expected to be laid and production at the largest mine at Pasquesia will likely resume early in 1991. Meanwhile, total 1990 production was just short of 100 000 t K_2O equivalent.

In Jordan, Arab Potash Co. Ltd. (APC) operated at near optimum capacity producing an estimated 834 000 t K_2O in 1990. Export shipments from Aqaba continued without interruption despite the Gulf crisis. There were some reports that APC had to absorb slightly higher shipping charges for their c.i.f. sales. Studies for a further 240 000 t/y K_2O by the mid-1990s, based on cold leach crystallization, have been completed.

Spain's production of potash declined slightly to about 700 000 t K_2O. In May 1990, the Cardona mine in Catalonia, which had a nominal capacity of 200 000 t/y, ceased operation. Part of this loss in output will be compensated by higher production at the Llobregat mine. In 1991, production is expected to fall below 0.7 Mt K_2O.

In Thailand, a Canadian company, Placer Dome Inc., in participation with Aokam Thai Ltd., was conditionally awarded an exploration concession of 3500 km^2 in the eastern part of the Sakon Nakhon Basin. The final documentation and a formal agreement will be completed and signed in early 1991. Another Canadian company, The Crew Group of Vancouver, hoped to finalize its application for a concession near Udon Thani (southern central part of the Sakon Nakhom Basin). This application is in partnership with the Metro Corporation of Thailand. Both areas are extensively underlain by carnallite, which is not considered an economic ore of potash. The companies, however, hope to find commercial deposits of sylvinite, which is the most common type of ore mined in other parts of the world. To the south, there is another potash-bearing area, the Khorat Basin, which also has extensive carnallite mineralization. Large reserves of carnallite were delineated in the western extremity, near Banmet Narong. Many potash experts believe that extraction of potash from carnollite is going to be technically very difficult. Economic extraction from this type of ore has never been achieved on a large scale any place in the world. Only a pilot mining operation would prove its economic viability. Nevertheless, countries of the Association of South-East Asian Nations (ASEAN), led by Thailand, agreed in 1990 to form a joint venture company which will be known as the ASEAN Potash Mining Company, whose objective will be to put into production this carnallite deposit at a rate of 600 000 t/y K_2O. Capital costs are projected at about $300 million and production could start in about four years after start-up of construction. The project still requires a full engineering feasibility study.

In the United Kingdom, Cleveland Potash Ltd. (CPL) completed a routine year, producing approximately 455 000 t K_2O in 1990 compared to 463 000 t in 1989.

In the United States, total nominal potash capacity was raised to about 1.76 Mt K_2O. Production in 1990 increased to an estimated 1.64 Mt compared to 1.58 Mt in 1989. This is a significant improvement over the low of 1.20 Mt established in 1986. Sales in 1990 were at near production levels and ending inventories were unchanged for the year at 0.3 Mt K_2O.

Great Salt Lake Minerals & Chemicals Corporation (GSL) in Utah, which resumed operations in 1989, performed according to expectations and intends to operate near capacity of 100 000 t by 1992. The plants of Reilly Wendover Chemical Inc. and Texasgulf Inc. in Utah also operated satisfactorily near optimum capacity levels.

In the Carlsbad area, Eddy Potash Co. and AMAX Chemical Corporation managed to produce continuously despite the low realized potash prices. Eddy operated its mine on a 10/4 basis (10 days out of 14). AMAX closed its mine for five weeks. The company had had its mine for sale for over a year. It was initially reported that a company was interested in acquiring the property for underground waste storage of hazardous non-radioactive material. On January 9, 1991, it was reported that a letter of intent to purchase the potash operation was received from the Horizon Gold Corporation. The intentions of the prospective buyer are not known. The AMAX mine has very limited and very low grade (11% K_2O after dilution) reserves and requires a potash price higher than that experienced in 1990 to be profitable.

Mississippi Chemical Corporation, which restarted its mine in 1989, produced at a planned level of about 270 000 t/y KCl. The company compacts and stores its product at a nearby surface plant formerly owned by National Potash. International Minerals & Chemical Corporation (IMC), one of the oldest, best-run and most versatile Carlsbad producers, operated continuously in 1990. The company produced about 1.0 Mt of various potash products and chlorides as well as sulphates. Western Ag-Minerals Co., now 100% owned by a Canadian company, Rayrock Yellowknife Resources Inc., produced a potassium-magnesium sulphate product at a steady rate in 1990.

Kalium Canada, Ltd. holds a deep-seated potash deposit near Hersey, Michigan. The company is operating a small pilot plant of about 40 000 t K_2O (product capacity) on site. It is expected that by the end of 1991 enough experience will be gained to prove the economic feasibility of a full-scale operation. One of the requirements in Michigan is that all of the by-product waste salt will have to be returned underground.

Potash

The U.S.S.R. is the world's leading producer of potash and the second leading exporter after Canada. The economic restructuring had a profound effect on demand, which over a two-year period declined by some 1.5 Mt K_2O in the U.S.S.R. and some 600 000 t in other COMECON countries. In response to the above, as well as other factors linked to inefficiencies in the distribution, storage and transportation systems, production in the U.S.S.R. declined from a peak of about 11.3 Mt in 1988 to 10.2 Mt in 1989 and 9.1 Mt in 1990. Net exports to the market economies increased by about 300 000 t K_2O, and a large proportion of this was in the form of so-called "Perestroika" potash. This potash was sold at cut-rate prices by Soviet and east European agencies, bypassing the main agency responsible for trade, SOJUZAGROCHIMEXPORT. The chaos created by often contradictory central and local regulations allowed producers, so far, to disregard this unified trade directive. However, SOJUZAGROCHIMEXPORT executives have been quoted to be confident that remedies to this situation will soon be found. One of the catalysts may be the West European Dumping Complaint which will be heard by the EEC in 1991. (The allegation is that Soviet potash has been dumped since mid-1989.)

MARKETS AND PRICES

On average, potash prices in 1990 were lower than in 1989. Some companies reported that netbacks declined by 7%-9%.

The price f.o.b. Vancouver quoted in U.S. dollars is the basis for most Canadian international "offshore" sales and a barometer for international prices. In many markets, prices are also quoted on a delivered basis c.i.f. national ports. Canpotex Limited, representing all Saskatchewan potash producers, sells both f.o.b. Vancouver or c.i.f. foreign ports or out of warehouses in southeast Asia.

At the beginning of the year, Canpotex quoted prices and executed sales in the US$97-$98/t range f.o.b. Vancouver. But mid-year prices were under pressure with many small sales in the low US$80-$90/t range. However, the principal suppliers maintained prices higher with sales at US$97/t f.o.b. to India and China (Canpotex). Even Kali-Bergbau (East Germany) and Soviet sales made in Rupees were equated to US$97 and US$96/t f.o.b. However, some tonnage also moved at lower prices to southeast Asia as, for example, Indonesian tenders in the mid-US$80 range. Some potash of Soviet origin was even offered for as low as US$72/t. International prices progressively strengthened during the second half of 1990 with Canpotex leading in contracts in the US$100-$101/t range in South Korea, China, Indonesia, and Japan. Towards the end of the year, a large sale to China was negotiated at US$100.50/t f.o.b. Vancouver. Arab Potash Co. Ltd. (APC) sold potash to India for US$110/t f.o.b. AQABA.

In the North American markets, prices were weaker than in 1989 as expected higher volumes did not materialize. PCS Inc. started with list prices per short ton (st) of US$80/78/76/74 f.o.b. mine respectively for granular/course/soluble/standard product (KCl) which was about a $7 decline from previous lists. In addition, there were discounts of $9/t and $4/t for winter-fall. Prices became weaker after the spring fertilization season and an attempt to raise prices by $5/t in July did not succeed. As of September 15, PCS Inc. also proposed to raise the price of granular product to $83-$85/st but IMC kept its price at $78-$89/st level. By December 1, prices moved up $5/st which was offset by winter-fall discounts. However, there was a firming tone to North American price towards the end of 1990 and Canadian producers expected higher prices in early January 1991.

OUTLOOK

The initial prognosis for potash demand in North America in 1991 is flat. This is related to no addition to acreage or even a small decline, with corn and cotton acreage up, but soybean and wheat acreage down. There is substantial uncertainty about soybean acreage since drought in South America may change prospects positively in the United States. Agronomists foresee a trend to higher acreage in the 1991/92 crop year.

The drastic drop in demand for potash in eastern Europe and the U.S.S.R. accounted for a fall in world demand by just over 1.9 Mt K_2O over the last two years. Many believe that this decline has yet to run its course and that a further decline may still be in store for all COMECON countries in 1991 and 1992. Under the new economic realities, the unit cost of potash as an input is rising substantially as farm subsidies are withdrawn. Marginal acreage will be abandoned, particularly in eastern Europe and notably in former East Germany. An added obstacle is the requirement, as of January 1991, for hard currency payment for potash supplied by East German companies as well as those in the U.S.S.R. It is, therefore, presumed that it will take three to four years before east European countries return to former levels of fertilizer consumption and perhaps longer for the U.S.S.R.

Demand for potash in China, which declined substantially in late 1989 and early 1990, has improved significantly and will continue to grow in 1991. Growth rates for potash consumption may soon approach former high levels ranging from 5%-10% per year. Canadian aid programs in support of balanced NPK fertilization continue to bear fruit. The allocation of hard currency for potash imports is the biggest problem, now that an excellent start has been made in many provinces to convince Chinese agronomists of the need for higher potash ratios in their fertilization recommendations. The logistics of transportation and on-time distribution of fertilizers present another great challenge.

Demand for potash in Latin America experienced a pause in 1990 but it is on the path of improvement. There is a growing political commitment to put agriculture on high priority, but higher growth levels are mitigated by economic weakness, low levels of investments, straining taxation systems and, as always, the lack of hard currency for imports.

A steady and impressive growth in potash demand is continuing in southeast Asia as well as in India. There is no reason to expect, yet, any change to this satisfactory performance.

In general, world potash demand should rise slightly in 1991, allowing production to rise to about 30.0-31.0 Mt K_2O from that of 27.3 Mt K_2O estimated for 1990.

In the longer term, the growth rate in potash consumption needs to increase again to an annual level of between 1.5% and 2.0% if adequate rates of food production on a global scale are not to be put into serious jeopardy.

Note: Information contained in this review was current as of mid-January 1991.

TARIFFS

Item No.	Description	Canada			United States
		MFN	GPT	USA	Canada
3104.20	Potassium chloride	Free	Free	Free	Free
3104.30	Potassium sulphate	Free	Free	Free	Free
3104.90.00.10	Magnesium potassium sulphate	Free	Free	Free	Free
3104.90.00.90	Other potassic fertilizer	Free	Free	Free	Free

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States effective January 1, 1990.

TABLE 1. CANADA, POTASH PRODUCTION, SHIPMENTS AND TRADE, 1989 AND 1990

Item No.		1989		1990p	
		(tonnes)	($000)	(tonnes)	($000)
Production, Potassium Chloride					
Gross weight		12 004 694	. .	11 477 000	. .
K_2O equivalent		7 333 499	. .	7 007 063	. .
Shipments					
K_2O equivalent		7 014 074	1 017 525	7 014 539	907 168
Imports, Fertilizer Potash				**(Jan.-Sept.)**	
3104.20	Potassium chloride, in packages weighing more than 10 kg				
	United States	3 981	738	2 806	339
	West Germany	454	53	593	77
	United Kingdom	4	. . .	3	. . .
	Total	4 438	792	3 402	417
3104.30	Potassium sulphate, in packages weighing more than 10 kg				
	United States	8 624	2 663	19 306	4 867
	Netherlands	2	2	25	18
	West Germany	3	6	4	10
	Italy	121	56	3	6
	Total	8 750	2 729	19 338	4 903
3104.90.00.10	Magnesium potassium sulphate				
	United States	30 964	4 238	25 181	4 272
	West Germany	45	8	50	9
	Total	31 009	4 246	25 543	4 281
3104.90.00.90	Other potassic fertilizer				
	United States	1 775	861	1 601	760
	Other countries	110	57	–	–
	Total	1 885	920	1 601	760
Potash Chemicals					
2815.20	Potassium hydroxide (caustic potash)	10 324	4 460	7 308	3 349
2834.21	Potassium nitrate	5 011	2 503	4 586	2 317
2835.24	Potassium phosphates	2 303	2 506	1 094	1 079
2836.40	Potassium carbonates	1 483	993	1 190	830
2839.20	Potassium silicates	706	553	715	543
	Total potash chemicals	19 827	11 015	14 893	8 118
Exports, Fertilizer Potash					
3104.20	Potassium chloride, in packages weighing more than 10 kg				
	United States	5 850 834	616 394	4 421 038	467 564
	People's Republic of China	1 095 625	123 029	945 679	99 380
	Malaysia	309 721	36 933	432 120	49 989
	Japan	634 133	75 844	382 057	48 389
	Brazil	555 080	63 091	329 313	36 747
	South Korea	425 936	50 045	264 882	33 982
	Australia	292 809	34 749	225 515	26 620
	India	337 192	34 107	166 296	18 794
	Indonesia	128 603	15 042	182 055	18 480
	France	214 953	25 032	137 008	15 734
	New Zealand	116 453	13 650	117 670	13 809
	Taiwan	105 167	12 323	98 924	11 445
	Colombia	54 127	4 610	106 428	10 375
	Denmark	96 037	10 590	95 575	9 701
	Philippines	90 274	9 660	112 488	9 340
	United Kingdom	24 701	3 047	107 372	8 959
	Belgium	71 130	7 613	71 897	8 165
	Chile	66 000	7 803	60 083	6 892
	South Africa	22 903	2 469	30 279	3 296
	Singapore	44 805	5 024	26 393	2 432
	Venezuela	30 957	2 806	21 000	2 237
	Nigeria	40 000	3 198	19 952	2 079
	Mexico	21 971	2 107	21 983	1 978
	Norway	16 086	1 691	16 236	1 869
	Bangladesh	62 929	6 904	15 750	1 821
	Jamaica	13 110	2 148	12 040	1 812

TABLE 1. (cont'd)

Item No.		1989		Jan.-Sept. 1990p	
		(tonnes)	($000)	(tonnes)	($000)
Exports (cont'd)					
	Guatemala	21 944	1 480	16 874	1 769
	Italy	37 210	4 284	12 271	1 640
	Netherlands	45 871	5 200	–	–
	Peru	10 734	1 327	–	–
	Other countries	77 496	8 606	80 680	8 489
	Total	10 914 791	1 190 806	8 529 858	923 787
3104.30	Potassium sulphate, in packages weighing more than 10 kg				
	United States	196	69	977	218
	Thailand	–	–	3 800	338
	Total	196	69	4 777	556

Sources: Energy, Mines and Resources Canada; Statistics Canada;.
p Preliminary; . . Not available; . . . Amount too small to be expressed; – Nil.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, POTASH PRODUCTION AND TRADE, FERTILIZER YEARS ENDED JUNE 30, 1966, 1971 AND 1976-90

	Production[2]	Imports[1,2]	Exports[1]
		(tonnes K_2O equivalent)	
1966	1 748 910	31 318	1 520 599
1971	3 104 782	26 317	3 011 113
1976	4 833 296	16 445	4 314 150
1977	4 803 015	24 289	4 175 473
1978	6 206 542	26 095	5 828 548
1979	6 386 617	21 819	6 256 216
1980	7 062 996	20 620	6 432 124
1981	7 336 973	35 135	6 933 162
1982	6 042 623	25 437	5 400 662
1983	5 378 842	21 846	4 864219
1984	7 155 599	17 934	6 730 733
1985	7 283 509	17 396	6 784 178
1986	6 519 777	12 837	6 479 678
1987	7 031 586	12 122	7 100 135
1988	7 839 625	14 486	7 315 318
1989	8 088 748	13 748	7 075 122
1990	6 773 514	36 367	6 719 385

Sources: Potash and Phosphate Institute; Canadian Fertilizer Institute.
[1] Includes potassium chloride, potassium sulphate, except that contained in mixed fertilizers. [2] Change of data source. Prior to 1978 figures were obtained from Statistics Canada.

TABLE 3. CANADA, POTASH PRODUCTION AND SALES IN 1989 AND BY QUARTERS, 1990

	Total (1989)	1990 1st quarter	1990 2nd quarter	1990 3rd quarter	1990 4th quarter
	(000 tonnes, K_2O equivalent)				
Production	7 360.2	1 654.5	1 980.4	1 465.9	1 900.0
Sales					
North America	4 193.6	916.0	1 226.4	906.8	972.5
Offshore	2 923.8	751.7	860.3	763.7	787.4
Total	7 117.4	1 667.7	2 086.7	1 670.5	1 759.9
Ending Inventories					
Mine site	846.6	682.5	641.0	575.9	499.9
Offsite	749.6	912.1	860.9	655.3	722.5
Total	1 596.2	1 594.6	1 501.9	1 231.2	1 272.4

Source: Potash and Phosphate Institute.

TABLE 4. CANADA, POTASH SALES BY PRODUCT AND AREA, 1988 AND 1989

		Agricultural					Industrial			Total
		Standard	Coarse	Granular	Soluble	Total	Standard	Soluble	Total	Sales
		(tonnes, K_2O equivalent)								
Alberta	1988	243	114	26 608	1 737	28 702	3 331	432	3 763	32 465
	1989	129	99	31 081	1 671	32 979	1 493	185	1 678	34 657
British Columbia	1988	2 615	399	5 918	59	8 991	0	0	0	8 991
	1989	0	43	5 311	29	5 383	48	13	61	5 444
Manitoba	1988	0	3 962	18 828	2 178	24 968	7	26	33	25 001
	1989	0	3 333	17 450	1 913	22 696	30	0	30	22 726
New Brunswick	1988	0	7 348	5 935	389	13 672	0	0	0	13 672
	1989	0	3 524	6 864	29	10 417	997	26	1 023	11 440
Nova Scotia	1988	0	0	5 619	268	5 887	0	0	0	5 887
	1989	0	980	4 468	0	5 447	0	0	0	5 447
Ontario	1988	5 363	118 369	46 324	2 415	172 471	11 695	298	11 993	184 464
	1989	422	86 784	47 247	1 829	136 283	6 244	394	6 637	142 921
Prince Edward Island	1988	0	54	10 031	0	10 085	0	0	0	10 085
	1989	0	131	6 950	0	7 081	0	0	0	7 081
Quebec	1988	230	20 265	96 265	89	116 849	783	0	783	117 632
	1989	124	2 616	66 785	50	69 575	733	0	733	70 308
Saskatchewan	1988	77	223	10 172	250	10 722	5 000	1 637	6 637	17 359
	1989	34	123	10 670	62	10 889	2 547	1 095	3 642	14 530
Newfoundland	1988	0	0	0	0	0	0	0	0	0
	1989	0	0	0	0	0	0	0	0	0
Totals	1988	8 528	150 734	225 700	7 385	392 347	20 816	2 393	23 209	415 556
	1989	708	97 632	196 827	5 583	300 750	12 091	1 712	13 804	314 554

Source: Potash and Phosphate Institute.

TABLE 5. CANADA, POTASH INVENTORY, PRODUCTION, DOMESTIC SALES AND EXPORT SALES, 1990

Month	Beginning Inventory	Production	Domestic Sales			Export Sales					Canadian Total Sales
						United States					
			Agriculture	Non-Agriculture	Total	Agriculture	Non-Agriculture	Total	Offshore Total	Exports Total	
	(000 metric tonnes K_2O)										
January	1 596.2	520.5	18.2	1.9	20.1	343.9	24.4	368.3	176.9	545.2	565.3
February	1 563.0	534.3	14.6	1.3	15.9	213.5	22.0	235.5	210.9	446.4	462.3
March	1 640.0	599.6	41.7	2.6	44.3	212.5	23.5	236.0	364.1	600.1	644.4
April	1 595.0	689.9	75.3	0.2	75.5	414.8	23.4	438.2	262.3	700.5	776.0
May	1 487.7	728.0	126.8	0.9	127.7	326.0	23.7	349.7	305.9	655.6	783.3
June	1 490.2	562.6	24.9	1.3	26.2	188.1	21.4	209.5	292.3	501.8	528.0
Subtotal		3 634.9	301.5	8.2	309.7	1 698.8	138.4	1 837.2	1 612.4	3 449.6	3 759.3
July	1 501.9	350.9	31.8	1.0	32.8	143.8	24.2	168.0	260.8	428.8	461.6
August	1 402.4	442.2	7.2	1.3	8.5	463.4	27.1	490.5	321.6	812.1	820.6
September	976.5	672.8	9.4	1.0	10.5	164.1	32.6	196.7	181.5	378.1	388.6
October	1 231.3	750.4	11.9	1.3	13.2	224.6	26.9	251.4	215.7	467.2	480.4
November	1 467.5	720.2	8.9	1.4	10.3	268.8	28.2	297.0	318.9	615.9	626.2
December	1 540.7	429.4	10.7	1.3	12.0	359.4	29.1	388.5	252.9	641.4	653.4
Subtotal		3 365.9	80.0	7.3	87.3	1 624.0	168.0	1 792.1	1 551.4	3 343.5	3 430.8
Total		7 000.8	381.5	15.5	397.0	3 322.8	306.4	3 629.3	3 163.8	6 793.1	7 190.1

Sources: Potash and Phosphate Institute of North America.
Inventories at the end of December 1990 were 1272.4 thousand tonnes K_2O.

TABLE 6. WORLD POTASH PRODUCTION, 1984-90

	1984	1985	1986	1987	1988	1989p	1990e
				(000 tonnes K_2O)			
Brazil	–	6	11	37	48	98	70
Canada	7 749	6 637	6 697	7 267	8 328	7 333	7 007
Chile	–	–	–	–	5	10	10
China	20	20	20	25	30	35	55
France	1 740	1 750	1 610	1 539	1 502	1 195	1 300
Germany, Dem. Rep.	3 463	3 465	3 485	3 510	3 510	3 200	2 600
Germany, Fed. Rep.	2 645	2 583	2 162	2 201	2 290	2 186	2 200
Israel	1 130	1 172	1 240	1 265	1 242	1 271	1 260
Italy	127	143	109	122	126	152	100
Jordan	291	45	662	722	786	792	841
Spain	677	645	702	740	766	742	690
U.S.S.R.	9 776	10 367	10 228	10 889	11 000	10 232	9 100
United Kingdom	319	337	391	429	452	463	455
United States	1 564	1 296	1 202	1 262	1 461	1 595	1 635
Total	29 501	28 960	28 551	30 008	31 546	29 304	27 323

Sources: International Fertilizer Industry Association Ltd.; U.S. Bureau of Mines; Energy Mines and Resources Canada.
p Preliminary; e Estimated; – Nil.

TABLE 7. CANADA POTASH, CURRENT SITUATION AND FORECAST

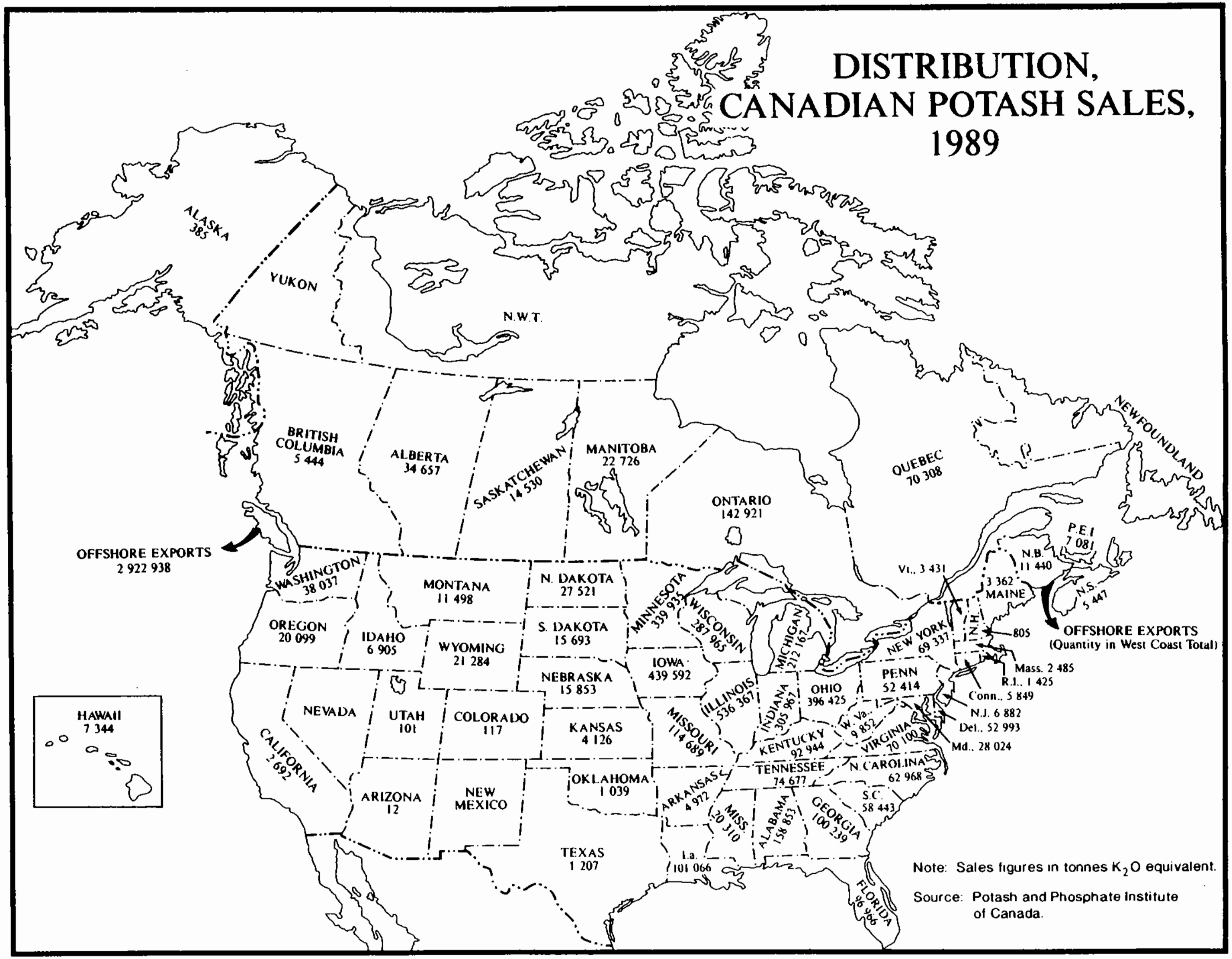
	Actual					Forecast		
	1985	1986	1987	1988	1989	1990[e]	1991	1992
	(000 tonnes K_2O)							
Capacity	9 780	10 580	11 020	11 430	11 550	11 800	11 800	11 800
Production	6 636	6 698	7 267	8 328	7 360	7 010	7 600	8 000
Capacity utilization (%)	68	63	66	73	64	59	65	68
Sales	6 577	7 023	7 837	8 030	7 124	7 220	7 500	8 000
of which: Domestic	434	322	480	420	315	405	420	450
United States	4 215	4 091	4 224	3 830	3 886	3 655	3 680	3 850
Offshore	1 928	2 610	3 114	3 780	2 923	3 160	3 400	3 700
Year-end stocks	1 766	1 537	1 135	1 360	1 596	1 220	1 200	1 200
World production	28 960	28 551	29 309	31 650	29 300	27 323	30 000	30 500
Canada/World Production Ratio (%)	22.9	23.5	24.7	26.3	25.1	25.6	25.3	26.2

[e] Estimated.

TABLE 8. CANADA, POTASH MINES-CAPACITY PROJECTIONS

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
	(000 tonnes K_2O equivalent)											
Potash Corporation of Saskatchewan Inc.												
- Allan[1]	575	575	575	575	575	575	960	960	960	960	960	960
- Cory	830	830	830	830	830	830	830	830	830	830	830	830
- Esterhazy (25% of IMC)	580	580	580	580	580	580	580	580	580	580	580	580
- Lanigan	690	690	1 240	1 740	2 090	2 090	2 090	2 090	2 090	2 090	2 090	2 090
- Rocanville	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160
Subtotal	3 835	3 835	4 385	4 885	5 235	5 235	5 620	5 620	5 620	5 620	5 620	5 620
Central Canada Potash	815	815	815	815	815	815	815	815	815	815	815	815
Cominco Ltd.	655	815	815	815	815	815	815	815	815	815	815	815
International Minerals & Chemical Corporation (75%)	1 745	1 745	1 745	1 745	1 745	1 745	1 745	1 745	1 745	1 745	1 745	1 745
Kalium Chemicals	1 055	1 055	1 055	1 245	1 245	1 245	1 245	1 245	1 245	1 245	1 245	1 245
Potash Company of America, Inc.	630	630	630	100	30	150	400	400	400	400	400	400
Saskaterra Fertilizers Ltd. (Allan)[1]	385	385	385	385	385	385	–	–	–	–	–	–
Subtotal	5 285	5 445	5 445	5 105	5 035	5 155	5 405	5 405	5 405	5 405	5 405	5 405
Total Saskatchewan	9 120	9 280	9 830	9 990	10 270	10 390	10 640	10 640	10 640	10 640	10 640	10 640
Denison-Potacan Potash Co.		200	450	650	780	780	780	780	780	780	780	780
Potash Company of America, Inc.	200	300	300	380	380	380	380	380	380	380	380	380
Total New Brunswick	200	500	750	1 030	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160
Canada	9 320	9 780	10 580	11 020	11 430	11 550	11 800	11 800	11 800	11 800	11 800	11 800

Note: Capacity means "rated" capacity; under normal conditions Canadian mines can operate comfortably at about 90% of rated capacity.
[1] PCS Inc. increased its share of Allan mine from 60% to 100% in mid-1990.
– Nil.



DISTRIBUTION, CANADIAN POTASH SALES, 1989
ALASKA 385
YUKON
N.W.T.
BRITISH COLUMBIA 5 444
ALBERTA 34 657
SASKATCHEWAN 14 530
MANITOBA 22 726
ONTARIO 142 921
QUEBEC 70 308
NEWFOUNDLAND
P.E.I. 7 081
N.B. 11 440
N.S. 5 447
OFFSHORE EXPORTS 2 922 938
OFFSHORE EXPORTS (Quantity in West Coast Total)
WASHINGTON 38 037
OREGON 20 099
CALIFORNIA 2 692
NEVADA
IDAHO 6 905
MONTANA 11 498
WYOMING 21 284
UTAH 101
COLORADO 117
ARIZONA 12
NEW MEXICO
N. DAKOTA 27 521
S. DAKOTA 15 693
NEBRASKA 15 853
KANSAS 4 126
OKLAHOMA 1 039
TEXAS 1 207
MINNESOTA 339 935
IOWA 439 592
MISSOURI 114 689
ARKANSAS 4 972
La. 101 066
WISCONSIN 287 965
ILLINOIS 536 367
MICHIGAN 212 167
INDIANA 305 967
OHIO 396 425
KENTUCKY 92 944
TENNESSEE 74 677
MISS. 20 310
ALABAMA 158 853
GEORGIA 100 239
FLORIDA 96 966
S.C. 58 443
N. CAROLINA 62 968
VIRGINIA 70 100
W. Va. 9 852
PENN 52 414
NEW YORK 69 337
Vt. 3 431
N.H. 805
MAINE 3 362
Mass. 2 485
R.I. 1 425
Conn. 5 849
N.J. 6 882
Del. 52 993
Md. 28 024
HAWAII 7 344
Note: Sales figures in tonnes K_2O equivalent.
Source: Potash and Phosphate Institute of Canada.

Primary Iron and Ferrous Scrap

1990

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PRIMARY IRON

Primary iron is the raw material used to make steel and other iron products such as castings. It includes blast furnace iron, direct reduced iron and, in Canada, electric smelted iron. Recycled ferrous scrap, as a substitute for primary iron, is becoming very important and increasingly sophisticated in steel production. Approximately 50% of the iron units used to make steel in Canada are sourced from scrap.

Primary iron is produced in Canada by three main processes. The bulk of production is by blast furnaces. Iron is also produced by electric smelting and by direct reduction, with equivalent quantities produced by each process. A small amount of iron derives from the melting of scrap using cupolas, which are melting furnaces used in the foundry industry.

CANADIAN EVENTS

Since almost all of the primary iron produced in Canada is used in the production of steel, trends in steel production and demand for steel mill products influence production of primary iron. Therefore, this review will frequently refer to developments in the steel industry.

Blast Furnace Iron

Canadian production of blast furnace iron in 1990 decreased about 26% to 6.55 Mt, compared to 7.79 Mt in the same period of 1989. This decrease was due to a decrease in raw steel production. Another major factor was a strike at both Stelco Inc. and The Algoma Steel Corporation, Limited that started in early August and was not settled until the end of September.

Primary iron production decreased proportionately more than steel production because, on average, less iron was used in each tonne of steel produced. This change may be explained by the following facts:

- The percentage of total steel production made by the electric furnace industry increased.

- A strike at the integrated producers provided an opportunity for electric furnace mills to increase market share, and since most electric furnace steel is made from ferrous scrap, the amount of steel made from pig iron was relatively lower. In 1990, electric furnace steel production was 4.51 Mt, a 5% decrease from the 4.72 Mt level of 1989.

The electric furnace mills had an additional advantage because the price of ferrous scrap was, on average, considerably lower in 1990 than it was in 1989. Lower scrap prices reduced the electric furnace-based steel producers' costs of production, allowing increased sales at the expense of the integrated producers.

The Canadian steel industry has 11 blast furnaces with a total capacity of 11.5 Mt/y. Associated with these furnaces are 866 coke ovens with a total capacity of 5.3 Mt/y. Maintenance on equipment was minimal during the year. At Stelco Inc. the Hilton Works E furnace was shut down for a reline that commenced on July 3. However, this work was disrupted by the strike and had not been resumed at year-end.

Electric Smelted Iron

Another source of primary iron is the nine electric furnaces at the ilmenite smelting facility operated by QIT-Fer et Titane Inc. at Tracy, Quebec. These furnaces have the capacity to produce 900 000 t/y of iron as a coproduct with titanium. This iron is used to produce three products: a range of specialty pig iron grades, which are sold mainly to the foundry industry; iron powder used by the powder metallurgy industry; and continuous cast steel billets sold to the steel industry for rerolling. This facility operated at capacity during 1990.

Direct Reduced Iron (DRI)

DRI is a semi-metallic product made by reducing iron ore in the solid state to approximately 95% metallics. Sidbec-Dosco Inc. has one operating Midrex DRI plant at Contrecoeur, Quebec. This plant has a capacity to produce 750 000 t/y and operated at a level greater than its nominal capacity during 1990. DRI together with scrap is used to produce steel at the company's electric furnace steel mill.

Steel Mill Developments

The three integrated steel producers are the major source of, and consumers of, primary iron in Canada. Highlights by company are:

The Algoma Steel Corporation, Limited – A number of capital equipment projects were put on hold during the second half of the year. The company had previously decided to install two ladle metallurgy stations. The construction of one station was deferred while the other station located in number 2 steelmaking shop was completed. Algoma chose the CAS-OB process, a proven technology that allows close control of chemistry and temperature. The new continuous round caster project was also deferred, even though it was quite advanced. Specifically, the building was completed, the equipment delivered and many of the foundations put in place. Reconstruction of its rail and its structural mills, which were scheduled to begin in 1989, was also affected.

Dofasco Inc. – Construction of a new $450 million integrated cold mill complex in Hamilton, which commenced in 1989, is progressing on schedule with first trial runs expected in the first quarter of 1992. Turnover of the facility to production is scheduled for September 1992. This complex will have the capacity to process approximately 1.1 Mt annually. The joint venture with Sidbec-Dosco Inc. to build a galvanizing line in Montreal, Quebec, proceeded on schedule with start-up expected during the first half of 1991. This jointly-owned company is called Sorevco; and the plant will have the capacity to produce 100 000 t/y. Plans were announced to proceed with a jointly-owned hot dip galvanizing line to be owned 50% by Dofasco Inc. and 50% by NKK/National Steel. The facility will be located in Windsor, Ontario, and will have a capacity of 360 000 t/y. Start-up is expected in 1993. Work on docking facilities, which includes new materials-handling equipment to increase capacity to handle water-borne iron ore pellets, was completed.

Stelco Inc. – The Z-Line galvanizing project, a $198 million flat rolled processing project that was approved in 1989, was suspended due to the strike but resumed late in 1990 with initial operations scheduled to commence early in 1991. This project includes a new combination galvanizing/continuous annealing line, a pickle line upgrade at Hilton Works, and a second reheat furnace at Lake Erie Works. The decision to combine the facilities of Stelco's subsidiary, Canadian Drawn Steel Company, with those of Bliss & Laughlin Industries Inc. of Harvey, Illinois, into one operating company was completed with the result that Stelco Inc. acquired a 39.3% ownership position in Bliss & Laughlin. Both companies manufacture cold finished bars.

INTERNATIONAL EVENTS

Steel Developments

Western World steel production, as calculated by the International Iron and Steel Institute (IISI), in the first eight months of 1990 decreased 2.8% over the same period in the previous year. This overall decrease in production was attributed to lower levels of demand for consumer durables, especially automobiles, brought about by recessionary pressures which were intensified by high interest rates. Canadian production decreased 15.8%. However, some of this reduction was the result of a four-month strike by the employees of Stelco Inc. and The Algoma Steel Corporation, Limited. Steel production in the European Communities (EC) declined by 3.5%, while in Japan it increased by 1.1%, due predominately to good levels of domestic demand. U.S. production declined by 1.8%.

However, by year-end U.S. production had increased to a level slightly higher than in 1989.

IISI member countries' raw steel production in August was 3.5% below the August 1989 level. Increased softening of world demand occurred during the second half of the year. U.S. production was up 8.6%, due mainly to large increases in demand for oil country tubular products. EC production was down 6.2%, while Japanese production was up about 4.3%. U.S. steel production was helped by good levels of exports which, while lower than in 1989, were high compared to historic levels.

In the first 10 months of 1990, U.S. exports totalled 3.08 Mt, down slightly compared to 3.57 Mt for the same period in 1989. A significant portion of these exports came to Canada. In the first 10 months of 1990, imports of steel mill products from the United States totalled 1.23 Mt, a significant increase over the 0.92 Mt imported in 1989. In comparison, Canadian exports increased slightly in spite of the high value of the Canadian dollar and the strike at the integrated producers, totalling 3.39 Mt in the first 10 months of 1990 compared to 3.28 Mt in the same period of 1989.

DRI Developments

Midrex plants account for about 60% of world DRI production; HYL-1 and HYL-111 plants are the second most important. Total DRI production, as calculated by the Midrex Corp. was almost 18 Mt in 1990, a 12% increase compared to the 15.94 Mt produced in 1989, or about 3.4% of world crude steel. Midrex Corp. has forecast that the merchant market for DRI will increase from less than 3.5 Mt by the end of 1990 to 16 Mt in the year 2000. DRI's inherent advantages of high purity and controlled chemistry have always been valued but, as long as ferrous scrap prices remained low compared to the price of DRI, the growth potential for the product was limited. This situation has changed considerably in recent years with scrap prices remaining high relative to historic levels, even during the 1990 recession. It should be noted that international trade in ferrous scrap tends to buffer price swings in the North American price of scrap.

The future demand for DRI looks good for the following reasons: demand for scrap is expected to remain high for the next decade; the availability of hot metal from blast furnaces is likely to decrease as older equipment reaches the end of its economic life; production of hot metal will be further complicated by the need for more rigorous environmental controls; and finally, the new direct smelting or direct steelmaking technologies are not yet commercially proven. Some of the shortfall of ferrous scrap expected in the mid-1990s could well be supplied by DRI.

World DRI capacity increased to 29.4 Mt, up 16% compared to 1989 levels. New facilities were started up by Essar Steel in India, Minerals and Resources Corporation (MINORCA) in Venezuela, and Ahwaz in Iran. The five Midrex modules at these sites added an additional 2.7 Mt to world capacity.

Additional DRI capacity is also under construction. Perwaja Trenggana Sdn Bhd, a Malaysian steel producer, announced plans to revamp a DRI facility and install a second unit utilizing the HYL-111 process, which will bring the company's total capacity to 1.1 Mt/y. Other HYL-111 projects were also announced. In Indonesia, a 1.35 Mt/y capacity plant is planned by PT Krakatau Steel, and in India, one for 750 000 t/y is planned by Grasim Industries Ltd. A major project in the Guyana region of Venezuela is in the feasibility study stage of planning. This project, which is called Comsigud, would have two Midrex MEGAMOD plants with a total capacity of 2 Mt/y of DRI. They would be part of a complex with 3 Mt/y pelletizing capacity, a hot briquetted iron plant and an electric furnace steel mill with a capacity to produce 1 Mt/y of continuous cast slab. The projected start-up date of the project is late 1993. The principals in this proposal are Corporacion Venezolana de Guayana (CVG) and Kobe Steel, Ltd.

Supplies of DRI were tight in 1990, with most of the capacity of merchant producers of hot briquetted iron sold out for the immediate future.

NEW PRIMARY IRON TECHNOLOGIES

The development of new processes that provide an alternative to the traditional blast furnace continues with even greater support than in past years. These processes are generally some form of direct smelting. They have economic and environmental advantages over the coke-oven blast furnace method, which requires coke and agglomerated iron ore. Agglomerated ore such as pellets or sinter is more expensive than iron ore concentrates, due to the cost of the necessary capital equipment and energy used to indurate the iron ore. Direct smelting processes that use concentrate or fines therefore represent considerable cost savings. As well, coke production requires high-grade metallurgical coal, whereas many direct smelting technologies require only pulverized lower grades of coal. A further consideration is environmental protection legislation that makes new coke ovens very expensive to build and to operate. Direct smelting processes have been engineered from original concepts to be environmentally compliant.

Another advantage is the much smaller minimum economic size of direct smelting plants, an important capital cost consideration which makes them an appropriate technology to supply hot iron for electric furnace mills. One of the direct smelting processes, the Corex process, has reached the level of a proven commercial technology, as a full-scale plant has been operating at ISCOR's steel plant in Pretoria, South Africa. The first operating campaign started in August 1988 and ended in February 1989. The official commissioning was in June 1990. The hot metal from this first commercial plant met the design specifications. A second commercial plant will likely be built in North America in the near future as a number of companies are very interested in this technology.

Other advanced direct smelting technologies are: the XR process by Kawasaki Steel Corporation; Direct Bath Smelting of Iron Ore, a joint venture of CRA Limited of Australia, and Kloeckner Slahlhorschung of West Germany; the Elkem Polar Process by Elkem a/s of Norway; and the Hlsmelt PROCESS owned by CRA Limited, Klockner Stahlwwerke Csiro and Midrex Corp. These technologies have reached technical maturity, appear economically viable and await verification at commercial scale.

High levels of research and development are being maintained on these new technologies by both major companies and governments. The U.S. Department of the Environment is contributing to the funding of research into direct steelmaking in cooperation with The American Iron and Steel Institute. The three-year US$3 million project commenced in February 1990 with the construction of a pilot plant at Universal, Pennsylvania, which was completed in June 1990. The project will concentrate on in-bath smelting and refining processes. In Japan, a number of projects are at advanced stages of development. They are: In-Bath Smelting Reduction by Nippon Steel Corporation (NSC), Coal Iron Gasification Process, a joint Japan-Sweden feasibility study for the International Energy Agency; and The Japan Iron and Steel Federation Direct Iron Ore Smelting Process, a joint development of The Japan Iron and Steel Federation and Nippon Kokan KK.

FERROUS SCRAP

Ferrous scrap has always been an important raw material in the production of steel. Presently it is the major source of iron units for the world electric furnace steel industry which in 1988 produced 213.6 Mt, or 27.5%, of the world's steel. The amount of steel produced with electric furnaces has been increasing for many years. For example, in 1975, electric furnaces produced 106.8 Mt which was 16.7% of world production. Scrap is also used in both open-hearth and oxygen furnaces. Oxygen furnaces can use up to about 30% scrap per batch of steel, and open-hearth furnaces can utilize very high percentages. Ferrous scrap is a commodity for which a large international trade exists. The importance of scrap is shown by IISI estimates of world consumption at over 300 Mt/y during the last few years.

CANADIAN EVENTS

Canadian demand for scrap remained strong throughout the first three quarters of 1990, in spite of lower levels of steel production. This situation can be partially explained by increased sales by electric furnace producers arising from the three-month strike at the integrated producers. Scrap consumption by steel producers decreased by 7.6% to 5.97 Mt. In Canada, total raw steel production during 1990 was 12.18 Mt, down 20.5% from the same period last year.

In Canada the steel industry consumed 6.5 Mt of scrap in 1990, compared to 7.8 Mt in the same period of 1989. Of this total, 2.1 Mt was internally generated and 4.4 Mt was purchased. The percentage of purchased scrap used by steelmakers decreased 18.5% in 1990.

PRICES

The price of scrap in Canada closely follows the trends in the United States because North America is effectively a single market for scrap.

On average, the prices for ferrous scrap were lower during 1990 than in the previous two years, although still relatively high by historic comparison. The weekly composite price for shredded scrap as quoted by the American Metal Market was at a low of US$123/t at the beginning of the year, reached a high of US$141/t in February 1990, and declined to $128/t by year-end. Canadian imports of ferrous scrap from the United States increased significantly, narrowing the differences between Canadian and U.S. prices.

Decreasing prices for North American ferrous scrap in 1990 were attributed mainly to a drop in steel production in both Canada and the United States. Even though U.S. production rallied at year-end, total North American production was down.

TRADE

In the last two years Canada ceased to be self-sufficient in scrap and became a net importer. Scrap supply was a problem for Canadian steel companies in the first half of 1990, and imports increased significantly. During the last three years, 90% of Canadian scrap exports have gone to the United States, and virtually all Canadian imports originate in the United States.

Canada's recycling industry is efficient, quite highly mechanized and competitive internationally. The world market for ferrous scrap is very competitive and tends to fluctuate widely from year to year. Offshore countries which have a history of buying Canadian scrap include South Korea, Spain, Italy and Japan.

CANADIAN INDUSTRY STRUCTURE

The Canadian ferrous scrap industry comprises approximately 600 firms. Most of these firms are small and are involved only in the simple collection of scrap. Dealers who are also involved in the sorting and storage of scrap are fewer in number, while those who engage in capital-intensive scrap processing total about 15. Scrap processing requires heavy equipment such as mechanical shredders, shears, presses and bundlers. A new competitively sized processor would require in excess of $10 million for capital equipment.

Scrap is such an important raw material that it is common for Canadian steel producers to hold equity in scrap processing companies in order to reduce the risk of supply problems and to assure quality control.

SCRAP CLASSIFICATION

The producers of ferrous scrap describe unprocessed scrap by its origin. "Home scrap" is produced in the manufacture of steel mill products, whereas "prompt industrial scrap" is generated by the secondary manufacturing industry. "Obsolete scrap" comes from discarded machinery, equipment and structures.

Prompt and obsolete scrap are generally processed by the recycling industry. It is sorted into a number of product classes for which standards have been written by the Canadian Association of Recycling Industries.

Scrap classification is based on factors such as size, type of material, cleanliness and residual alloying elements. The most common grades are as follows:

Primary Iron and Ferrous Scrap

SCRAP PRODUCTS[1]

Class No.	Grade and Type
100	No. 1 heavy melting steel
101	No. 1 hydraulic bundles
102	No. 1 bushelling prepared
103	No. 2 heavy melting steel
104	Plate and structural steel
105	No. 2 hydraulic bundles
106	Hydraulic silicon bundles
107	No. 2 bushelling prepared
108	No. 1 bushelling (clips)
109	Short shovelling steel turnings (crushed)
110	Machine shop turnings
111	Mixed turnings and borings
112	Cast iron borings
113	No. 1 shredded scrap
114	No. 2 shredded scrap
115	Briquetted steel turnings, alloy free
116	Briquetted steel turnings, alloyed
117	Foundry steel

[1] From Canadian Association of Recycling Industries.

USES

Most ferrous scrap is used in electric furnace steel mills and integrated mills for the production of steel. The foundry industry is the second largest market for scrap. Minor markets include the production of iron powders, sinter, ferroalloys and abrasives.

In the integrated steel industry, the increasing use of continuous casting and improvements in basic oxygen furnaces (BOF) will tend to reduce the levels of internally generated scrap and increase the demand for purchased scrap.

In the case of the electric furnace steel industry, the price-demand relationship is much more direct because ferrous scrap is the principal raw material. Consequently, electric furnace mills can produce steel at considerably less cost than integrated mills in periods of low steel demand and low scrap prices, allowing them to capture market share. Many companies in this industry have been installing ladle-refining facilities to improve the quality of their products, thereby allowing them to compete with the integrated mills over a larger product range.

Another development that has been watched closely by the steel industry is the new "thin slab casting" technology used first in a commercial plant by Nucor Corporation of Charlotte, North Carolina. Nucor's first plant has been operating profitably since June 1990 and the company has announced plans to build a second sheet steel mini-mill in Crawfordsville, Indiana with a capacity of 1 Mt/y. This technology will allow the electric furnace mills to compete in the sheet steel market, increasing the demand for, and therefore the price, of scrap. Currently, sheet can be produced only by integrated mills. The second plant using this technology will be built for the Yieh Loong Group of Taiwan.

OUTLOOK

Canadian production of primary iron is expected to increase during 1991. Steel production in 1990 was adversely affected by a downturn in the economy and by an extended strike at both Stelco Inc. and The Algoma Steel Corporation, Limited. Persistence of the recession during 1991, as well as continuing high Canadian dollar relative to the United States, will delay and reduce the expected increase in demand for steel. However, 1991 iron production is expected to increase proportionally more than steel production because both Stelco and Algoma will be back in production. The integrated steel producers are expected to regain the market share lost to imports and to the electric furnace-based industry because of the 1990 strike.

In the next two to three years, the ratio of iron production to steel production is expected to increase, but at a lower rate than the trend of the past five years. The major factors causing the change, market penetration by electric furnace steel producers and the increased use of continuous casting equipment, are now approaching their expected maximums. The proportion of ferrous scrap to iron ore used in steelmaking, henceforth will be the largest determinant of the ratio, and will depend on scrap prices.

In the medium term (five to ten years), primary iron and steel production should increase as Canadian steel production increases in the context of greater trade with the United States under the Free Trade Agreement. Free trade is expected to have two effects: 1) stimulate the domestic steel-intensive secondary manufacturing industries, thus boosting domestic demand; and 2) provide good potential for exports of steel mill products to the United States.

Since the U.S. market still imports over 25% of its steel requirements, the Canadian steel industry could displace some of the tonnage that the United States imports from offshore. Furthermore, the Canadian steel industry is expected to continue to be marginally competitive in some offshore markets due to higher productivity and currency exchange rates.

In the longer term, the export potential is good because the Canadian industry is modern, efficient, and is emphasizing high value-added products where there is less competition from the developing nations that have lower operating costs.

From a period of steady growth, international steel demand and production have softened. Growth is expected to begin again by year-end 1991 or early 1992 due to an expected improvement in the economy. North American output of steel is expected to improve at somewhat less than 1%/y during the first half of the decade after declining by about 5% in 1990. From a decline in 1990, the European steel industry should perform slightly better than the industry in North America, with growth averaging slightly more than 1%/y during the 1990s. Japan's production is not expected to decline significantly in 1991, and in the medium term is forecast to increase at a rate between 1% and 2%. This growth should derive from continuing high levels of domestic demand and from the potential to increase export sales. Steel production in the newly industrialized nations is expected to increase at over 2% a year throughout the decade.

The outlook for DRI is quite positive because ferrous scrap is forecast to be in short supply and high priced in the medium term. Further, the availability of hot metal from blast furnaces is unlikely to increase as older equipment reaches the end of its economic life, resulting in shortages by the end of the decade. The steel industry is expected to wait for the new reduction technologies to be commercially proven over the next five to ten years. This shortfall could well be supplied by DRI.

The future for iron produced by newer technologies also looks good because many direct smelting processes have reached technical maturity, appear economically viable and only await verification at commercial scale.

Scrap prices, which softened during 1990, are expected to begin to increase in 1991 and 1992. Canadian scrap prices should be supported by prices in the United States, where steel production, especially electric furnace steel, is expected to increase. U.S. steel producers have become much more productive and competitive relative to imported steel.

Integrated and electric furnace mills are experiencing rapid technological change, which will have a long-term impact on the scrap market. Recent research and development efforts have focused on increasing the amount of scrap that can be used in the BOF. New developments that improve the existing processes include systems in which fuel and oxygen are blown into the BOF to preheat the scrap charge, and Lance Bubbling Equilibrium (LBE) equipment, in which inert gases are blown through the bottom of a BOF-type vessel. The more efficient mixing created by the LBE system results in higher yields, increases the amount of scrap that can be charged, and improves the quality of the steel. Technical developments in the electric furnace mills have centred on the treatment of the steel in a separate holding vessel, a process called ladle metallurgy. This technique frees the main furnace for more primary production and allows a more precise final treatment to adjust the chemistry of the steel. The improved products will allow electric furnace mills to capture a greater share of the steel market and thereby increase the demand for scrap.

Primary Iron and Ferrous Scrap

Another technology that could be rapidly adopted by the industry is the continuous casting of thin slab. This thin slab can be rolled into sheet using relatively low-cost mills. Prior to the development of this technology, sheet could be produced only by integrated mills. Nucor Corporation of the United States has constructed a mill based on the "thin slab casting" technology, which has been a technical and commercial success. A contract for a second plant using this technology has been signed by the equipment manufacturing companies and the Yieh Loong Group of Taiwan.

Scrap usage in 1990 is expected to be close to the levels of 1988. In the medium term, to 1995, usage should increase 4%-5%/y as more continuous steel is produced and a greater percentage of the steel made in North America is produced in electric furnaces. The growth rate after 1995 is forecast to slow to approximately 2%/y.

For the scrap recycling industry, the anticipated rising demand for higher quality scrap, especially in terms of low levels of tramp elements and more desirable product forms, will likely require the installation of more sophisticated process equipment. This could include X-ray spectrometers to analyze scrap, mechanical separators, and high pressure bailers and briquetting machines for the production of high-density product. There will likely also be an introduction of better shredders that could improve the separation of ferrous metal from nonferrous metals and nonmetallic components in the processing of obsolete automobiles.

Note: Information contained in this review was current as of mid-January 1991.

TABLE 1. CANADA, IMPORTS OF STEEL SCRAP, BY PROVINCE OF ENTRY, 1988-90

		1988[1]		1989		Jan.-Sept. 1990p	
		World	United States	World	United States	World	United States
Nova Scotia	tonnes	10	10	29	29	15 092	15 092
	$000	2	2	11	11	2 225	2 225
New Brunswick	tonnes	134	134	1 061	1 061	903	903
	$000	47	47	186	186	23	73
Quebec	tonnes	52 366	52 134	82 372	82 296	45 497	45 428
	$000	8 573	8 496	10 903	10 880	5 503	5 475
Ontario	tonnes	327 002	326 667	769 279	769 114	347 095	346 876
	$000	41 935	41 815	95 631	95 583	36 379	36 302
Manitoba	tonnes	51 341	51 341	101 425	101 425	37 135	37 135
	$000	8 982	8 982	14 548	14 548	5 236	5 236
Saskatchewan	tonnes	213 208	213 208	202 966	202 966	190 659	190 659
	$000	23 043	23 043	20 770	20 770	18 618	18 618
Alberta	tonnes	18 597	18 597	42 947	42 947	563	563
	$000	2 466	2 466	5 767	5 767	28	28
British Columbia	tonnes	3 132	3 132	5 395	5 395	1 616	1 435
	$000	724	724	608	608	276	268
Total all provinces[2]	tonnes	665 829	665 213	1 205 486	1 205 244	638 573	638 103
	$000	85 803	85 575	148 437	148 365	68 354	68 241

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Beginning in 1988, imports are based on the new Harmonized System and may not be in complete accord with previous method of reporting. Steel scrap includes H.S. classes 7204.29, 7204.30, 7204.41, 7204.49 and 7204.50. [2] "All provinces" includes Yukon and Northwest Territories.
p Preliminary.
Note: Totals may not add due to rounding.

TABLE 2. CANADA, EXPORTS OF STEEL SCRAP, BY PROVINCE OF LADING, 1988-90

		1988[1]		1989		Jan.-Sept. 1990p	
		World	United States	World	United States	World	United States
Newfoundland	tonnes	13 954	6 910	2 157	257	–	–
	$000	2 013	940	443	40	–	–
Nova Scotia	tonnes	5 997	5 327	5 275	55	10 850	130
	$000	1 167	806	867	58	2 638	367
Prince Edward Island	tonnes	–	–	–	–	–	–
	$000	–	–	–	–	–	–
New Brunswick	tonnes	505	431	514	514	1 296	1 296
	$000	95	82	293	293	321	321
Quebec	tonnes	171 791	41 813	221 137	49 308	173 273	18 014
	$000	24 709	7 464	30 297	9 051	23 327	3 593
Ontario	tonnes	1 174 421	1 094 502	294 996	278 455	355 111	319 512
	$000	103 855	84 324	53 903	48 189	48 718	43 606
Manitoba	tonnes	8 126	7 731	3 197	3 102	11 916	11 795
	$000	2 201	2 015	1 708	1 644	2 818	2 790
Saskatchewan	tonnes	3 313	3 282	201	201	44	44
	$000	488	479	270	270	84	84
Alberta	tonnes	2 395	2 018	1 689	1 233	1 392	980
	$000	1 044	808	663	469	512	375
British Columbia	tonnes	173 100	166 826	243 734	239 253	255 570	225 668
	$000	24 220	21 334	33 765	31 828	36 655	31 876
Total all provinces[2]	tonnes	1 553 602	1 328 840	772 900	572 378	809 957	577 944
	$000	159 801	118 263	122 220	91 855	115 151	83 090

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Beginning in 1988, imports are based on the new Harmonized System and may not be in complete accord with previous method of reporting. Steel scrap includes H.S. classes 7204.29, 7204.30, 7204.41, 7204.49 and 7204.50. [2] "All provinces" includes Yukon and Northwest Territories.
p Preliminary; – Nil.
Note: Totals may not add due to rounding.

TABLE 3. CANADA, EXPORTS OF STAINLESS STEEL SCRAP, BY PROVINCE OF LADING, 1988-90

		1988[1]		1989		Jan.-Sept. 1990p	
		World	United States	World	United States	World	United States
Newfoundland	tonnes	–	–	1 048	–	–	–
	$000	–	–	207	–	–	–
Nova Scotia	tonnes	654	232	885	57	549	432
	$000	747	109	1 454	114	931	807
New Brunswick	tonnes	276	208	495	56	253	212
	$000	234	131	786	72	510	472
Quebec	tonnes	1 772	1 099	9 335	3 458	5 975	3 788
	$000	2 995	2 001	17 874	7 466	6 841	4 046
Ontario	tonnes	18 570	10 420	14 886	7 112	18 728	11 349
	$000	25 785	10 512	28 279	11 031	21 347	12 299
Manitoba	tonnes	1 659	1 399	1 997	1 864	3 055	3 055
	$000	2 215	1 823	2 056	1 900	1 125	1 125
Saskatchewan	tonnes	–	–	21	21	–	–
	$000	–	–	32	32	–	–
Alberta	tonnes	416	219	1 884	1 344	623	407
	$000	745	287	3 275	2 174	667	396
British Columbia	tonnes	7 898	5 160	4 470	1 687	1 886	297
	$000	5 000	1 093	4 944	425	2 025	209
Total all provinces[2]	tonnes	31 245	18 737	35 021	15 599	31 069	19 540
	$000	37 723	15 959	58 911	23 217	33 449	19 356

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Beginning in 1988, exports are based on the new Harmonized System and may not be in complete accord with previous method of reporting. Stainless steel scrap includes H.S. class 7204.21. [2] "All provinces" includes Yukon and Northwest Territories.
p Preliminary; – Nil.
Note: Totals may not add due to rounding.

TABLE 4. CANADA, CRUDE STEEL PRODUCTION AND SHIPMENTS, 1988-90

	1988	1989	1990
		(tonnes)	
Furnace capacity, January 1[1]			
Steel ingot			
Basic open-hearth	750 000	500 000	–
Basic oxygen converter	11 810 000	11 736 900	11 736 900
Electric	6 253 450	6 393 450	6 664 640
Total	18 813 450	18 630 350	18 401 450
Steel castings	399 352	403 590	631 600
Total furnace capacity	19 212 802	19 033 940	19 033 140
Production			
Steel ingot			
Basic open-hearth and basic oxygen	9 927 173	10 608 346	7 676 182
Electric	4 800 676	4 724 095	4 508 219
Total	14 727 849	15 332 441	12 184 401
Continuously cast, included in total above	10 299 910	11 760 472	9 423 667
Steel castings[2]	137 865	125 698	96 335
Total steel production	14 865 714	15 458 139	12 280 736
Shipments from plants			
Steel castings	130 074	x	89 128
Rolled steel products	13 261 522	13 325 808	11 563 101
Total	13 391 596	x	11 652 229

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] The capacity figures, as of January 1 in each year, take into account both new capacity and obsolete capacity anticipated for the year. [2] Produced mainly from electric furnaces.
– Nil; x Confidential.

TABLE 5. CANADA, PIG IRON PRODUCTION, SHIPMENTS, TRADE AND CONSUMPTION, 1988-90

	1988	1989	1990
		(tonnes)	
Furnace capacity January 1[1]			
Blast	12 229 000	12 067 000	10 025 000
Electric	700 000	900 000	900 000
Total	12 929 000	12 967 000	10 925 000
Production			
Basic	w	w	w
Foundry iron[2]	w	w	w
Total	9 498 264	10 138 904	7 346 127
Consumption of pig iron			
Steel furnaces[3]	9 826 869	10 128 221	7 441 171
Consumption of iron and steel scrap			
Steel furnaces	7 460 000	7 789 670	6 554 354

Sources: Statistics Canada; Primary Iron and Steel (monthly).
[1] The capacity figures, as of January 1 in each year, take into account both new capacity and obsolete capacity anticipated for the year. [2] Includes malleable iron. [3] Includes pre-reduced iron.
w Withheld to avoid disclosing company proprietory data.

TABLE 6. AUTOMOBILE SHREDDERS IN CANADA

Company	Location	Capacity
		(tonnes/month)
Intermetco Limited	Hamilton, Ontario	8 000
United Steel and Metal, division of USACO Limited	Hamilton, Ontario	5 000
Bakermet Inc.	Ottawa, Ontario	8 000
Industrial Metal, division of Co-Steel Inc.	Toronto, Ontario	10 000
Zalev Brothers Limited	Windsor, Ontario	8 000
Sidbec-Feruni inc.	Contrecoeur, Quebec	8 300
Fers et Métaux Recyclés Ltée	Longueuil, Quebec	4 000
	Laprairie, Quebec	4 000
Associated Steel Industries Ltd.	Montreal, Quebec	8 000
Native Auto Shredders	Regina, Saskatchewan	6 000
Cyclomet	Moncton, New Brunswick	4 000
Navajo Metals, division of General Scrap & Car Shredder Ltd.	Calgary, Alberta	3 000
Stelco Inc.	Edmonton, Alberta	8 000
Richmond Steel Recycling Limited	Richmond, British Columbia	5 800
General Scrap & Car Shredder Ltd.	Winnipeg, Manitoba	3 000
Total		85 100

TABLE 7. WORLD RAW STEEL PRODUCTION, 1989 AND 1990

	1989[r]	1990[e]
	(000 tonnes)	
U.S.S.R.	160.1	153.9
Japan	170.9	110.3
United States	88.9	88.7
People's Republic of China	61.3	67.2
West Germany	41.1	38.4
Italy	25.2	25.4
Brazil	25.0	20.6
Republic of Korea	21.9	23.1
France	19.3	19.0
United Kingdom	18.7	17.9
Czechoslovakia	15.5	14.8
Canada	15.5	12.1
Poland	15.1	13.6
India	14.4	14.9
Romania	14.4	11.0
Spain	12.8	12.7
Belgium	10.9	11.4
South Africa	9.6	8.7
Taiwan	9.0	9.6
East Germany	7.8	5.6
Turkey	7.9	9.3
Mexico	7.9	8.8
North Korea	6.9	7.0
Australia	6.7	6.6
Netherlands	5.7	5.4
Sweden	4.7	4.5
Austria	4.7	4.3
Yugoslavia	4.5	3.7
Argentina	3.9	3.6
Luxembourg	3.7	3.6
Venezuela	3.4	3.2
Hungary	3.3	3.0
Finland	2.9	2.9
Indonesia	1.9	2.6
Bulgaria	2.9	2.4
Egypt	2.1	2.1
Saudi Arabia	1.8	1.8
Iran	1.1	1.7
Others	14.8	14.7
Total	785.1	769.1

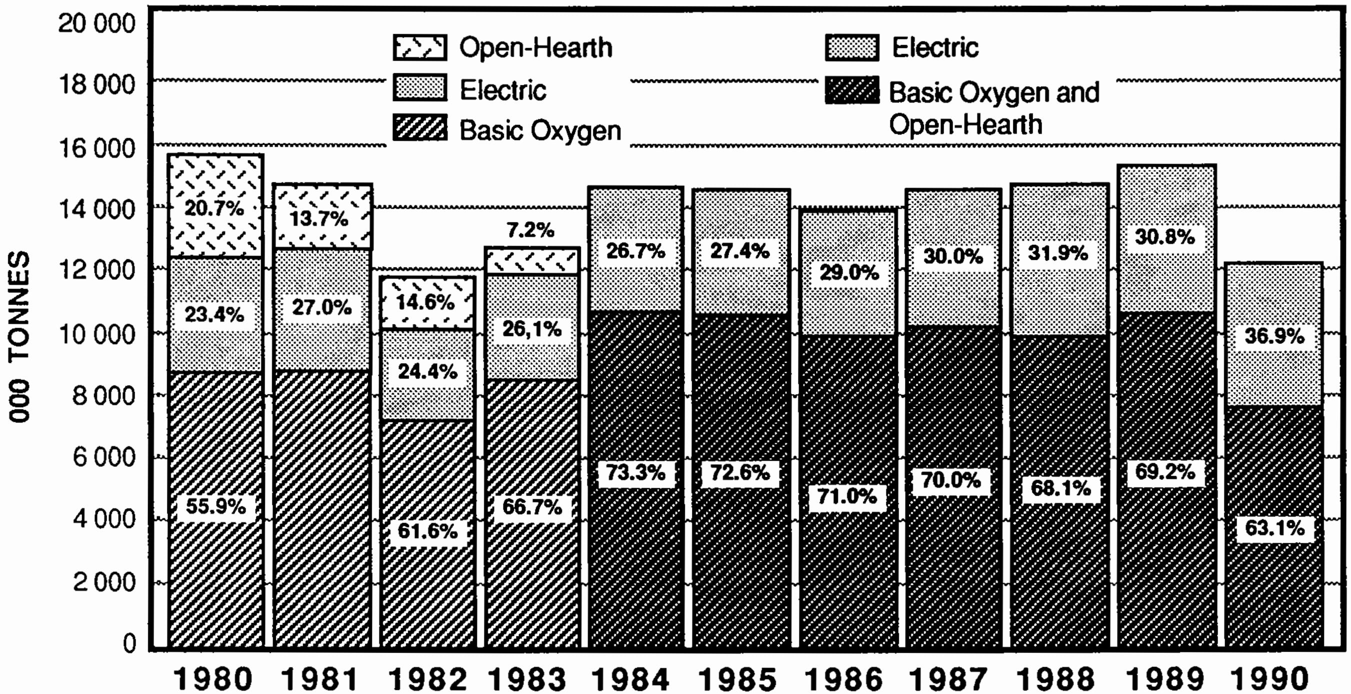
Source: International Iron and Steel Institute.
[e] Estimated; [r] Revised.
Note: Totals may not add due to rounding.

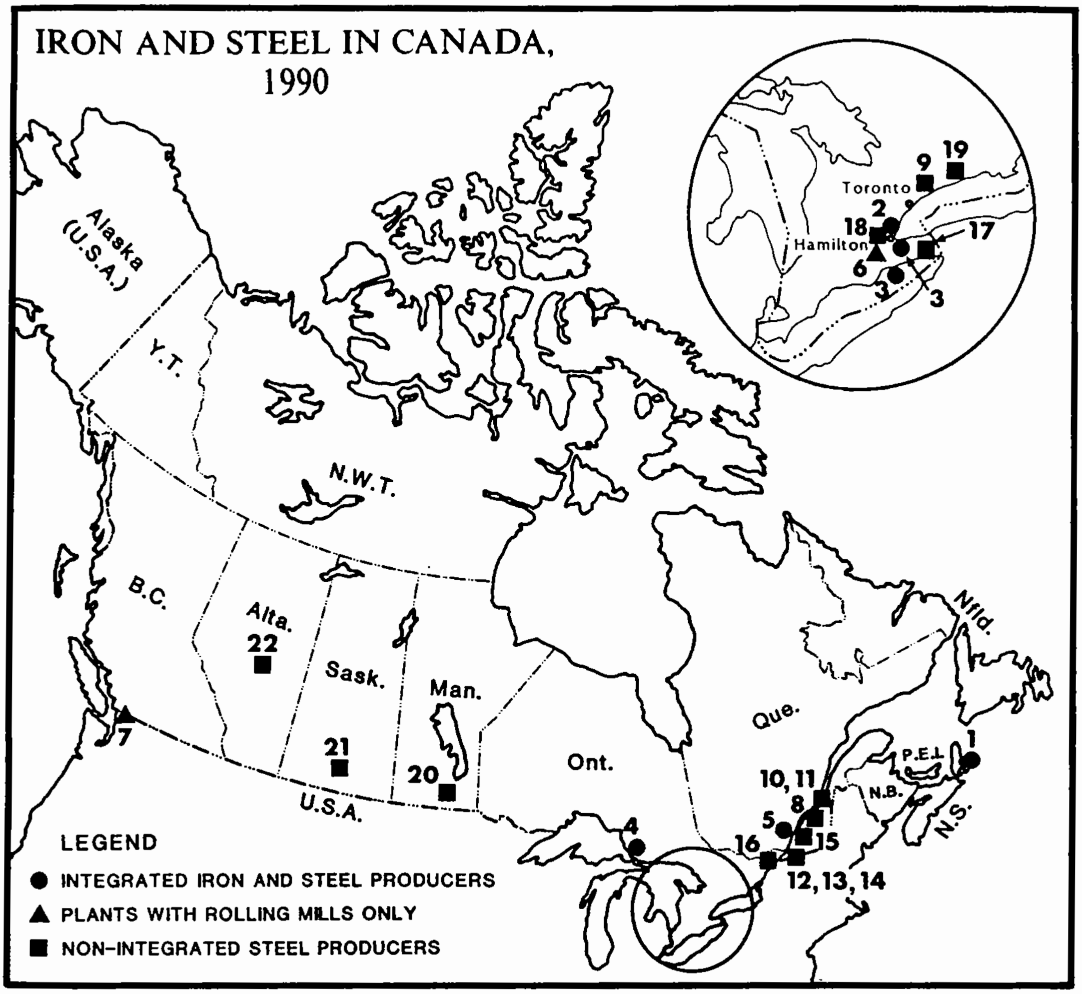
TABLE 8. CAPACITY AND PRODUCTION OF DIRECT REDUCED IRON (DRI), 1989 AND 1990

Country	Capacity		Production	
	1989	1990	1989	1990
	(Mt/y)		(Mt/y)	
Argentina	0.93	0.93	1.17	1.03
Brazil	0.31	0.31	0.26	0.28
Burma	0.04	0.04	0.02	0.02
Canada	1.00	1.00	0.71	0.73
Egypt	0.72	0.72	0.82	0.71
Germany	0.40	0.40	0.35	0.31
India	0.60	1.48	0.36	0.75
Indonesia	2.00	2.00	1.30	1.41
Iran	0.73	1.13	0.04	0.30
Iraq	1.47	1.47	0.20	0.17
Libya	0.55	1.10	0.09	0.50
Malaysia	1.25	1.25	0.64	0.62
Mexico	3.03	4.03	2.09	2.47
New Zealand	0.17	0.17	0.00	0.00
Nigeria	1.02	1.02	0.13	0.11
Peru	0.12	0.12	0.05	0.03
Qatar	0.40	0.40	0.53	0.58
Saudi Arabia	0.80	0.80	1.21	1.09
South Africa	1.36	1.36	0.84	0.86
Trinidad	0.84	0.84	0.70	0.70
United Kingdom	0.80	0.80	0.00	0.00
United States	0.40	0.40	0.29	0.39
U.S.S.R.	1.67	1.67	1.70	1.69
Venezuela	4.50	5.93	2.44	3.13
Total	25.11	29.37	15.94	17.88

Source: Midrex Corp., North Carolina, United States.

CANADA, PRODUCTION OF STEEL
BY FURNACE TYPE, 1980-90





Integrated iron and steel producers
(numbers refer to locations on map above)

1. Sydney Steel Corporation (Sydney)
2. Dofasco Inc. (Hamilton)
3. Stelco Inc. (Hamilton and Nanticoke)
4. The Algoma Steel Corporation, Limited (Sault Ste. Marie)
5. Sidbec-Dosco Inc. (Contrecoeur)

Plants with rolling mills only

6. Stanley Strip Steel division of Stanley Canada Inc. (Hamilton)
7. Pacific Continuous Steel Limited (Delta)

Non-integrated steel producers

8. QIT-Fer et Titane Inc. (Sorel)
9. Courtice Steel Inc. (Cambridge)
10. Stelco Inc. (Contrecoeur)
11. Atlas Stainless Steels, division of Sammi Atlas Inc. (Tracy)
12. Sorel Forge, division of Slater Industries Inc.
13. Canadian Steel Foundries, division of Hawker Siddeley Canada Inc. (Montreal)
14. Canadian Steel Wheel Limited (Montreal)
15. Sidbec-Dosco Inc. (Montreal and Longueuil)
16. Ivaco Inc. (L'Orignal)
17. Atlas Specialty Steels: division of Sammi Atlas Inc. (Welland)
18. Hamilton Specialty Bar: division of Slater Industries Inc.
19. Co-Steel Inc. (Whitby)
20. Manitoba Rolling Mills, subsidiary of The Canam Manac Group Inc.
21. IPSCO Inc. (Regina)
22. Stelco Inc. (Edmonton)

Salt

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DOMESTIC PRODUCTION AND DEVELOPMENTS

In 1990, Canadian production of salt was estimated at 11.12 Mt, a 1% increase over 1989. Salt production in Ontario fell due to a six-month strike that affected The Canadian Salt Company Limited's operations between the months of February and August. Shipments of all types of salt remained fairly stable at 11.1 Mt, of which about half was from Ontario compared to two thirds in 1989. Rock salt shipments accounted for 67% of total shipments, followed by salt in brines (25%) and evaporated salt (8%). The average unit value of salt shipments was estimated at $21.62/t, a 4.6% increase over 1989. The salt production capacity in Canada remained stable at 12.6 Mt, of which rock salt accounted for 68%, followed by captive brines (24%) and evaporated salt (8%). In 1990, captive brining plants operated at 90% capacity; rock salt mines and evaporated salt facilities operated at 87% and 91% respectively. Salt operations overall ran at an average of 88.1% of capacity, compared to 87.8% in 1989.

Sales of salt products for de-icing purposes were strong in 1989/90 due to cold temperatures that prevailed early in the winter season. Occasional shortages in supply occurred in some regions and in Ontario in particular. Imports increased in order to supplement some shortfalls in domestic shipments due to the strike noted above. Strong sales of de-icing salt were recorded in Quebec and Ontario, and better than average in Atlantic Canada. Shipments in the 1990/91 winter period started slowly.

Sales to the chloralkali sector remained stable. The Canadian pulp and paper industry, the largest end-user for chloralkali, experienced some slowdowns during 1990. Pulp mills ran at 84% of capacity, compared to 93% in 1989; operating rates ranging between 72% and 79% were reported during the fourth quarter of 1990. Canadian production of wood pulp fell 5% to 22 639 000 t in 1990. Pulp shipments decreased 8%, mostly due to lower offshore sales which accounted for 53% of total shipments.

The pulp and paper industry continued its restructuring for conversion of bleaching processes away from chlorine technology. However, the rate of substitution was reduced in 1990 due to a weakness in the economy and reduced revenues. Chlorine is under scrutiny with respect to its use in solvents (chlorofluorocarbons), in drinking water disinfection and in pulp bleaching. In 1990, the production of chlorine declined 1.5% as strong sales in the polyvinyl chloride (PVC) sector did not totally offset lower sales in the pulp and paper industry. The market for PVC and its feedstocks (ethylene dichloride-EDC and vinyl chloride monomer-VCM) remained firm in 1990 despite the decline in housing starts; Canadian PVC plants ran at 90% of capacity as exports tripled during the first nine months of 1990, compared to the same period last year. The demand for plastic windows, siding and pipes was strong in the building and construction sectors. In 1990, sales of sodium hydroxide (caustic soda) were booming with sustained demand in industrial chemical and pulp and paper markets. Caustic soda was the major bleaching chemical accounting for 44%, followed by chlorine with 36%. The imbalance between chlorine and caustic soda, two co-products from the same electrolysis process, continued and exerted upward pressures on caustic soda prices due to its restrained supply. The sales of sodium chlorate increased 12% in 1990; sodium chlorate is considered as the primary substitute for chlorine bleaching in pulp mills. Several sodium chlorate companies in Canada announced or completed expansion and modernization projects during the year.

Salt

Atlantic Region

Salt production in the Atlantic provinces was from an underground rock salt mine at Pugwash, Nova Scotia, an underground potash and salt mine at Sussex, New Brunswick, and a brining operation near Nappan, Nova Scotia.

In New Brunswick, Potash Company of America, a division of Rio Algom Limited, produced potash and salt at its underground mine near Sussex. Salt is extracted at a rate of 400 000-500 000 t/y and is sold mainly to the eastern United States and eastern Canada. Reserves are estimated to be large enough to operate for as long as potash is extracted, which is for at least 20 years. Salt is marketed for road de-icing and chemical plants under a sales contract with Akzo Salt Ltd.

In Nova Scotia, The Canadian Salt Company Limited operates an underground rock salt mine at Pugwash in Cumberland County, with a rated capacity of approximately 1.2 Mt/y. Most of the salt from this mine is used for snow and ice control. At the evaporated salt plant, saturated brine is fed to a quadruple effect vacuum pan, rated at 13 t/h, where brine solution is evaporated to produce high-quality salt crystals for use in the chemical and food industries. In 1990, the $7 million expansion and upgrading project continued. Development work at the 300-m level continued throughout 1990 and production is expected to start during the course of 1991. A crusher and an access ramp have been installed and excavation for the ventilation drifts and crosscuts will start in the spring of 1991. One of the evaporate pans was replaced in 1990. It is expected that 1991 production will continue at the same level as in 1990. The bagging operation bought in 1989 by The Canadian Salt Company Limited from Avalon Salt of Newfoundland is used at capacity for the bagging of solar salt supplied from its facility in the Bahamas.

Sifto Canada Inc., a division of North American Salt Co., has a brining operation at Nappan in Cumberland County, Nova Scotia. Evaporated salt products are sold for table salt, fisheries and water conditioning. As in the year before, the plant operated at a very high rate of capacity in 1990.

Quebec

During 1990, operations at Seleine Mines Inc. returned to normal production levels following the strike that ended in September 1989. Development work at the 268-m mining level was completed as planned and production has started. Mineable reserves at the 223-m level were exhausted as expected during 1990; reserves at the 173-m level are projected to last until the end of 1993. Each level has an average reserve life of five years, holding about 8 Mt per level. The development of the covered outdoor stockpiling facility was completed in 1990, increasing the storage capacity to 270 000 t. This new storage capacity allows the mine to produce for 11 months instead of the previous 9 months in the past. Because of changes in priorities, the replacement of the secondary and tertiary impact crushers by rolling bar crushers was not done; however, it is still planned for the near future as it should increase the recovery rate by 5% (to 85%).

Ontario

The year 1990 saw the completion of the sale of Canadian and U.S. assets of Domtar Inc., Sifto Salt Division, to Carey Salt Holdings, Inc. of Mission, Kansas. Canadian operations are now known as Sifto Canada Inc., a division of North American Salt Co. Former Sifto American assets are now operating under North American Salt Co. Canadian operations consist of the Goderich, Ontario rock salt mine and evaporated salt plant, brining operations at Nappan, Nova Scotia and Unity, Saskatchewan, and the Patience Lake, Saskatchewan operation.

In 1990, salt was produced from two underground rock salt mines (Goderich and Ojibway) and from brining operations at Goderich, Sarnia, Windsor and Amherstburg.

At Goderich, Sifto Canada Inc. operated an underground rock salt mine. The new underground mill installed in 1989 is providing a higher output. Sifto's salt is marketed mainly for ice control and is sold mainly in eastern Canada, in the north-central United States (Great Lakes Basin), and in regions accessible through the Mississippi River system. Salt produced at Goderich is also used by the chemical and water treatment industries. Evaporated salt is produced at the Sifto brining operation located near Goderich. The installation of a new compactor in the near future should help Sifto to develop new markets.

The Canadian Salt Company Limited produced both rock salt from the Ojibway underground mine and vacuum salt products from brine wells near Windsor. The mine capacity is 2.5 Mt/y. Rock salt is extracted from a depth of 297 m while brine is pumped from the 427-m and 457-m levels. Production at both operations was hampered by a strike that affected 250 employees between the months of February and August 1990. The strike also affected the underground development work in the southwest area; however, it is expected that the work will be completed and that production will start during 1991.

In the vicinity of Amherstburg, General Chemical Canada Ltd. operated a brining operation for the manufacture of sodium carbonate and by-product calcium chloride. At Sarnia, Dow Chemical Canada Inc. extracted brines from wells for the production of caustic soda and chlorine.

Prairie Provinces

In Saskatchewan, four companies produced salt from the Middle Devonian Prairies formation. International Minerals & Chemical Corporation (Canada) Limited (IMCC) supplied by-product rock salt from its potash operation at Esterhazy. Its salt is distributed locally for road de-icing. Sifto Canada Inc. operated a brining operation near Unity for the production of fine vacuum pan salt; the Unity plant has the only fused salt facility operating in Canada as other salt operations switched to salt pelletizing through compaction. Sifto Canada Inc. reached an agreement with local authorities on the environmental considerations over air emissions from this unit's furnace, allowing its production to continue. Two evaporators underwent major repairs and a turbine generator was replaced. A dust collection system has been installed at the Patience Lake operation where salt is recovered by processing waste salt from a nearby potash operation. The capacity of production is reported to be in the range of 50 000-100 000 t/y. The Canadian Salt Company Limited at Belle-Plaine produced evaporated salt from by-product brines sourced from an adjacent potash solution mine operated by Kalium Chemicals, a division of Kalium Canada, Ltd. Saskatoon Chemicals, a division of Weyerhaeuser Canada Ltd., produced brines from wells near Saskatoon for the manufacture of caustic soda and chlorine.

In Alberta, two producers operated brining operations: at Fort Saskatchewan near Edmonton, Dow Chemical Canada Inc. extracted salt brines for the manufacture of chloralkali and, at Lindberg, The Canadian Salt Company Limited produced fine vacuum pan salt. New brine wells, drilled for solution mining in 1989, entered into production in 1990; no increase was reported in total production as these wells were replacements for wells going out of production.

British Columbia

There was no production of salt in this province where three companies operated six chloralkali plants. These operations used solar salt imported from Mexico, the United States and Chile.

CONSUMPTION

In Canada, the apparent consumption of salt has averaged 9.0 Mt/y since the mid-1980s, a 30% increase compared to the early 1980s. In 1989, the apparent consumption of salt in Canada was estimated at 11.4 Mt, a 25% increase over 1988 due to higher sales in both the de-icing and chemicals sectors. Imports accounted for 21% of the total domestic consumption. The amount of salt used in the manufacture of chemicals was estimated at 4.4 Mt in 1989, accounting for 50% of total sales, followed by snow and ice control (44%), with the remainder being used for water conditioning, food processing, fisheries and other industrial usages. Most of the salt used as a de-icing agent is consumed in Ontario, Quebec and Atlantic Canada. Ice and snow control consumption of salt in Canada ranges between 3.2 Mt/y and 4.5 Mt/y.

Some 60% of world salt consumption is as a chemical raw material, followed by table salt (19%) and road de-icing salt (11%); the remaining 10% was used in animal feed and water treatment. The consumption pattern differs in North America where the chemical industry consumes about half of total production, followed by highway usage and the food industry.

The industrial chemicals industry consumes salt for the manufacture of chloralkali such as caustic soda (sodium hydroxide), chlorine and sodium chlorate. Salt for four caustic soda and chlorine plants in Canada is obtained from on-site brining and natural brines; other plants use mined rock salt or imported solar or evaporated salt. Other industrial chemicals that require significant quantities of salt include sodium bicarbonate, sodium chlorite, sodium hypochlorite and sodium carbonate (soda ash), and calcium chloride.

Chlorine, which is a major market for salt, is currently under investigation as the principal pulp-bleaching agent responsible for the presence of traces of dioxin (2, 3, 7, 8,-TCDD) and furan (2, 3, 7, 8,-TCDF) in certain pulp and paper mill effluents in North America. These chlorinated compounds have been identified as carcinogenic to some animals; however, their effect in small dosages on humans is controversial. In April 1990, Environment Canada released draft regulations to impose stringent national pollution standards on the Canadian pulp and paper industry. A set of regulations, which were to be effective by January 1, 1991, was prepared under the Canadian Environmental Protection Act and is to prohibit the use and sale of defoamers containing any measurable concentrations of dioxins and furans. By 1994, the release of these chemical compounds will be banned in pulp mill effluents. Also to be effective January 1, 1991, regulations under the Fisheries Act will tightly control discharges of conventional deleterious substances such as biochemical oxygen-demanding matter and total suspended matter. The final regulations are expected to be announced by mid-1991 and would apply to every pulp mill across Canada. The national average of dioxins and furans discharges from Kraft pulp mills was estimated at 6 kg/t of pulp produced. In the United States, the Environmental Protection Agency tabled proposals to regulate the reduction of dioxins and furans released from pulp mills and to impose a concentration limit in effluents at 10 parts per quadrillion.

Many mills in North America have already started the conversion of their bleaching process away from chlorine technology. A target of 50% substitution is contemplated while several modifications could achieve 70% substitution. A limit of 2.0 kg/t for absorbable organic halides (AOX), which include furans and dioxins, could be readily achieved; however, a cap could be legislated at 1.5 kg/t and would require a substitution level up to 80%-90% in older mills, and up to 60%-70% in more recent mills.

The Chlorine Institute is sponsoring research to determine the process involved in the production of dioxins and furans from bleaching, and to investigate methods to destroy these organochlorine compounds at discharge points. Most mills in Canada have carried out extensive process modifications and effluent treatments; several opted for reducing chlorine usage by installing other bleaching processes such as extended lignification, oxygen delignification, sodium chlorate bleaching, integrated chlorine dioxide with hydrochloric acid recycling, and ozone and hydrogen peroxide bleaching processes.

Sodium chloride, or salt, remains the primary de-icing agent. Different de-icers are used in accordance with site requirements. On streets and highways, rock salt, calcium chloride-salt mixtures, salt brines and mechanical measures (plowing and blowing) are mostly used. On bridges, salt, sand-salt mixtures and salt alternative methods are used; pavement heating and non-corrosive chemicals with corrosion inhibitors are under investigation. On runways and airways, non-corrosive compounds are used and comprise urea, formamide and glycols. In residential and commercial areas, rock salt, potassium chloride (potash), calcium chloride and various combinations of these materials with abrasives are regularly utilized. Calcium chloride is the second most used de-icer, being effective at temperatures ranging between -10°C and -20°C; this chemical is usually mixed with salt at a 2%-4% rate. The use of abrasives is mostly limited to highways and residential areas; a mixture of coarse sand and small crushed stone is spread to improve the skid resistance of slippery roads.

The growing concerns over the degradation of the environment and the corrosion of infrastructures such as bridge decks and parking lots have led to numerous experiments with de-icing salt substitutes. Research for alternatives has focused on abrasive mixes, magnesium chloride, ammonium compounds, tetrapotassium pyrophosphates, calcium magnesium acetate (CMA), sodium formate, isopropyl alcohol, ethylene glycol and technical urea. Studies have also been conducted on non-chemical treatments, including a series of measures that are largely used in Europe such as ice-retardant pavement surfacing and roadway heating. The effects of salt-spreading on the environment depend on a variety of factors such as weather conditions, road characteristics, traffic loads, winter maintenance methods and local topography. Environmental effects may include adverse impacts on plant growth and crop productivity in the immediate vicinity of highways, and higher salinity levels in streams and groundwater systems. For many years, provincial and regional agencies in charge of road maintenance have pursued the objective of optimizing the use and selection of ice and snow control methods. Cost, operational reliability, public safety and environmental considerations have resulted in improvements to existing methods and in better road safety and rideability.

In Ontario, the Ministry of Transportation has conducted field experiments on salt alternatives since 1986. During the winter season of 1989/90, tests with Calcium Magnesium Acetate (CMA) were carried out on Highway 26 near Owen Sound. In 1990/91, a new series of experiments will be conducted on an expanded scale in the same area. CMA has proven to be an effective and environmentally safe alternative, but its lack of effectiveness at low temperatures and its high cost limit its application. In Canada, field tests were conducted with chemical additives that mix with asphalt to produce an anti-icing pavement; experiments occurred in Ontario late in the 1970s and in Prince Edward Island in the mid-1980s.

Since mid-1987, the Roads and Transportation Association of Canada (RTAC) has been coordinating an extensive project for evaluating degradation of highways and related infrastructures. The Canadian Strategic Highway Research Program (C-SHRP) is a $5 million project funded by provincial and federal grants over a five-year period. In 1990, the SHRP program in the United States initiated an $800 000 project to evaluate the testing procedure for de-icing chemicals and to develop improved sodium chloride products. The two-year program comprises two phases: field observations to be carried out during the winter of 1991/92, and investigations of the effectiveness of salt and non-chloride chemicals. The project is due for completion by late 1992.

Other sectors that consumed salt include water softening, food processing and the fisheries industry, which together account for close to 5% of total consumption in Canada. Salt consumption in Canada for water softeners was estimated at 150 000-200 000 t/y. All Canadian production was consumed in the domestic market as trade in conditioning salt was estimated to be small. A typical annual consumption per household in Canada ranged between 350 kg/y and 450 kg/y of salt. The bulk of the market was reported to be located in suburban and rural areas where hard water is seldom treated on a large-scale basis. Some major municipalities in western Canada such as Regina and Calgary use water softeners extensively as the local water carries high calcium and magnesium concentrations. In 1990, the sales of salt for water treatment continued to show strong growth. Sales in eastern Canada were stable while sales in Ontario, the largest market for salt in this sector, registered a small 2.5% increase. In western Canada, the demand for salt in water-softening units grew by 4%. In 1990, the water treatment sector in Canada was evaluated at $600 million, a 10% increase over 1989. Industrial water equipment accounted for 42%, followed by bottled water sales (17%), and commercial units (13%). The residential water-softening market was evaluated at $50 million and salt sales in this market segment at $20 million. Fused salt, which was a popular product for water softening, has been replaced by compacted salt pellets, nuggets and crystals; in some instances, coarse salt is used. Growth in this market is tied to housing starts and local water characteristics. New water treatment devices that do not use salt, such as electromagnetic equipment and catalytic units, have not yet been approved in Canada.

TRADE

In 1989, salt imports jumped 96% to 2.36 Mt which represents a record for imports over the past decade. The main reasons behind this major increase were a six-month strike at Seleine Mines Inc. and rigorous winter conditions. The average unit value for imported salt decreased 24% to $15.04/t. Exports declined 29.5% to 2.14 Mt, valued at $37 million in line with the 1984-87 average of 2.3 Mt/y. During the first nine months of 1990, imports amounted to 1.61 Mt, an 18.5% decrease over 1989, which was primarily due to a return to normal import volumes from the United States into central Canada. Imports were mainly from the United States (76%), Mexico (15%) and Chile (5%) for deliveries in Ontario (46%), British Columbia (28%) and Quebec (19%). Nine-month exports in 1990 declined 22% to 1.16 Mt, valued at $22.7 million. Exports were shipped to about 20 countries, but the bulk was for the United States which accounted for 99.8%. Deliveries were shipped mainly from Ontario (79%), with the remainder coming from Quebec, Nova Scotia and Alberta. The unit value of 1990 exports averaged $19.60/t, a 12% increase over the same period in 1989.

WORLD PRODUCTION AND REVIEW

In 1989, world production rose 3% to 190 Mt. Although salt is produced in a great number of countries, production was dominated by the United States which accounted for 19%, followed by China (15%), the U.S.S.R. (8%) and West Germany (7%). Canada ranked fifth with 6%. In 1989, major increases were reported in China (+27%), Australia (+13%) and Mexico (10%). Salt production in the United Kingdom posted an 18% decrease.

United States

In 1990, salt production was estimated at 35.7 Mt, valued at US$800 million. Thirty-two companies operated 69 plants in 13 states. At year-end 1989, the annual salt production capacity was reported at 39.9 Mt; salt producers operated at a rate of 89.5% of capacity during 1990. Apparent consumption amounted to 39.1 Mt, about half-a-percent decline from 1989. Brine sales accounted for 47% of the salt sold or used, followed by rock salt (36%), evaporated salt (10%) and solar salt (7%). The chemical industry consumed 46% of the total salt sold; road and ice control usage accounted for 26%. The average unit value for rock salt shipment rose less than 1% to US$16.50/t, while the average unit value for salt from brine lost 12% to US$5.00/t. Imports remained stable at 5.5 Mt and were mainly from Canada, Mexico and the Bahamas. The net import reliance for 1990 is estimated at 10% of apparent consumption. Exports rose 28% to 1.8 Mt, mostly shipped to Canada.

The purchase of Domtar's Sifto Salt Division by Carey Salt Holdings, Inc. was completed in 1990. North American Salt Co. is a new company formed at the time of the transaction by Carey Salt Co. and American Salt Co. The agreement between North American Salt Co. and the U.S. Justice Department called for North American Salt Co. to sell some of its Kansas salt mines in order to acquire Sifto's Côte Blanche rock salt mine and associated depots at Baldwin, Louisiana. To satisfy this requirement, North American Salt Co. sold its mine at Hutchinson to Hutchinson Salt Co. during the summer and its Lyons mine to Lyons Salt Co. in November. Old American assets of Sifto will now operate under the North American Salt Co. name.

Three chlorine facilities in California, New York and West Virginia closed as a result of a drop in the demand for chlorine-based products.

Japan

In 1989, Japan produced 1.36 Mt of salt, a 1.5% increase over 1988. Imports remained stable at 7.5 Mt, of which 51% came from Australia and 48% from Mexico. Consumption of salt in 1989 was estimated at 8.9 Mt, used mainly for chloralkali (62%), sodium carbonate (17%), food processing (12%) and the balance for general industry, household usage and road de-icing.

Australia

A major A$23 million expansion program of the Australian Dampier salt field was announced by Dampier Salt Ltd. Investments will be made for upgrading existing equipment, which will increase the field capacity by 500 000 t/y to 3 Mt/y. It is also reported that the company has the potential to bring its total production capacity to 7 Mt/y. This expansion will also strengthen the company's position as Australia's first producer with a total capacity of 4.5 Mt/y. This incremental production is aimed at the growing demand from the chemical industry, especially in north and southeast Asia as the salt consumption in Asia is expected to grow at an annual rate of 2% to reach 12 Mt/y by the year 2000. Exports to Japan are predominant, but it is expected that Korea, Taiwan and Indonesia will become significant customers. Gulf Holdings Pty Ltd. announced its intention to build an A$80 million solar salt facility in the region of Onslow with an anticipated capacity of 1.5 Mt/y. Production is scheduled to start in late 1992 with projected export sales at A$30 million.

China

There are reports that 41 lakes in the Qaidam Basin in northwest China's Qinghai province will become a major production centre for industrial minerals with salt being a major component. The 33 salt lakes have reserves in excess of 60 billion tonnes, said to represent 97% of China's total salt lake reserves. The 1989 total production of lake salt in the Basin amounted to 1.2 Mt and was sold in 27 provinces, municipalities and autonomous regions. Pilot operations in a rock salt mine at Dingyuan, in Anhui province, began in 1990. Reserves are estimated at 1.2 billion tonnes and the production capacity of the first phase of the project is said to be 100 000 t/y.

INTERNATIONAL TRADE

Salt is a widespread, low value, bulk commodity. It is relatively easy to extract and transportation represents a significant proportion of the total delivered price of salt. Consequently, international trade in salt is small relative to world production, i.e., about 20% of total world production. Trade in the Pacific area will account for one half of seaborne movements by 1991, followed by North America (24%) and northwestern Europe (20%). Australia is expected to remain the major supplier to Japan while Mexico will continue to export mainly to Japan and North America. Imports to the European Communities are expected to remain minimal as this region is essentially self sufficient.

PRICE

The price of salt depends on factors such as production methods, purity, scale of operations, transportation costs and product availability. During those periods when a shortage occurs for reasons of strikes or technical problems, prices for salt will likely rise until alternative sources are found. In the peak period of demand, de-icing rock salt prices may increase if harsh winter conditions persist, as it was the case in the winter season of 1989/90. Most likely, the replenishment of stocks during such periods will be subjected to higher prices.

In 1990, prices for salt products rose 3.5%, at a pace below the annual inflation rate; prices for value-added products such as fine evaporated salt or water treatment pellets or nuggets increased 4% compared to 3% for agricultural and de-icing products.

Prices for de-icing rock salt, bulk f.o.b. plant, rose 3%-6% and varied between $46 and $81/t. Prices in Atlantic Canada were in the $46-$60/t range, in Quebec $60-$81/t and in Ontario $46-$50/t. Prices for agricultural products rose 3% on average; a 25-kg lick block cost around $5-$9; fine evaporated salt prices rose 3%-4% and varied between $100 and $135/t. Water conditioning grades were sold for $7-$9 per 40-kg bag, a 4% increase over 1989.

OUTLOOK

In 1991, the domestic consumption of salt is forecast to decrease slightly due to lower sales in the de-icing and chemical sectors. Salt production is expected to increase with the return to normal operating levels at Canadian mines that were affected by strikes in the last two years. Imports of rock salt are likely to decline as domestic salt output rises. Rock salt prices are projected to remain flat while value-added products should achieve a marginal, inflationlike increase in 1991.

Salt

De-icing salt will continue to face mounting environmental pressures. Enhanced de-icers will become attractive alternatives where their cost can be justified, in particular in corrosion- and accident-sensitive areas such as bridge decks. The optimization of spreading rates in combination with the search for adequate abrasive mixtures will continue to be evaluated.

The manufacture of inorganic chemicals will remain a major market for salt in spite of environmental concerns. In 1991, salt consumption in chemicals is forecast to decline slightly as a result of the economic recession that will prevail in North America during the year. The pulp and paper industry, the major consumer of chloralkali, will experience a downturn in 1991, with lower operating rates in the 75%-80% range. During the 1990-94 period, the demand is forecast to grow at a marginal rate of 0%-1%/y while consumption is expected to decline in the pulp and paper sector at a rate of 8%-9%/y, and in the chlorinated chemicals sector at a rate of 1.5%/y. These declines will be offset by an anticipated growth in the PVC sector, in which sales of chlorine will register an annual increase of 4%-5% up to 1994.

Meanwhile, the demand for chlorine's coproduct, caustic soda or sodium hydroxide, is forecast to be strong in the pulp and paper, detergents and pH control sectors. Consumption of caustic soda is projected to increase 1.0%-2.5%/y up to 1994. The market will likely remain firm as new capacities are installed in the growing bleached chemothermomechanical pulp (BCTMP) segment in Canada. A serious imbalance between caustic soda and chlorine demands should force many caustic soda consumers to look for alternatives, such as calcined trona or sodium carbonate for use in BCTMP mills, or to reduce its consumption rate as in Kraft mills.

The substitution rate in the conversion of bleaching processes away from chlorine will accelerate as more stringent government regulations are announced. The conversion rate, targeted at 50% by many pulp mills, will probably reach 70%-80% within the next five years and trigger a favourable market for sodium chlorate. In North America, the consumption of sodium chlorate is forecast to grow at a rate of 11%/y up to 1994. Several expansions were announced or completed in Canada during 1990; the capacity of production for sodium chlorate will reach 1 004 000 t/y by 1992, a 35% increase over 1990. These increases will take place in western Canada (80%) and Quebec (20%). Overall, chloralkali plants in Canada are expected to operate at 75%-80% of capacity in 1991 due to reduced demand for chlorine. Further rationalization is expected in the North American chloralkali industry; some high-cost operations will likely shut down within the next three years. Up to 1995, the demand for salt in this sector should experience a small growth with the combination of flat chlorine sales and increasing sodium chlorate consumption.

The demand for salt in water treatment will remain strong in 1991, but at a lower rate than experienced in the last three years. A reduced growth rate is projected in anticipation of slowdowns in the cyclical housing sector. Sales of salt in the fisheries and food industries are expected to decline. Fish-processing plants have been facing adverse economic conditions and are projected to operate at reduced rates. The food industry will continue to reduce its salt requirements due to increasing public concern for lower sodium intake. Salt substitutes are expected to make sustained gains in this market.

Note: Information contained in this review was current as of mid-January 1991.

TARIFFS

Item No.	Description	Canada			United States
		MFN	GPT	USA	Canada
2501.00	Salt (including table salt and denatured salt) and pure sodium chloride, whether or not in aqueous solution; seawater				
2501.00.10	Table salt made by an admixture of other ingredients when containing 90% or more of pure sodium chloride	4%	2.5%	Free	Free
2501.00.90	Other	Free	Free	Free	Free

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, effective January 1, 1990.

TABLE 1. CANADA, SALT SHIPMENTS AND TRADE, 1989 AND 1990

Item No.		1989		1990p	
		(tonnes)	($000)	(tonnes)	($000)
Shipments					
	By type				
	Mined rock salt	7 447 694	157 813	7 454 149	166 939
	Fine vacuum salt	821 304	60 877	881 260	64 101
	Salt content of brines used or shipped	2 788 395	9 786	2 761 221	8 824
	Total	11 057 393	228 476	11 096 630	239 864
	By province				
	Nova Scotia	x	x	x	x
	New Brunswick	x	x	x	x
	Quebec	x	x	x	x
	Ontario	7 282 214	138 505	6 138 386	115 306
	Saskatchewan	311 615	17 597	408 948	20 422
	Alberta	1 425 548	17 189	1 354 455	16 085
	Total	11 057 393	228 476	11 096 630	239 864
Imports				(Jan.-Sept.)	
2501.00	Salt[1]				
	United States	1 842 380	29 764	1 221 948	22 653
	Mexico	342 503	3 324	237 856	2 451
	Chile	116 388	1 098	75 560	702
	Bahamas	25 230	466	19 368	338
	Japan	2 718	101	6 906	197
	Spain	22 550	423	8 220	174
	Other countries	9 046	309	36 981	680
	Total	2 360 815	35 485	1 606 839	27 195
	By province of clearance				
	Newfoundland	39 726	722	24 180	492
	Prince Edward Island	30	1	–	–
	Nova Scotia	13 845	299	42 824	431
	New Brunswick	6	...	555	61
	Quebec	558 931	8 145	309 100	4 693
	Ontario	1 086 923	17 169	744 806	14 283
	Manitoba	7 490	185	6 638	200
	Saskatchewan	2 005	127	3 790	156
	Alberta	24 783	842	19 703	672
	British Columbia	627 076	7 995	455 243	6 207
	Total	2 360 815	35 485	1 606 839	27 195
Exports					
2501.00	Salt[1]				
	United States	2 069 267	36 404	1 157 172	22 417
	St. Pierre and Miquelon	1 364	118	1 355	107
	Puerto Rico	21 993	91	–	–
	Other countries	44 697	312	1 494	211
	Total	2 137 321	36 925	1 160 021	22 735

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Includes table salt, pure sodium chloride and seawater salt.
p Preliminary; x Confidential; – Nil or not reported; ... Too small to be expressed.
Note: Totals may not add due to rounding.

TABLE 2. CANADA, SALIENT STATISTICS FROM SALT-PRODUCING AND BRINING OPERATIONS, 1988 AND 1989

Company	Location (Initial Production)	Annual Production Capacity	Shipments 1989p (1988)	Employment 1989p (1988)	Remarks
		(000 tonnes)			
Canadian Salt Company Limited, The	Pugwash, N.S. (1959)	1 200	n.a. n.a.	192b (196)	Rock salt mining to a depth of 305 m.
	Pugwash, N.S. (1962)	110	n.a. n.a.		Dissolving rock salt fines for vacuum pan evaporation.
	Îles-de-la-Madeleine, Que. (1982)	1 500	n.a. n.a.	174 (183)	Rock salt mining to a depth of up to 273 m.
	Ojibway, Ont. (1955)	2 500	n.a. n.a.	278 (216)	Rock salt mining at a depth of 300 m.
	Windsor, Ont. (1892)	150	n.a. n.a.	128 (129)	Brining, vacuum pan evaporation.
	Belle Plaine, Sask. (1969)	170	n.a. n.a.	43 (29)	Producing fine salt from by-product brine from nearby potash operation.
	Lindbergh, Alta. (1968)	140	n.a. n.a.	67 (68)	Brining, vacuum pan evaporation.
		5 770	4 856.1 (4 367.5)	882 (821)	
Dow Chemical Canada Inc.	Sarnia, Ont. (1950)	900	724.2 (902.0)	4a (4)	Brining to produce caustic soda and chlorine.
	Fort Sask., Alta. (1968)	1 400	1 280.0 (1 119.0)	3a (3)	Brining to produce caustic soda and chlorine.
		2 300	2 004.2 (2 021.0)	7a (7)	
General Chemical Canada Ltd.	Amherstburg, Ont. (1919)	690	676.4 (688.0)	8a (8)	Brining to produce sodium carbonate.
International Minerals & Chemical Corporation (Canada) Limited	Esterhazy, Sask. (1962)	120	106.0 (114.0)	3 (3)	By-product rock salt from potash mine for use in snow and ice control.
Potash Company of America division of Rio Algom Limited	Sussex, N.B. (1980)	450	490.0 (440.0)	29 (32)	Rock salt produced in association with potash for use in snow and ice control.
Saskatoon Chemicals - a division of Weyerhaeuser Canada Ltd.	Saskatoon, Sask. (1968)	70	65.0 (68.1)	5a (5)	Brining to produce caustic soda, chlorine and sodium chlorate.
Sifto Canada Inc.c	Nappan, N.S. (1947)	100	n.a. n.a.	80 (80)	Brining for vacuum pan evaporation.
	Goderich, Ont. (1959)	2 800	n.a. n.a.	335 (335)	Rock salt mining at a depth of 536 m.
	Goderich, Ont. (1880)	120	n.a. n.a.	67 (70)	Brining for vacuum pan evaporation.
	Unity, Sask. (1949)	180	n.a. n.a.	85 (85)	Brining, vacuum pan evaporation and fusion.
		3 200	3 246.0 (3 009.0)	567 (570)	
Total		**12 600**	**11 443.7 (10 707.6)**	**1 501 (1 446)**	

Sources: Mineral Policy Sector, Energy, Mines and Resources Canada, 1990; company surveys.
[a] Employment part of chemical complex; [b] Includes employment in brining operations at Pugwash; [c] Formerly Domtar Inc. Sifto Salt Division, sold during 1990; [p] Preliminary; n.a. Not available.

TABLE 3. CANADA, SALT SHIPMENTS AND TRADE, 1980-90

	Producers' Shipments					
	Mined Rock	Fine Vacuum	In Brine and Recovered in Chemical Operations	Total	Imports	Exports
	(tonnes)					
1980	4 507 416	781 428	2 134 010	7 422 854	1 151 203	1 637 601
1981	4 371 314	764 037	2 107 243	7 242 594	1 254 992	1 507 710
1982	5 223 073	773 086	1 944 172	7 940 331	1 526 879	1 721 893
1983	5 846 994	714 464	2 040 925	8 602 383	814 250	1 914 629
1984	7 030 664	754 675	2 450 060	10 235 399	1 053 217	2 530 038
1985	6 608 739	805 209	2 670 749	10 084 697	1 255 518	2 263 076
1986	6 867 287	815 044	2 649 515	10 331 846	1 328 298	2 502 518
1987	6 670 863	866 475	2 591 715	10 129 053	1 112 102	1 924 686
1988	7 126 762	783 368	2 777 050	10 687 180	1 202 219[r]	3 030 124[r]
1989	7 447 694	821 304	2 788 395	11 057 393	2 360 815	2 137 321
1990[p]	7 454 149	881 260	2 761 221	11 096 630	n.a.	n.a.

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[p] Preliminary; [r] Revised; n.a. Not available.

TABLE 4. CANADA, SALT PRODUCTION CAPACITY BY PLANT, 1985-90

Company and Location	Type of Salt[1]	1985	1986	1987	1988	1989	1990
				(000 t/y)			
Canadian Salt Company Limited, The							
Pugwash, Nova Scotia	RS	1 200	1 200	1 200	1 200	1 200	1 200
Pugwash, Nova Scotia	ES	110	110	110	110	110	110
Seleine, Quebec	RS	1 200	1 200	1 200	1 200	1 500	1 500
Ojibway, Ontario	RS	2 500	2 500	2 500	2 500	2 500	2 500
Windsor, Ontario	ES	150	150	150	150	150	150
Belle-Plaine, Saskatchewan	BES	170	170	170	170	170	170
Lindberg, Alberta	ES	140	140	140	140	140	140
Sifto Canada Inc.							
Nappan, Nova Scotia	ES	90	100	100	100	100	100
Goderich, Ontario	RS	2 800	2 800	2 800	2 800	2 800	2 800
Goderich, Ontario	ES	120	120	120	120	120	120
Unity, Saskatchewan	ES	180	180	180	180	180	180
Dow Chemical Canada Inc.							
Sarnia, Ontario	SB	790	800	830	900	900	900
Fort Saskatchewan, Alberta	SB	1 250	1 400	1 400	1 400	1 400	1 400
General Chemical Canada Ltd.							
Amherstburg, Ontario	SB	620	620	650	690	690	690
Potash Company of America							
Sussex, New Brunswick	BRS	500	500	500	450	450	450
International Minerals & Chemical Corporation (Canada) Limited							
Esterhazy, Saskatchewan	BRS	120	120	120	120	120	120
Saskatoon Chemicals							
Saskatoon, Saskatchewan	SB	70	70	70	70	70	70
Total		12 010	12 180	12 240	12 300	12 600	12 600

Source: Mineral Policy Sector, Energy, Mines and Resources Canada.
[1] RS Rock salt; BRS By-product rock salt from potash operations; ES Evaporated salt; BES Evaporated salt processed from salt brine recovered from potash operations; SB Salt brines.

TABLE 5. CANADIAN CHEMICAL PLANTS USING SALT AS A MAJOR RAW MATERIAL: DEVELOPMENTS AND PROJECTS IN 1990

Company	Location	Parent Company	Plant Location	Type of Cells	Products	Annual Capacity[r]	Remarks
						(tonnes)	
Albchem Industries Ltd.	Bruderheim, Alberta	Sherritt Gordon Limited, Vencap Equities Alberta Ltd., Alberta	Bruderheim, Alberta	metal	sodium chlorate	50 000	$45 million investment announced for new plant to come on stream early in 1991.
Albright & Wilson Americas Inc.	Islington, Ontario	Tenneco, Inc., Texas, U.S.A.	Buckingham, Quebec	metal	sodium chlorate	132 000	44 000 t/y expansion completed by end of 1990.
			Grande Prairie, Alberta	metal	sodium chlorate	45 000	A new grass-roots operation is planned for completion in the spring of 1992.
			Thunder Bay, Ontario	metal	sodium chlorate	53 000	
			North Vancouver, British Columbia	metal	sodium chlorate	72 000	A 20 000 t/y expansion is planned by mid-1991. Ultimately graphite will be eliminated.
Alby Chlorate Canada Inc.	Valleyfield, Quebec	Alby Klorat AB, Sweden; Olin Corp., U.S.A.	Valleyfield, Quebec	metal	sodium chlorate	105 000	60 000 t/y expansion completed by mid-1990. Olin Corp. (U.S.A.) sold interest to new owner.
B.C. Chemicals Ltd.	Prince George, British Columbia	B.C. Chemicals Ltd., Prince George, B.C.	Prince George, British Columbia	metal	sodium chlorate	34 000	The company announced plans to expand its capacity to 77 000 t/y by 1991.
Canadian Occidental Petroleum Ltd.	Calgary, Alberta	Occidental Petroleum Corporation, Los Angeles, CA, U.S.A.	Amherstburg, Ontario	metal	sodium chlorate	50 000	
			Brandon, Manitoba	metal	sodium chlorate	85 000	A multi-stage expansion was completed late in 1990.
			Bruderheim, Alberta	metal	sodium chlorate	50 000	A new $60 million plant is announced to be completed by mid-1991.
			Nanaimo, British Columbia	metal	sodium chlorate	16 000	8000 t/y expansion completed by mid-1990.
				diaphragm	caustic soda chlorine	31 000 28 000	Permanent shutdown during 1990.
			North Vancouver, British Columbia	diaphragm	caustic soda chlorine	155 000 141 000	
			Squamish, British Columbia	metal	sodium chlorate	11 000	
				mercury	caustic soda chlorine	75 000 68 000	
Canso Chemicals Limited	Abercrombie Point, Nova Scotia	C-I-L Inc., North York, Ontario	Abercrombie Point, Nova Scotia	mercury	caustic soda chlorine	20 000 18 000	

Dow Chemical Canada Inc.	Sarnia, Ontario	The Dow Chemical Company, Michigan, U.S.A.	Fort Saskatchewan, Alberta	diaphragm	caustic soda chlorine	524 000 476 000	
			Sarnia, Ontario	diaphragm	caustic soda chlorine	130 000 118 000	Permanent shutdown announced for the end of 1991.
				diaphragm	caustic soda chlorine	401 000 365 000	20% expansion to be completed by mid-1991.
Eka Nobel Canada Inc.	Magog, Quebec	Nobel Industries AB, Sweden	Magog, Quebec	metal	sodium chlorate	122 000	
General Chemical Canada Ltd.	Amherstburg, Ontario	General Chemical Corporation, Morristown, New Jersey, U.S.A.	Amherstburg, Ontario	metal	calcium chloride sodium carbonate	450 000 400 000	
Great Lakes Forest Products Limited	Thunder Bay, Ontario	Canadian Pacific Securities Limited Montreal, Quebec	Dryden, Ontario	membrane	caustic soda chlorine	16 000 14 500	
ICI Canada Inc.	Montreal, Quebec	Imperial Chemical Industries plc (ICI), England	Bécancour, Quebec	diaphragm	caustic soda chlorine	325 000 295 000	
			Cornwall, Ontario	mercury	caustic soda chlorine	38 500 35 000	
			Dalhousie, New Brunswick	metal	sodium chlorate	22 000	A new plant announced to be completed by end of 1991.
				mercury	caustic soda chlorine	31 000 28 000	
PPG Canada Inc. Industrial Chemical Division	Beauharnois, Quebec	PPG Industries, Inc. Pittsburgh, Penn., U.S.A.	Beauharnois, Quebec	metal	sodium chlorate	40 000	
				membrane	caustic soda chlorine	80 000 73 000	New membrane technology rose capacity by 20% in 1990.
St. Anne Chemicals Company Ltd.	Nackawic, New Brunswick	Parsons & Whittemore, Inc. New York, U.S.A.	Nackawic, New Brunswick	metal	sodium chlorate	10 000	Captive production. A 25% expansion is planned.
				membrane	caustic soda chlorine	10 000 9 000	Captive production.
Saskatoon Chemicals	Saskatoon, Saskatchewan	Weyerhaeuser Canada Ltd. Kamloops, B.C.	Saskatoon, Saskatchewan	metal	sodium chlorate	44 000	22 000 t/y expansion completed during 1990.
				membrane	caustic soda chlorine	36 000 33 000	

Sources: Mineral Policy Sector, Energy, Mines and Resources Canada; Chemicals Directorate and Investments, Department of Industry, Science and Technology Canada (Ottawa); December 1990.
r Revised.

TABLE 6. WORLD SALT PRODUCTION, 1985-89

Countries	1985[r]	1986[r]	1987[r]	1988[p]	1989[e]
			(000 tonnes)		
United States	35 470	33 300	33 140	34 770	35 290
China[e]	14 440	17 300	17 960	22 000	27 985
U.S.S.R.[e]	16 100	15 300	15 400	14 800	14 785
West Germany	13 080	13 100	13 465	13 605	13 100
Canada	10 085	10 330	10 125	10 690	11 140
India	9 880	10 120	9 900	9 200	8 985
France	7 110	7 080	7 840	7 910	8 040
United Kingdom	7 145	6 855	7 080	6 130	5 800
Mexico	6 470	6 200	6 390	7 190	7 650
Australia	5 835	6 130	6 485	6 975	7 350
Poland	4 860	5 420	6 165	5 700	5 700
Romania	5 020	5 355	5 395	5 400	4 990
Italy	3 745	4 010	4 265	4 370	4 385
Other	33 690	34 365	34 970	35 220	35 295
Total	172 930	174 865	178 580	183 960	190 495

Sources: Energy, Mines and Resources Canada; U.S. Bureau of Mines, 1989.
[p] Preliminary; [e] Estimated; [r] Revised.

Silica 1990

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SUMMARY

The consumption of silica sand by the glass container industry, which is the largest consumer of high-quality silica, continued to be affected negatively by the use of recycled glass waste and the use of lighter glass in vehicle construction. Competition from aluminum, paper and plastics also continued to erode markets traditionally belonging to glass containers.

Markets for the flat glass and fibreglass industry were slow due to a low level of activity in general in Canada, and high interest rates affecting car sales and the construction industry.

Demand for silicon carbide and foundry sand did not fare as well as last year because iron and steel activity was substantially reduced in Canada.

The sandblast industry continued to suffer from environmental pressures related to health hazards and competition from products such as olivine, garnet and nepheline syenite.

During the year, Unimin Corp. of Connecticut, United States, purchased all the operations of the Indusmin Division of Falconbridge Limited. The transaction included two silica mines (one in Ontario and one in Quebec); a silica refinery in Midland, Ontario; and the nepheline syenite operation at Nephton, Ontario. Unimin is the largest producer of silica sand in the United States and also processes other industrial minerals such as mica, dolomite and feldspar.

Unimin's largest shareholder is SCR-Sibelco SA of Belgium, which in turn is Europe's largest producer of industrial sand, including micronized silica, surface-treated silica, etc. Sibelco has quarries and factories in several countries of Europe.

The closure of Tenneco Canada Inc. in Newfoundland in 1989, a producer of elemental phosphorus that uses silica in its process, resulted in the permanent closure of Dunville Mining Company Limited, also located in Newfoundland.

SUPPLY

Newfoundland

The quartzite quarry at Villa Marie was closed during the summer of 1990 as a result of the permanent closure of Tenneco Canada Inc., a producer of elemental phosphorus.

Nova Scotia

Nova Scotia Sand and Gravel Limited produces a high-purity silica from sand deposits for a variety of uses such as sandblasting, glass, foundry sand and fracturing sand. The mine is located near Shubenacadie.

New Brunswick

Chaleur Silica Ltd. produces silica for use as a flux in Brunswick Mining and Smelting Corporation Limited's Belledune lead smelter for cement plants and as sandblasting material.

Sussex Silica Inc. mines a high-grade (+98% SiO_2) silica deposit near Sussex. The company produces lump silica and sand of various sizes. Lump silica and coarse-grained sand are used in the manufacture of silicon metal and silicon carbide in Quebec. The fine sand is used in sandblasting, as filter sand and decorative sand in the Maritimes, and as a flux for base-metal smelters.

Quebec

Unimin Canada Ltd., a subsidiary of Unimin Corp., is the largest producer (in terms of volume and value of production) of silica east of

Ontario. Silica is mined from a quartzite deposit at Saint Donat and from a sandstone deposit at Saint Canut. Silica from Saint Donat (capacity of 100 000 t/y) is refined at the Saint Canut plant near Montreal. Most silica produced by Unimin Limited originates from Saint Canut where the ore is crushed, screened and beneficiated by attrition scrubbing, flotation and magnetic separation. Production capacity of the Saint Canut plant is about 550 000 t/y of finished products. The major markets for Unimin products are the glass containers, flat glass, fibreglass and silicon carbide industries.

Uniquartz Inc. intends to mine a silica-rich sandstone deposit near St. Jean Vianney, about 30 km from Matane. The deposit is reported to contain more than 25 Mt of high-purity ore. Some lump ore has been sold on a trial basis in the past to European consumers for the production of ferroalloys. A feasibility study for the production of lump ore for the silicon and ferrosilicon industries, and high-purity silica sand for the glass, foundry and sandblast industries is under way.

Hogan Holdings Inc. (formerly Baskatong Quartz Inc.) produces lump high-purity silica from a quartzite deposit north of Saint Urbain. The silica is used mainly by SKW Canada Inc. at Bécancour for the production of ferrosilicon and silicon metal, and also by Elkem Métal Canada Inc. at Chicoutimi. Baskatong also produces high-purity silica from quartz vein deposits located at Lac Bouchette south of Lac Saint-Jean. This silica is sold almost exclusively to SKW for the production of ferrosilicon. At year-end, the company reported it had recently opened a new high-purity quartz vein deposit in the Eastern Townships of Quebec.

Loma Enterprises Ltd. of Beauport crushes and classifies the fines produced by SKW Canada Inc. for sale to the silicon carbide and sandblast industries.

Armand Sicotte & Sons Limited mines Potsdam sandstone at Sainte Clothilde, south of Montreal. Lump silica is used for the production of ferrosilicon, phosphorus and cement.

The Good Sand Company Ltd. mines silica sand and gravel at St. Joseph-du-Lac and at Ormstown. The material is used mainly for sandblasting, but also for fibreglass and foundries.

Temisca Exploration Inc. of St. Bruno-de-Guigues produces silica on a small scale for use in sylviculture, filtration, sandblasting, foundries and as traction sand. The company started the construction of a new plant that will increase capacity to some 50 000 t/y by mid-1991.

Société de Haute Technologie du Québec Inc. is scheduled to begin production of a 40 t/y high-quality synthetic (cultured) quartz-growing facility at Trois-Rivières, Quebec by mid-1991 at a cost of $7 million. Initially, very high-purity quartz will be imported from the United States and Brazil. Synthetic quartz is used as oscillators in communications equipment, computers, lasers, etc.

In mid-October, Glaverbec Inc. started the production of a 500 t/d flat glass plant near Quebec City. The plant is expected to consume approximately 100 000 t/y of silica.

Ontario

Unimin Canada Ltd. is the largest producer (in terms of volume and value of production) of silica west of Quebec, with a reported total capacity of about 550 000 t/y. Lump quartzite from Badgeley Island (capacity 150 000 t/y), north of Georgian Bay, is shipped by lake boat to Canadian destinations for the manufacture of ferrosilicon. The finer material produced by crushing is shipped to Midland (capacity 400 000 t/y), south of Georgian Bay, where it is further processed to a glass-grade silica sand and silica flour for ceramic and other uses.

Manitoba

Marine Transport Limited of Selkirk produces high-purity silica sand from a quarry on Black Island on Lake Winnipeg, some 130 km north of Selkirk. The silica sand, mined from a poorly consolidated white sandstone, is well rounded and suitable for use in foundries, glass, fibreglass, construction and as traction sand. The ore is washed, screened and dewatered at a plant on the island, and then shipped by barge to a processing plant at Selkirk on the Red River.

Inco Limited produces, from the Manasan quarry, a low-grade silica from an impure quartzite for its Thompson smelter. Production varies from year to year, depending on nickel production.

Saskatchewan

Hudson Bay Mining and Smelting Co., Limited (HBMS) produces smelter flux from two pits in the Amisk Lake area of northern Saskatchewan. The silica sand is used by HBMS at its Cu-Zn smelter in Flin Flon, Manitoba.

Alberta

Sil Silica, division of Clarepine Industries Inc., produces silica sand from local sand dunes in the Bruderheim area. Silica is sold mainly as fibreglass and sandblasting material. It is also sold as foundry sand, filtration sand, fracturing sand and as railway traction sand.

British Columbia

Mountain Minerals Co. Ltd. mines a high-purity, friable sandstone deposit near Golden. Rock is crushed, screened, washed, dried and separated into several sizes. These different sizes are sold for glass sand, sandblasting sand, foundry sand, filter media sand, golf course sand and fine sand.

TRADE

Most silica sand imported into Canada comes from loosely consolidated and easily processed sandstone or lake sand deposits located near the Great Lakes region of the United States in Illinois, Wisconsin, Michigan and Indiana. The imported silica sand is used mainly by iron and steel foundries and by the glass industry of Ontario and Quebec.

OUTLOOK

Little improvement is expected in 1991 in Canada in the container glass industry. In the longer term, environmental concerns and the disposal problems posed by plastic containers should encourage a greater use of glass containers which are easier to recycle. However, the glass container industry is under increased pressure to increase recycling which will likely mean a reduction in the consumption of industrial minerals.

Markets for the flat glass and fibreglass industries are not expected to improve as long as the economy remains weak.

In the long term, competition from U.S. producers of silica for glass and foundry sand will remain strong in Ontario and Quebec because of the proximity of these provinces to the low-cost producers of the Great Lakes region in the United States. Also, due to the downsizing of passenger cars and the recycling of silica sand at foundries, no growth can be expected in the foundry sand industry in Canada. Competition from substitutes for glass containers such as paper, plastics and aluminum will remain strong across Canada. Sandblasting will continue to decline as a result of tighter environmental controls and substitution. The filler market is still very small, but its growth will continue to be strong.

OPPORTUNITIES

Higher value silica products could be produced in Canada because of the low cost of electricity in certain parts of the country. Such products include:

a) cultured quartz for the production of oscillators used in the electronics industry;
b) raw vitreous silica (minimum 99.8% SiO_2) and manufactured products of vitreous silica for the chemical industry, etc.;
c) refined silicon carbide for advanced ceramics;
d) monocrystalline silicon for the production of silicon chips;
e) high-purity ground silica (minimum 99.5% SiO_2; 2 to 20 microns) for use as an abrasive for metal polishes, cleansers, fillers in plastics, rubber, etc.; and
f) chemical-grade silicon metal for the production of silicones.

With the exception of a cultured quartz facility being built in Quebec, none of these products are yet manufactured in Canada.

Also, there are potential opportunities for:

g) an integrated silicon carbide plant in western Canada, based on local raw materials and inexpensive electricity;
h) a new reinforcement fibreglass plant (in Canada there is only one plant in Ontario);
i) the production of silicones[1] by reacting silicon metal powder with methyl chloride;
j) fused silica[1] from the hydrolysis of silicon tetrachloride[2] in a flame of hydrogen and oxygen for use as a thickening agent in inks, paints, cosmetics, rubber, etc., and specialty coatings such as powder coatings, etc.; and
k) precipitated silica and silica gel[1] by reacting sodium silicate with sulphuric acid (the products are used for reinforcing rubber, extenders in paints, fillers in inks, thickening and polishing agents in toothpastes, etc.).

REFERENCES

1 No production facility yet exists in Canada, although most raw materials are available.

2 Produced through the chlorination of silicon metal or silica.

Note: Information contained in this review was current as of mid-January 1991.

TABLE 1. CANADA, SILICA PRODUCTION AND TRADE, 1989 AND 1990

Item No.		1989		1990p	
		(tonnes)	($000)	(tonnes)	($000)
Production (shipments)					
	By province				
	Quebec	905 619	18 119	..	..
	Ontario	916 456	10 367	..	..
	Manitoba	406 595	4 601	..	..
	British Columbia	50 000	1 654	..	..
	Nova Scotia	22 800	1 371	..	..
	New Brunswick	18 241	503	..	..
	Newfoundland	9 180	43	..	..
	Saskatchewan	3 309	16	..	..
	Alberta	–	–	..	..
	Total	2 332 200	36 674	..	..
Imports[1]				(Jan.-Sept.)	
2505.10	Silica sands and quartz sands				
	United States	654 185	15 997	667 749	13 545
	United Kingdom	58	26	124	94
	Other countries	228	128	180	108
	Total	654 473	16 157	668 055	13 749
2506.10	Quartz (other than natural sands)				
	United States	5 451	372	4 279	286
	Brazil	1 029	76	102	6
	Total	6 480	449	4 381	292
2506.21	Quartzite crude or roughly trimmed				
	United States	1 496	153	737	85
	Total	1 496	153	737	85
2506.29	Quartzite n.e.s.				
	United States	2 211	183	913	51
	Brazil	39	5	–	–
	Total	2 250	189	913	51
2811.22	Silicon dioxide				
	United States	9 883	17 794	7 513	14 173
	West Germany	1 562	4 779	1 244	4 068
	Other countries	773	1 040	483	628
	Total	12 218	23 623	9 240	18 872
Exports					
2505.10	Silica sands and quartz sands				
	United States	8 196	588	111 817	813
	Bahamas	–	–	800	166
	Other countries	396	102	449	189
	Total	8 592	693	120 266	1 172
2506.10	Quartz (other than natural sands)				
	United States	10 850	57	3	6
	Other countries	75	3	–	–
	Total	10 925	61	3	6
2506.21	Quartzite crude or roughly trimmed				
	United States	24 854	121	45	8
	Total	24 854	121	45	8
2506.29	Quartzite n.e.s.				
	United States	5 400	65	23	3
	Total	5 400	65	23	3
2811.22	Silicon dioxide				
	United States	123	65	754	129
	Other countries	9	25	–	–
	Total	132	92	754	129

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Includes sand for use in foundries and glass manufacturing, ground and flour sand, volatized and silica flue dust.
p Preliminary; .. Not available; n.e.s. Not elsewhere specified; – Nil.
Note: Numbers may not add to totals due to rounding.

TABLE 2. IMPORTS OF SILICA SAND (FROM UNITED STATES) BY PROVINCE AND BY USE, 1989

	Foundry		Glass Manufacturing	
	(tonnes)	($000)	(tonnes)	($000)
Newfoundland	–	–	–	–
Nova Scotia	155	7	–	–
Prince Edward Island	–	–	–	–
New Brunswick	105	8	–	–
Quebec	18 016	679	22 031	222
Ontario	264 157	5 311	131 537	1 305
Manitoba	1 592	124	–	–
Saskatchewan	29	31	–	–
Alberta	1 093	44	–	–
British Columbia	31 064	965	773	32
Total	316 215	7 172	154 342	1 559

Sources: Statistics Canada; Energy, Mines and Resources Canada.
– Nil.
Note: Totals may not add due to rounding.

TABLE 3. CANADA, SILICA CONSUMPTION,[1] 1988 AND 1989

	1988	1989p
	(tonnes)	
Lump	1 057 994	1 145 320
Sand	2 101 497	1 950 878
Flour	60 920	55 239
Total	3 220 411	3 151 437

Source: Energy, Mines and Resources Canada.
1 Available data, as reported by consumers.
p Preliminary.

TABLE 4. FLAT GLASS AND CONTAINER GLASS MANUFACTURING PLANTS IN CANADA

Company	Plant Location	Type of Glass
PPG Canada Inc.	Owen Sound, Ontario	Flat
AFG Glass Inc.	Scarborough, Ontario	Flat
Glaverbec Inc.	St. Augustin, Quebec	Flat
Consumers Glass a division of Consumers Packaging Inc.	Scoudouc, New Brunswick	Containers
	Pointe-St-Charles, Quebec	Containers
	Candiac, Quebec	Containers
	Etobicoke, Ontario	Containers
	Milton, Ontario	Containers
	Brampton, Ontario	Containers
	Hamilton, Ontario	Containers
	Lavington, British Columbia	Containers

Source: Energy, Mines and Resources Canada.

TABLE 5. TYPICAL BATCH FORMULATIONS FOR FLAT GLASS, GLASS CONTAINERS AND FIBREGLASS

Raw Materials	Percent by Weight	Source of
Flat glass[1]		
Silica sand	60	SiO_2
High calcium limestone	4	CaO
Dolomitic limestone	15	MgO and CaO
Soda ash	20	Na_2O
Salt cake or gypsum	0.5	Na_2O,CaO and SO_3
Rouge	0.5	Fe Colorant
Glass containers[2]		
Silica sand	60	SiO_2
Limestone	14-18	CaO,MgO
Soda ash	19	Na_2O
Alumina source (feldspar, nepheline syenite or aplite)	4-5	Al_2O_3,Na_2O,SiO_2
Others		
Gypsum and/or barite	1	SO_3,BaO
Fibreglass		
Insulating fibre[3]		
Silica	40	SiO_2
Soda ash	10	Na_2O
Feldspar or nepheline syenite	20	Al_2O_3,Na_2O,SiO_2
Borax or ulexite	15	B_2O_3
Dolomite or limestone	15	MgO,CaO
Reinforcing fibre[4]		
Silica	28-30	SiO_2
Boric acid	8-11	B_2O_3
Colemanite	11-17	CaO.B_2O_3
Kaolin	26-28	Al_2O_3,SiO_2
Limestone or dolomite	28-31	CaO,MgO
Soda ash	0-1	Na_2O

Source: Energy, Mines and Resources Canada compiled data obtained from: [1] LOF Glass Company, Toledo, Ohio. [2] Brockway Inc., Brockway, Pennsylvania. [3] Fiberglas Canada Inc. [4] PPG Canada Inc.

TABLE 6. FIBREGLASS PLANTS IN CANADA

Company	Plant Location	Type of Fibre
Fiberglas Canada Inc.	Candiac, Quebec	Insulating
	Markham, Ontario	Insulating
	Sarnia, Ontario	Insulating
	Edmonton, Alberta	Insulating
Manson Insulation Inc.	Brossard, Quebec	Insulating
	Scarborough, Ontario	Insulating
Manville Canada Inc.	Innisfail, Alberta	Insulating
Graham Fiber Glass Limited	Erin, Ontario	Insulating
Ottawa Fiber Inc.	Ottawa, Ontario	Insulating
Fiberglas Canada Inc.	Guelph, Ontario	Reinforcing

Source: Energy, Mines and Resources Canada.

TABLE 7. CANADA, REPORTED CONSUMPTION[1] OF SILICA, BY INDUSTRIES, 1988 AND 1989

	1988	1989p
	(tonnes)	
Primary glass and glass containers, and glass fibre wool and glass fibre	865 614	753 091
Nonferrous smelting and refining	623 285	814 820
Foundries	414 899	400 612
Chemicals	211 197	132 245
Abrasives	131 236	132 222
Other products[2]	974 180	918 447
Total	3 220 411	3 151 437

[1] Available data, as reported by consumers. [2] Includes asbestos products, asphalt roofing products, cement, ceramic products, structural clay products, cleansers, fertilizers, paint and varnish, pulp and paper and products, refractory brick, rubber products, ferroalloys, primary steel and other miscellaneous products.
p Preliminary.

Silver 1990

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The silver market weakened in 1990 as prices declined due to a combination of soft investment and industrial demand, and increased by-product production. It is estimated that over 60% of world silver output is produced as a by-product or coproduct of base-metal and gold mining. During 1990, the London silver price dropped to an average of US$4.83/oz from $5.50 in 1989 and $6.51 in 1988.

CANADIAN DEVELOPMENTS

Canadian silver production rose in 1990 to 1399 t from 1312 t the previous year, in spite of a substantial reduction in output by two of Canada's largest by-product silver producers, Brunswick Mining and Smelting Corporation Limited at Bathurst, New Brunswick, and Cominco Ltd. at Kimberley, British Columbia. Although output increased, the value of production declined to $256 million from $275 million in 1989.

Production in New Brunswick fell to about 115 t, which was 40% lower than in 1989. The reduction in output was largely a result of the continuing strike at Brunswick Mining and Smelting's Bathurst operations, where 1100 miners and 470 smelter employees walked out July 1 and July 21, respectively. The principal strike issues included higher wages and protection against contracting out. In December, the company retracted its latest offer after it was rejected by union members, and announced that production would continue at 25% of capacity with salaried personnel until March 1991.

NovaGold Resources Inc. opened its Murray Brook gold-silver mine in New Brunswick in September 1989. The vat leach operation, which processes 1300 t/d of ore, had produced 3350 kg of silver to the end of 1990.

Silver production in British Columbia increased by 25% to 623 t in 1990. The major increase came from the Samatosum mine owned by Minnova Inc. and Rea Gold Corporation, near Kamloops. The mine completed its first full year of operation in 1990 and is estimated to have produced 133 t of silver, which is almost three times the 1989 level. Minnova plans to extend the life of the mine through 1993 by proving up 210 000 t of underground reserves. Definition drilling, from a 200-m adit, commenced in November and is targeted for completion in early 1991.

The temporary suspension of operations at Cominco Ltd.'s Sullivan mine in Kimberley, British Columbia resulted in a major loss in production. The mine closed in January due to rising production costs and did not resume output until November, after completion of an $11 million development program.

Silver output during 1990 at Canada's largest silver producer, the Equity Silver mine in British Columbia, is estimated at 212 t, essentially unchanged from 1989. Production will decline in 1991 and the mine is scheduled to close in 1992 due to an exhaustion of ore reserves. Equity Silver Mines Limited and the Government of British Columbia are discussing the level of funding required to meet post-closure reclamation costs. The company has deposited $21 million towards reclamation and will provide an additional $10 million in 1991.

Denver-based Min Ven Gold Corporation closed its Blackdome mine near Clinton, British Columbia, in January 1991 when reserves were exhausted. The operation produced about 3.7 t of silver during 1990.

Teck Corporation's Beaverdell silver mine, located east of Kelowna, British Columbia, is scheduled to close on February 28, 1991, after 90 years of continuous operation. Low silver prices and declining head grades are responsible for the closure of the 36 000 t/y underground operation.

Silver

Treminco Resources Ltd. acquired 100% ownership of the Sandon mine, located east of New Denver, British Columbia, from Dickenson Mines Limited in November 1989. The company reduced its per-unit production cost at the 39-employee operation from $135/t to below $100/t, through rationalization and extending mill operations to a seven-day week. There were 29 000 t of ore milled in 1990 and 13 996 kg of silver in lead-zinc concentrate produced. Reserves, as of October, were estimated at 38 000 t grading 325.7 g/t silver, 3.76% lead and 6.85% zinc.

Cheni Gold Mines Inc. downgraded the Cliff Creek zone's reserves at its Lawyers mine in British Columbia after additional work indicated mineralization to be erratic within a relatively tight structure. The revised estimate of probable reserves was 422 700 t grading 264.0 g/t silver and 6.5 g/t gold. Possible reserves were 103 400 t grading 267.4 g/t silver and 5.8 g/t gold.

Underground exploration confirmed the high grade nature of the 21B polymetallic deposit at Prime Resources Group Inc.'s and Corona Corporation's equally owned Eskay Creek property north of Stewart, British Columbia. A feasibility study is planned for 1991, with preliminary reserves estimated at 3.96 Mt grading 998.4 g/t silver and 26.4 g/t gold.

Significant mineralization was encountered immediately south of the Eskay Creek property on the SIB claim group owned by Silver Butte Resources Ltd. and American Fibre Corporation. Exploration drilling of a coincident geophysical and soil geochemical anomaly intersected 14.3 m grading 1059.8 g/t silver and 14.4 g/t gold.

Silver production in the Yukon increased by 19% over 1989 to 84.5 t. Yukon production is expected to increase again in 1991 when Curragh Resources Inc. and its 20% partner, Hillsborough Resources Limited, bring the 90 000 t/y Mt. Hundere mine on stream. Reserves are estimated at 5.1 Mt grading 65 g/t silver, 12.6% zinc and 4.7% lead.

Canadian silver production is expected to decline substantially over the next few years as reserves are exhausted at various mines, particularly in British Columbia. However, the level of production is expected to recover slowly over the longer term as new base-metal prospects are developed. Examples include: Aur Resources Inc.'s Louvicourt deposit, Audrey Resources Inc.'s new C lense at the Mobrun mine and the new 97 zone at VSM Exploration Inc.'s and Serem Quebec Inc.'s Grevet Zinc property, all in Quebec; Minnova Inc.'s Winston Lake mine in Ontario, where deep drilling has intersected significant base-metal mineralization containing silver; and Placer Dome Inc.'s Mt. Milligan property in British Columbia.

WORLD DEVELOPMENTS

According to the Silver Institute, world silver mine production was estimated at 14 400 t in 1990 compared to 13 723 t in 1989. The largest producing nations are Mexico, the United States, Peru, the U.S.S.R., Canada, Australia and Poland.

The Mexican government in 1990 commenced free trade discussions with the United States and initiated a more favourable climate for foreign investment. A more liberal mining code was established, which permits up to 100% foreign ownership in mining properties and opens portions of previously protected land to exploration. Japan's Metal Mining Agency has already taken advantage of the new system by signing an investment agreement with Mexico's Comisión de Formento Minero to develop a pilot bioleaching gold-silver plant in Mexico.

Bolivia, like Mexico, plans to attract and increase foreign investment by revamping its mining code. The new code will allow foreign investment for exploration in areas previously reserved for national mining interests only. In December, it was reported that Empresa Minera Inti Raymi S.A., owned by Battle Mountain Gold Co. (85%) and Zealand Corporation (15%), plans to develop the Kori Kollo deposit in 1991. The company expects to produce about 19 t/y of silver from an open-pit operation. Mineable reserves are reported at 50 Mt of sulphide ore and 5.2 Mt of oxide ore, with a combined grade of 2.3 g/t gold and 15.1 g/t silver.

Silver production in Peru continued to be adversely affected during 1990 by strikes, economic slowdowns and electricity shortages due to drought and sabotage.

In June, leftist guerrillas sabotaged Empresa Minera del Centro del Perú S.A.'s (Centromin Perú S.A.) Casapalca mine near La Oroya. The operations returned to full capacity in July after repairs were completed to the three oxygen compressors that had been bombed.

Workers walked out for four days during October at Centromin Perú S.A.'s La Oroya refinery, 150 km east of Lima, Peru. Employees were demanding wage increases at the same rate as the rapidly rising inflation. The plant produced 606.5 t of silver in 1989.

Also in October, the Peruvian government introduced a Silver Deposit Certificate Plan. The new strategy is aimed at reducing the quantity of silver entering the market, with the ultimate goal of stabilizing its price. The plan calls for producers to deposit their silver at local banks in return for a silver certificate that is valued at the sale price quoted by the Central Reserve Bank. Certificates can be redeemed at any time by delivery of the silver from the bank holding it. Previous attempts by the government to stabilize the price failed.

Although statistics are not yet available, it is expected that silver production in the United States rose in 1990, as a result of additional by-product output from gold-silver operations in Nevada and the commencement of Cominco Ltd.'s Red Dog lead-zinc-silver mine in Alaska. Red Dog shipped its first concentrates in July.

Pressure increased from the U.S. Department of Defense to sell silver from its stockpile, with a view to purchasing more strategic metals with the proceeds. The stockpile's silver reserves are presently being reduced through annual coin programs. Approximately 1400 t of silver have been used for coinage since 1986. It was estimated that the stockpile contained 3.1 Mt of silver in mid-1990.

In July, the U.S. Defense Logistics Agency completed its fourth and final auction of the allotted 77.76 t of Mint silver stocks, which were up for sale during the 1990 fiscal year. Another 77.76 t of treasury stocks are required by law to be sold during the 1991 fiscal year starting October 1, 1990. Revenue from the sales is to be used to reduce the federal deficit. Controversy has arisen over the sales as silver producers want the government to deplete its reserves through existing or new coin programs, rather than by direct sale on an already over-supplied market.

The American Eagle silver coin program in the United States is proving to be highly successful. In the first nine months, 141.8 t of silver were used to mint the coins.

Also in the United States, the Greens Creek mine in Alaska completed its first full year of production in 1990. The mine is owned by Hecla Mining Company, Kennecott Corporation, Exalas Resources Inc. and CSX Corporation. Silver output during the first nine months was reported at 140.42 t, up 4% from the same period last year. The average cash cost of production is reported at US$2/oz.

Low silver prices were responsible for the closure of part of Hecla Mining Company's Lucky Friday mine during the latter part of 1990. Operating costs at the mine were reported as US$4.00-$4.50/oz of silver.

In October, Nerco Inc. announced the suspension of operations at its Candelaria mine in Nevada due to depressed silver prices. Mine production for 1990 is estimated at 137 t silver and 435 kg gold.

Elsewhere in the world, Billiton International Metals B.V. began development of its Wetar Island silver mine in Indonesia during 1990. The mine is expected to produce about 25 t/y of silver and 1.7 t/y of gold.

Also in Indonesia, the Freeport-McMoRan Copper Company, Inc. increased proven reserves by 107 Mt at its 12 000 t/d Grasberg open-pit mine in Irian Jaya. Reserves now stand at 267 Mt grading 1.47% copper, 1.69 g/t gold and 2.64 g/t silver.

In Chile, the La Coipa operation owned by Placer Dome Inc. and Consolidated TVX Mining Corporation completed its first full year of production. Compania Minera Mantos de Oro is operator of the mine, which commenced production with a 1000 t/d mill in June 1989. Construction of the Stage 2, 15 000 t/d mill began in September 1990 with start-up expected during the first half of 1991. The property hosts three deposits, mineable by open-pit methods, with reserves of 51.5 Mt grading 1.6 g/t gold and 65 g/t silver using a cut-off of 0.9 g/t gold for the Ladera and Farellon deposits, and 9.2 Mt grading 0.19 g/t gold and 172 g/t silver using a 0.12 g/t gold cut-off for the Coipa Norte deposit. Recoveries during the first five years of the projected 12-year mine life are expected to be 85% for gold and 80% for silver.

In July, Engelhard Corporation announced that acceptable terms could not be reached over the sale of its worldwide gold and silver operations to Degussa AG. However, the company indicated that it would sell its North American electrical contacts, metal-joining and jewellery facilities in the near future.

CONSUMPTION AND USES

The major industrial uses for silver are in photographic materials, electrical and electronic products, sterling and electroplated ware, jewellery and brazing alloys and solders.

Despite the fact that developments in photographic technology and an increase in recycling have drastically reduced silver requirements for this application, photography has continued to be the most important industrial market for the metal. Overall consumption in 1989 was reported at 5785 t. One of the largest single photographic applications, accounting for about 40% of total consumption, is in the production of X-ray films. In view of increasing worldwide concern for human health, the use of X-ray film is expected to grow at an average annual rate of about 4% during the early 1990s.

It is estimated that silver consumption in the photographic industry will exceed 7100 t in 1995, an increase of approximately 22% over 1989. New camera designs and greater access to film development are considered to be two aspects which will facilitate growth in this sector. Automatic 35-mm cameras are increasing in popularity and the disposable camera market is reported to be growing rapidly, with 20 million sold in Japan in 1989. Also promoting the use of film is the mini-lab. These very efficient, automated units can be established in areas with low demand for film development at a relatively small investment. There were estimated to be 17 000 mini-labs in the United States in 1989, with 50 000-60 000 operating worldwide.

The second largest market for silver, representing about 25% of industrial consumption in the United States, is in contact and conductor products for the electrical and electronics industries. While these industries have grown in importance, silver consumption in this area has remained relatively constant due to improvements in utilization technologies and miniaturization.

It was reported at the end of 1989 that the U.S. Navy was testing a new silver-iron battery for undersea vehicles. The new battery, patented by Westinghouse Electric Corporation, offers a significantly longer shelf life, quicker rechargeability and the capability to withstand more abuse than competing products.

Another promising new use is in a silver alloy coating for the bottom of microwaveable cookware, which allows for the browning or crisping of food surfaces.

One growing market for silver is its use in utility power generation. Luz International has constructed a number of solar-electric power plants in Southern California that use banks of silver-coated mirrors to capture the sun's energy. The company expects to complete five more plants by 1994. The new plants will serve the residential electrical demands of 810 000 people and will subsequently reduce oil imports by more than 3 million barrels annually. It is estimated that 2488 kg of silver will be used to coat the project's 650 000 mirrors. The company's newest plant is reported to generate power at a cost of US8¢/kW, which is considered to be competitive with other power systems.

The use of silver in the production of coinage has been one of the fastest growing markets for the metal in recent years. In 1989, this included 818 t used in the minting of 317 coinages in 66 different nations. Two of the largest selling bullion coins are the one-ounce American Silver Eagle and the Canadian "Maple Leaf." The Royal Canadian Mint reported that sales of its "Maple Leaf" coin in 1989 totalled 3.25 million ounces. American Eagle sales in 1989 were reported to be over 5.8 million ounces.

In 1990, Canada introduced the world's first cameo coins as part of a new silver coin aviation series called "Pioneers in Powered Flight: 1900 to 1949." Ten 31-g coins containing 92.5% sterling silver, and having a 24-karat gold-covered cameo, will commemorate the first 50 years of powered flight in Canada. These limited-edition coins will be introduced in pairs over the next five years. Other coin programs include China's Panda silver coin, Australia's first silver bullion coin called the Kookaburra, and the new commemorative silver coin honouring Japan's modern court and parliamentary system. Japan issued 10 million of the new coins during the last quarter of 1990. Each coin weighs 15 g and has a face value of 5000 yen.

With little prospect of significantly higher prices in the near term, investment demand for silver bullion during 1990 remained depressed. In 1989, private stocks of investment bullion declined by 1642 t to 27 528 t.

MARKETS, PRICES AND STOCKS

While silver is traded in the major financial centres around the world, the London Silver Market, part of the London Bullion Market Association, is the most important of the physical markets. In June 1989, the London Metal Exchange discontinued its silver contract due to low trading volumes. The most important futures market is the Commodities Exchange, Inc. (COMEX) in New York.

The London silver price declined steadily during 1990 from a monthly average high of US$5.25 in January to a low of $4.08 in December. The metal broke the $4.00 barrier and fell to $3.95 in mid-December.

Handy & Harman reported world stocks of silver bullion at the end of 1989 at 47 600 t. This included over 38 800 t of private investment stocks and almost 8700 t held by governments, principally the United States, Mexico, India and Peru. At the end of 1990, COMEX stocks were reported at over 8250 t compared to 7500 t at the beginning of January.

The possibility of significant sales of the large silver stocks held by governments has continued to exert a negative influence on the silver market. While the reduction of the large U.S. stockpile through coin and bullion sales has been fairly limited to date, large disposals by the United States or other governments, such as Peru, remain a concern.

OUTLOOK

Canadian silver production is expected to decline substantially over the next few years as currently outlined reserves are exhausted and mines close in British Columbia. However, the level of production is expected to recover slowly over the longer term as new base-metal mines come on stream, which will increase by-product silver production.

Silver, like gold, has the good fortune of being used for both investment and industrial purposes. Unfortunately, supplies of silver have been increasing steadily, but involuntarily, from both base-metal and gold mines, and this has exerted downward pressure on prices.

The price of silver is expected to remain depressed and fluctuate in the $3.50-$4.50 range during 1991 as supplies continue to rise and demand remains soft.

The long-term outlook for silver is mixed. It is anticipated that any decrease in supply resulting from mine closures due to low metal prices will be short-lived as a steady growth in base-metal demand is predicted over the long term. Therefore, oversupply is expected to continue to place downward pressure on prices in the future. However, if the metal value remains low, industrial demand may increase as silver becomes a more attractive substitute in various uses, such as in certain electrical applications. The long-term forecast for the price of silver is in a range between $4.00 and $5.50/oz.

Note: Information contained in this review was current as of mid-January 1991.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EEC MFN	Japan[1] MFN
2616.10	Silver ores and concentrates	Free	Free	Free	Free	Free	Free
71.06	Silver (including silver plated with gold or platinum), unwrought or in semi-manufactured forms, or in powder form						
7106.10	Powder						
7106.10.10	Containing by weight 92.5% or more of silver	4%	Free	Free	Free	3.8%	2%
7106.10.20	Containing by weight less than 92.5% of silver	10.2%	6.5%	Free	Free	3.8%	2%
7106.91	Unwrought						
7106.91.10	Containing by weight 92.5% or more of silver	Free	Free	Free	Free-3.6%	Free	2.5%
7106.91.20	Containing by weight less than 92.5% of silver	10.2%	6.5%	4%	Free-3.6%	Free	2.5%
7106.92	Semi-manufactured						
	Containing by weight 92.5% or more of silver						
7106.92.11	In bars, sheets or plates	Free	Free	Free	3.6%	3.8%	2.5%-5.8%
7106.92.19	Other	11%	7%	4.4%	3.6%	3.8%	2.5%-5.8%
	Containing by weight less than 92.5% of silver						
7106.92.21	Containing by weight 50% or more of copper	4%	2.5%	1.6%	3.6%	1.8%	2.5%-5.8%
7106.92.22	Containing by weight less than 50% of copper	10.2%	6.5%	4%	3.6%	1.8%	2.5%-5.8%
7107.00	Base metals clad with silver, not further worked than semi-manufactured	10.2%	6.5%	4%	3.9%	1.8%	5.8%

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, effective January 1, 1990; Official Journal of the European Communities, Vol. 33, No. L247, 1990, "Conventional" column; Customs Tariff Schedules of Japan, 1990.
[1] GATT rate is shown; lower tariff rates may apply circumstantially.

TABLE 1. CANADA, SILVER PRODUCTION AND TRADE, 1989 AND 1990

Item No.		1989		1990p	
		(kilograms)		(kilograms)	
Production (shipments)[1]					
	Newfoundland	x		x	
	Prince Edward Island	–		–	
	Nova Scotia	x		x	
	New Brunswick	191 381		114 744	
	Quebec	147 804		146 210	
	Ontario	348 528		366 524	
	Manitoba	36 205		34 113	
	Saskatchewan	x		x	
	Alberta	–		–	
	British Columbia	498 013		622 749	
	Yukon	70 944		84 474	
	Northwest Territories	18 246		29 265	
	Total	1 312 433		1 399 572	
	Total value ($000)	274 737		255 588	
				(Jan.-Sept.)	
		(kilograms)	($000)	(kilograms)	($000)
Exports					
2603.00	Copper ores and concentrates				
2603.00.81	Silver content	384 904	67 382	385 516	61 019
2607.00	Lead ores and concentrates				
2607.00.81	Silver content	75 114	11 761	66 381	16 254
2608.00	Zinc ores and concentrates				
2608.00.81	Silver content	35 043	4 272	13 095	1 420
2616.10	Silver ores and concentrates				
2616.10.81	Silver content				
	West Germany	2 802	1 392	1 576	314
	United Kingdom	–	–	6	2
	Japan	446	90	–	–
	Belgium	423	95	–	–
	Total	3 671	1 577	1 582	317
2616.90	Precious metal ores and concentrates, n.e.s.				
2616.90.81	Silver content	37 409	142 006	34 224	6 846
71.06	Silver (including silver plated with gold or platinum), unwrought or in semi-manufactured forms, or in powder form				
7106.10	Powder	397	29	454	89
	Other				
7106.91	Unwrought	940 673	200 604	926 609	181 573
7106.92	Semi-manufactured	81 453	17 569	6 266	1 466
7107.00	Base metals clad with silver, not further worked than semi-manufactured	1 038	239	–	–
Imports					
2603.00.00	Copper ores and concentrates				
2603.00.00.81	Silver content	9 301	1 667	3 732	707
2607.00.00	Lead ores and concentrates				
2607.00.00.81	Silver content	158 330	30 043	192 694	15 167
2608.00	Zinc ores and concentrates				
2608.00.00.81	Silver content	22 199	2 438	45 571	7 597

TABLE 1 (cont'd)

Item No.		1989		Jan.-Sept. 1990p	
		(kilograms)		(kilograms)	
Imports (cont'd)					
2616.10	Silver ores and concentrates				
2616.10.00.81	Silver content				
	United States	469	156	10 341	1 458
	Peru	–	–	24 105	3 580
	Portugal	371	89	–	–
	Total	840	245	34 446	5 039
71.06	Silver (including silver plated with gold or platinum), unwrought or in semi-manufactured forms, or in powder form				
71.06.10	Powder	4 542	1 134	3 487	781
	Other				
7106.91	Unwrought	83 918	17 898	80 566	15 993
7106.92	Semi-manufactured	142 451	14 790	8 401	1 740
7107.00	Base metals clad with silver, not further worked than semi-manufactured	26 009	1 117	3 992	329

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Includes recoverable silver in ores, concentrates and matte shipped for export; crude gold bullion produced; blister and anode copper produced at Canadian smelters; and base and other bullion produced from domestic ores.
p Preliminary; – Nil; x Confidential; n.e.s. Not elsewhere specified.

TABLE 2. CANADA, SILVER PRODUCTION, TRADE[1] AND CONSUMPTION, 1975, 1980 AND 1983-90

	Production[2]	Exports: In Ores and Concentrates	Exports: Refined Silver	Exports: Total	Imports Refined Silver	Consumption[3] Refined Silver
	(kilograms)					
1975	1 234 642	471 410	713 566	1 184 976	420 078	642 089
1980	1 070 000	396 690	881 761	1 278 451	339 180	265 938
1983	1 197 031	439 406	1 045 867	1 485 273	339 439	283 349
1984	1 326 720	423 963	1 081 391	1 505 354	215 192	299 440
1985	1 197 072	338 834	1 325 694	1 664 528	575 815	217 613
1986	1 087 989	373 232	1 292 552	1 665 784	169 074	312 905
1987	1 374 946	488 235	555 665	1 043 900	140 960	331 245
1988	1 443 166	448 069r	1 144 121	1 592 190	119 606r	457 698
1989	1 312 433	536 141	1 023 561	1 559 702	256 920	531 046p
1990p	1 399 572	500 798a	933 329a	1 434 127a	96 446a	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Beginning 1988, Exports and Imports are based on the new Harmonized System and may not be in complete accordance with previous method of reporting. Ores and concentrates include HS classes 2603.00.81, 2607.00.81, 2608.00.81, 2616.10.81 and 2616.90.81. Refined silver includes HS classes 7106.10, 7106.91, 7106.92 and 7107.00. [2] Includes recoverable silver in: ores, concentrates for export; crude gold bullion produced; blister and anode copper produced at Canadian smelters; and base and other bullion produced from domestic ores. [3] Some years include only partial consumption for coinage.
[a] Exports and imports are January–September figures; [p] Preliminary; [r] Revised; . . Not available.

TABLE 3. WORLD SILVER MINE PRODUCTION, 1987-89

	1987	1988	1989p
		(tonnes)	
Americas			
Mexico	2 414.9	2 359.0	2 306.1
United States	1 241.0	1 661.0	2 007.0
Peru	2 054.5	1 551.6	1 839.9
Canada	1 452.0	1 484.0	1 306.0
Chile	499.8	506.5	536.0
Bolivia	140.2	231.8	294.9
Other	185.8	265.8	230.9
Total America	7 988.2	8 059.7	8 520.8
Europe			
Spain	217.6	230.0	249.7
Sweden	215.0	225.0	200.0e
Yugoslavia	151.1	139.0	133.0
Other	177.7	168.7	176.9
Total Europe	761.4	762.7	759.6
Africa			
South Africa	208.1	199.7	177.9
Morocco	157.9	225.1	194.8
Namibia	113.6	108.5	109.8
Other	112.9	129.4	107.2
Total Africa	592.5	662.7	589.7
Asia			
Japan	281.0	251.5	155.8
Other	302.0	285.2	302.1
Total Asia	583.0	536.7	457.9
Oceania			
Australia	1 119.3	1 134.6	1 075.0
Other	63.0	71.4	92.8
Total Oceania	1 182.3	1 206.0	1 167.8
Eastern countries			
U.S.S.R.	1 550.0	1 580.0	1 500.0
Poland	831.0	1 063.0	1 083.0
North Korea	300.0	310.0	313.0
People's Republic of China	125.0	145.0	155.0
Other	121.0	126.0	63.0
Total Eastern	2 927.0	3 222.5	3 114.0
Total	14 034.4	14 450.3	14 609.8

Sources: World Bureau of Metal Statistics; Energy, Mines and Resources Canada.
p Preliminary; e Estimated.

TABLE 4. AVERAGE ANNUAL SILVER PRICES, 1970-90

Year	Canada	United States	United Kingdom
	(C$/oz)	(US$/oz)	(Pence/oz)
1970	1.851	1.771	73.778
1971	1.857	1.546	63.086
1972	1.671	1.685	67.403
1973	2.567	2.558	103.783
1974	4.595	4.708	199.819
1975	4.503	4.419	200.118
1976	4.291	4.353	242.423
1977	4.922	4.623	265.512
1978	6.171	5.401	282.203
1979	12.974	11.094	519.607
1980	24.099	20.632	900.778
1981	12.617	10.518	515.303
1982	9.831	7.947	455.331
1983	14.154	11.441	753.644
1984	10.521	8.141	607.056
1985	8.364	6.142	477.560
1986	7.532	5.470	373.030
1987	8.877	7.001	428.243
1988	8.325	6.535	367.295
1989	6.666	5.500	335.538
1990	5.598	4.820	270.703

Sources: Northern Miner; Handy & Harman; London Silver Market.

TABLE 5. CANADIAN CONSUMPTION[1] OF UNMANUFACTURED SILVER, 1988 AND 1989

	1988	1989
	(kilograms)	
Chemicals - silver salts and others	140 461	119 487
Coinage	109 239	178 395
Silver alloys	21 910	17 060
Wire, rod and sheet	14 818[r]	7 348
Sterling and electroplating	13 855	12 849
Other uses	157 415[r]	195 906
Total	457 698	531 046

Source: Energy, Mines and Resources Canada.
[1] Available data as reported by consumers.
[r] Revised.
Note: Totals may not add due to rounding.

TABLE 6. MONTHLY AVERAGE SILVER PRICES, 1989 AND 1990

	London Silver Market		Handy & Harman	
	(C$/oz)	(US$/oz)	(C$/oz)	(US$/oz)
1989				
January	7.14	6.00	7.12	5.97
February	6.99	5.88	7.00	5.89
March	7.11	5.95	7.08	5.93
April	6.89	5.79	6.88	5.79
May	6.49	5.44	6.49	5.45
June	6.33	5.28	6.33	5.28
July	6.22	5.23	6.23	5.24
August	6.09	5.19	6.08	5.18
September	6.07	5.13	6.07	5.13
October	6.04	5.14	6.03	5.13
November	6.41	5.48	6.41	5.48
December	6.47	5.57	6.42	5.53
1990				
January	6.14	5.25	6.14	5.24
February	6.33	5.29	6.31	5.28
March	5.99	5.08	5.97	5.06
April	5.89	5.06	5.87	5.05
May	5.96	5.07	5.96	5.07
June	5.77	4.92	5.75	4.90
July	5.64	4.87	5.62	4.86
August	5.73	5.00	5.70	4.98
September	5.56	4.80	5.55	4.79
October	5.09	4.39	5.06	4.37
November	4.85	4.17	4.85	4.17
December	4.73	4.08	4.72	4.07

Sources: London Silver Market; Handy & Harman.

TABLE 7. SILVER CONSUMPTION IN MAJOR NON-SOCIALIST COUNTRIES, 1987-89

	1987	1988	1989
		(tonnes)	
Industrial Uses			
United States	3 688.9	3 732.4	3 695.0
Canada	323.5	339.0	342.1
Mexico	121.3	242.6	466.5
United Kingdom	668.7	693.6	699.8
France	609.6	699.8	870.9
West Germany	1 259.7	1 468.1	1 424.5
Italy	758.9	559.9	615.8
Japan	2 867.7	3 057.5	3 175.6
India	575.4	699.8	799.3
Others	1 866.2	1 928.4	4 914.5
Subtotal	12 739.9	13 421.1	17 004.0
Coinage			
United States	469.7	273.7	292.4
Canada	99.5	109.2	189.5
West Germany	161.7	161.7	295.5
Mexico	15.6	46.7	62.2
Others	317.3	255.0	230.3
Subtotal	1 063.8	846.3	1 069.9
Total	13 803.7	14 267.4	18 073.9

Sources: Handy & Harman, "The Silver Market 1989"; Energy, Mines and Resources Canada.

Specialty Metals

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Review of antimony, arsenic, beryllium, bismuth, calcium, cobalt, columbium, germanium, indium, rhenium, selenium and tellurium, strontium, tantalum, and titanium.

Tables relevant to these commodities begin on page 58.12.

ANTIMONY

Canada's 1990 antimony production was 653 tonnes (t) valued at $1.4 million, compared to 2818 t and $7 million for 1989. The dramatic decline in production was due to the January 1990 closure of the Durham mine of Dominion Explorers Inc.

The closure of Durham, located in Lake George, New Brunswick, was due to continued depressed antimony markets. The annual output from Durham, North America's only primary mine, represented about 10% of the Western World's mine production. Following the mine closure, Dominion Explorers sold the property to Antimony Products of Canada (Apocan), a subsidiary of Amspec Chemical Corp. Amspec is a major antimony trioxide producer in the United States. Durham was Amspec's second acquisition of antimony operations in Canada in recent years.

In 1988, Apocan acquired the idled pilot plant and research facilities from Enhanced Recovery Systems Ltd. in Chatham, New Brunswick. These two acquisitions are intended as backups in the event of supply disruptions.

Canadian antimony, also derived from lead ores, is produced in the form of antimonial lead at Cominco Ltd.'s lead smelter in Trail, British Columbia, and as antimony slag at the lead smelter of Brunswick Mining and Smelting Corporation Limited at Belledune, New Brunswick.

Also in British Columbia, Minnova Inc. is shipping antimony containing copper concentrates to Europe from its Samatosum mine, which commenced operation in 1989. Samatosum, which also produces lead concentrates, is located about 40 km east of Barrie, British Columbia.

Recently discovered antimony deposits in Canada include the Beaverbrook deposit of Noranda Exploration Company, Limited in Newfoundland, and the Tulsequah deposit of Dominion Explorers Inc. in British Columbia. Both deposits, though not yet defined, contain massive lenses of coarse-grained stibnite (Sb_2O_3).

In June 1990, the Bolivian government withdrew from its agreement with the People's Republic of China to coordinate policy and set quarterly prices for antimony metal and concentrates. The agreement was signed in January 1989, with the initial producer prices (in US$) set at $2250/t for the metal. However, both countries appeared unable to keep their individual producers in line. Free market prices dropped to a historic low of $1580/t by year-end. The People's Republic of China is the world's largest producer and exporter of antimony concentrate and intermediate products.

Antimony prices in the dealer market started the year at US88¢-90¢/lb, as quoted by Metals Week, and declined to US78¢-80¢/lb towards year-end. Despite steady demand, oversupply of low-priced materials from China was the key factor behind the continuing price erosion for antimony.

ARSENIC

Arsenic occurs as a minor constituent of complex ores mined primarily for their copper, lead, zinc, silver or gold content, with copper ores being the main source of arsenic worldwide; arsenic is usually recovered from dusts and residues associated with the roasting of these ores. It is collected as impure arsenic trioxide which is either purified on site or sold directly to a refiner. Ninety-six percent of arsenic is consumed as arsenic trioxide or another arsenic compound. Only 4% is consumed as metallic arsenic. In the literature, arsenic trioxide is commonly referred to as arsenic.

The demand for arsenic has been relatively flat over the past few years, with the average price of arsenic trioxide quoted at US23¢/lb in 1990, down from US27¢/lb in 1989. The average price of arsenic metal increased to US$1.80 from US47¢ in 1989. Environmental concerns about the use of arsenic in agricultural herbicides, desiccants and insecticides greatly reduced its demand since the early 1980s. The wood preservatives industry, which created a brief supply shortage in the late 1970s, remains the largest single consumer of arsenic.

CANADIAN DEVELOPMENTS

Canadian arsenic is produced as arsenic trioxide as a by-product of the treatment of arsenious gold ores. The value of Canadian arsenic trioxide shipments in 1990 is estimated at $288 342 compared to the 1989 actual shipment value of $1 285 915.

Giant Yellowknife Mines Limited in the Northwest Territories recovers arsenic trioxide from dust and residues collected during the roasting of gold ores. Recovery technology includes the electrostatic precipitation of dust, cooling of the arsenic-containing gases and collection of arsenic trioxide in the baghouse. The arsenic trioxide grades 85%-93%. Because of the current weak market situation, the company is stockpiling its arsenic trioxide in permanent underground storage vaults. Giant Yellowknife's pilot plant project to re-treat crude arsenic trioxide and to produce high quality industrial product for the wood preservative industry, although successful, is on hold pending improved market conditions.

As of November 1990, Giant Yellowknife is owned by Royal Oak Resources Ltd. of Vancouver, British Columbia.

WORLD PRODUCTION

According to the U.S. Bureau of Mines, 1990 world mine production of arsenic is in the order of 56 000 t with major producers being: France (18%), Sweden (14%), the U.S.S.R. (14%) and Chile (11%). Major sources of arsenic trioxide include Peru and the Philippines (from copper ores), Chile (copper-gold ores), and Canada (gold ores). Worldwide arsenic metal reserves approximate 1 Mt. Further, it is estimated that world resources of copper and lead contain approximately 11 Mt of arsenic.

USES

In 1990, about 70% of arsenic was used in wood preservatives, 22% in agricultural chemicals, 4% in glass manufacturing, 2% in nonferrous alloys and 2% in other uses. The United States is the largest consumer of arsenic, using over 50% of world production.

The wood preserving chemicals most commonly used are chromated copper arsenate (CCA), ammoniacal copper arsenate (ACA) and fluor chrome arsenate phenol (FCAP). Arsenical wood preservatives are used wherever rot or insect damage may occur such as in building foundations, fence posts, submerged footings and utility poles.

The agriculture share of arsenic use has dropped from over 80% a decade ago to the current 22%. Monosodium methanearsenate (MSMA) and disodium methanearsenate (DSMA) are the most common agricultural arsenical chemicals. These compounds are used as herbicides and plant desiccants and defoliants primarily in the cotton industry where they control grassy and broad-leaved weeds. Arsenicals are considered essential as growth regulators for grapefruit growers and for the control of some grape diseases.

The glass industry uses arsenic trioxide as a decolourizing agent and to remove tiny air bubbles in the glass. Because of environmental concerns the glass industry has been substituting arsenic acid for arsenic trioxide to reduce dust problems associated with handling the trioxide.

Arsenic metal is used as a minor alloying agent (.01-.05) in certain copper- and lead-based alloys. When added to lead for use in acid storage batteries, arsenic strengthens the lead posts and grids to help withstand sudden jars. Arsenic is also added to lead in many countries, except the United States, to make shot for bullets. Arsenic increases the corrosion resistance and tensile strength of copper used in industrial plant piping and auto radiators. Arsenic trioxide can be used in place of arsenic metal in some alloying applications although it is more difficult to use and creates more environmental problems.

High-purity arsenic metal (99.999%) is used in the electronics industry. Gallium arsenide and its alloys are important semi-conductors and are used in such products as light-emitting diodes, microwave devices, solar cells and photo-emissive surfaces. Gallium arsenides have higher operating frequencies, lower power consumption, lower noise and higher resistance to nuclear radiation than their silicon counterparts. Integrated circuits using gallium arsenide have extensive military applications.

HEALTH AND SAFETY AND REGULATORY DEVELOPMENTS

The inhalation and ingestion of arsenic dusts and fumes is hazardous to human health.

In the United States, arsenic in the workplace is regulated by the Occupational Safety and Health Administration (OSHA), which has set an eight-hour time-weighted occupational exposure limit to inorganic arsenic of 10 $\mu g/m^3$. Arsenic also falls under the Environmental Protection Agency's (EPA) Superfund legislation as the EPA is particularly interested in groundwater contamination.

PRICES

The January 1990 price for arsenic metal was US$6.00/lb. This was the peak price the metal achieved following the dramatic December 1989 price jump from US$0.60/lb to US$4.50/lb. The price rise was caused by arsenic metal plant shutdowns in China, creating a sudden demand-supply imbalance. The arsenic metal price slipped throughout 1990 to US$3.00-$3.50/lb in April, and to under US$1.00/lb by December.

The price of arsenic trioxide (As_2O_3) is not dependent on that of arsenic metal. As_2O_3 ended 1989 at US26¢/lb, and finished 1990 at US23¢/lb.

OUTLOOK

The outlook for arsenic is somewhat uncertain although supplies are abundant and demand is expected to remain relatively flat. As arsenic is produced primarily as a by-product, its production is largely a function of the demand for, and production of, other metals (copper, gold, lead and zinc). However, environmental concerns have reduced demand for arsenic. Although substitutes exist for most uses (e.g. pentachlorophenols and creosote for chromated copper arsenate), arsenical compounds are either the preferred or only product for certain uses (e.g. grapefruit orchards and grape vineyards).

BERYLLIUM

Brush Wellman Inc. produces the vast majority of the world's primary beryllium, (205 t in 1990) from its deposit at Spor Mountain, Utah. Other leading producers include the U.S.S.R. (76 t), China (54 t), and Brazil (35 t). Canada has no domestic production; Canada's minimal beryllium imports are principally from the United States.

Although there are occurrences of beryllium minerals scattered throughout Canada, the two promising prospects are the Thor Lake deposit in the Northwest Territories and the Strange Lake deposit on the Labrador/Quebec border. In February 1990, the Hecla Mining Company terminated its joint venture with Highwood Resources Ltd. for the development of the beryllium-rare earth deposit at Thor Lake. Hecla dropped its option because of an inability to obtain sales commitments for beryllium, the primary product. Proven reserves at Thor Lake total 4000 t of beryllium. Later in the year, Hecla signed a letter of agreement with the Iron Ore Company of Canada (IOC) to conduct a feasibility study of IOC's Strange Lake deposit. This deposit contains yttrium, zirconium, niobium and rare earths in addition to beryllium. The study was under way at the end of 1990.

Specialty Metals

The U.S. Environmental Protection Agency (EPA) recently added beryllium to its list of drinking water toxins. Permissible levels were set at 1 microgram/litre.

Due to its light weight, high strength, and high thermal conductivity, beryllium metal and alloys have high technology applications such as in navigational instruments, space vehicles and electronics. The prospects for increased beryllium usage depend on increased civilian markets.

BISMUTH

Preliminary figures indicate that Canadian bismuth refinery production in 1990 was estimated to be 188 t, marginally higher from the 1989 figure of 179 t. Concurrently, the mine output decreased from 205 t to 118 t due to the strike at Brunswick Mining and Smelting Corporation Limited's (BMS) Bathurst mine. The processing of stockpiled inventory and imported dirty lead-bismuth concentrates accounts for the difference in mine output and refinery production. In 1990, Japan drastically revised bismuth reserves, at 20% less tonnage than previously thought. As a result, Canada's reserves are now ranked fifth behind Peru, Australia, the United States and Mexico.

Bismuth, due to its low abundance, is usually recovered as a by-product of processing other ores, e.g. lead, lead-zinc, copper, tin, tungsten, silver and gold. Most of the bismuth in lead concentrates stays with the impure lead through the smelting operation up to the final stages of the refining process.

In Canada, bismuth metal is recovered at Cominco Ltd.'s Trail, British Columbia electrolytic lead refinery and is refined to 99.99+% purity. However, only lead-bismuth alloys are produced at BMS's pyrometallurgical lead refinery at Belledune, New Brunswick.

Bismuth prices started 1990 at about US$3.91/lb. In June 1990, following aggressive trader selling in thin market conditions, the price of bismuth was down to US$2.50/lb. At year-end, bismuth prices continued in the doldrums with material available in the free market at US$2.50/lb. However, Metal Bulletin prices for December 1990 averaged US$4.48/lb (U.S. free market min. 99.6%).

According to the U.S. Bureau of Mines, bismuth is generally used in pharmaceuticals and chemicals (44%), metallurgical additives (32%), fusible alloys and solder (23%), and other (1%).

The future of the bismuth market is uncertain. As a by-product, supply is a function of the major metals' production, in this case, lead, zinc, and copper. However, on the demand side, bismuth-based pharmaceuticals have experienced market growth in the "ulcer" business. Recent research has revealed that only 20% of the patients treated with bismuth developed a recurrence of an ulcer or gastritis. Some 75% of those treated with conventional drugs suffer a relapse within a year.

CALCIUM

Timminco Limited produces all of Canada's calcium metal at its Haley, Ontario operation. Timminco has an annual production capacity of about 900 t. The capacity is variable as the operation can switch a portion of its production between calcium and magnesium metal. Reported Canadian calcium metal consumption was 57 t for 1989.

Worldwide production of calcium was estimated at 2500 t in 1990, compared with 2700 t (estimate) in 1989. Other major calcium producers are China, France, the United States and the U.S.S.R.

Calcium, a powerful reduction agent, can be used to reduce oxides of niobium, samarium, titanium, uranium and vanadium. Calcium deoxidizes, desulphurizes and degasses steels and cast irons; it is easier working with alloys than the pure metal due to calcium's reactivity. Calcium is an alloying element for lead in maintenance-free automotive batteries; in lead, calcium increases corrosion and creep resistance, and strength.

During 1990, calcium metal prices averaged about US$2.50/lb, compared with $2.25/lb in 1989.

COBALT

Canadian cobalt production in 1990 was an estimated 2290 t valued at $52.5 million, compared to 2344 t at $45.8 million for 1989.

Inco Limited and Falconbridge Limited, Canada's two largest producers, both produce cobalt as a by-product of nickel-copper operations. Sherritt Gordon Limited of Fort Saskatchewan, Alberta also produces cobalt from toll-refining and from purchased materials, from both domestic and imported sources.

In the Sudbury area, Inco reactivated the Creighton No. 3 mine late in 1990 due to operational problems at its Indonesian nickel smelters. The No. 3 mine was temporarily shut down in March 1990 following a sharp drop in nickel prices. Inco was also developing the McCreedy East, a major new mine expected to come on stream in 1993 and reach full production in 1996.

In late 1990, Inco announced that it had earmarked $287 million for a major expansion at its nickel complex at Thompson, Manitoba. The company is developing the large 1-D orebody for production in late 1992. In the meantime, Inco was also expanding the nearby Birchtree mine by 50%; the mine was reopened in 1989 after being idle for 12 years. The two Thompson mine expansions will reach capacity operation in 1997, which will more than make up for depletion of other orebodies in the area.

Although these mine expansions were intended to maintain Inco's market share in nickel, the level of cobalt output, a by-product of nickel, will also be maintained.

Falconbridge's total cobalt output for 1990 was about 1800 t, somewhat less than its target of 2000 t. The drop in production was partly due to a lower nickel output and partly to reduced supplies of raw materials. Falconbridge recovers cobalt at the Kristiansand, Norway refinery from its Sudbury nickel and copper matte as well as from purchased and custom-refined materials.

Sherritt's cobalt production during the first nine months of 1990 was about 454 t, the same as in 1989. However, this was some 30% lower than the same period in 1988; the drop was mainly due to a lack of nickel feed. One major factor in the feed problem was the expiry and non-renewal of Sherritt's 10-year toll-refining contract with Inco.

Geddes Resources Limited continued exploration and evaluation of its Windy Craggy copper-cobalt deposit. The deposit is located in the Saint Elias Mountains in northwest British Columbia, near the Alaska border. The company has been conducting environmental impact studies and in February, it filed the Stage I impact report to the Mine Development Review Committee of British Columbia.

Reserves at Windy Craggy are impressive. Drilling results indicate that the deposit remains open at depth and along strike. According to company estimates, besides large and high-grade copper ores, cobalt reserves are equivalent to about six years of the Western World's annual demand.

Cobalt prices started the year at US$7.55-$7.75/lb. This was the equivalent of the producer price minus discounting of US50¢ to $1/lb. Prices rose gradually before exceeding the producer price of US$8.40/lb in July. Then prices increased steadily, reaching the US$12.50-$13.00/lb level in September. In October, news of a cave-in at Zaire's Kamoto mine resulted in a further price increase to the US$13.50-$14.50/lb level, the highest level in nine years. Prices, however, dropped back to US$12.30-$12.70/lb at year-end, after Zaire assured customers that it would be able to meet its commitments for the balance of 1990 and into 1991.

The producer price, on the other hand, remained at US$8.40/lb for cathode throughout 1990, the level the two major African producer countries, Zaire and Zambia, have held since November 1988. At the end of September, these two producers announced a joint price increase to US$11.00/lb effective January 1, 1991.

Despite Zaire's plan to increase its output by 30% in 1991, the market in the short term will likely remain in short supply if demand remains strong. Zambia's output is on a decline because of decreasing ore grades. Canada's cobalt production will probably remain at the 1990 level as it will take some time for the new mines to reach their planned production goals. The recession and lower nickel prices could also result in production cutbacks in coming years.

COLUMBIUM

Columbium is produced in Canada at the Niobec mine, located near St. Honoré, Quebec. Production in 1990 was 3394 t of columbium pentoxide (Cb_2O_5) contained in concentrates, 3% lower than the 1989 output level of 3502.8 t, the lower output being due to mill recovery problems. In 1991, production is expected to drop further because of lower ore grades.

Other important columbium properties in Canada include the Aley deposit in British Columbia, the Oka mine in Quebec, the Thor Lake deposit in the Northwest Territories and the Strange Lake deposit on the Labrador-Quebec border.

The Aley property contains a large undeveloped pyrochlore deposit owned by Cominco Ltd. Reserves are estimated to be in the 10 Mt range with some zones grading up to 1% Cb_2O_5. Pyrochlore and columbite are both present, together with some rare-earth enriched dikes.

At the Thor Lake property, extensive development and feasibility work has been carried out by Hecla Mining Company of Canada Ltd. over the last two years. This multi-mineral deposit, located about 100 km southeast of Yellowknife, Northwest Territories, is owned by Highwood Resources Ltd.

In February 1990, Hecla decided not to bring Thor Lake into production due to a lack of sales commitments for beryllium, the primary product. The Thor Lake property, which is also rich in tantalum, hafnium, zirconium and rare earths, was to have been brought on stream under a joint venture between Hecla and Highwood Resources.

The bulk of the world's columbium is used in steelmaking. The demand for columbium in 1990 remained at a high level despite a drop in steel production. Continuing strong demand from Japan has compensated for a weaker European market. In Japan, the steel industry continued to switch to columbium from vanadium because of vanadium's wide price fluctuation, and away from titanium for economic reasons.

Columbium prices remained at about the same level as in 1989. Standard-grade ferrocolumbium was quoted at US$6.58/lb of contained columbium, and high-purity columbium oxide at US$7.64/lb. The spot price for columbite ore was unchanged at US$3.00-$3.50/lb.

In the short term, the recession and lower steel output will have a negative impact on the columbium industry. The long-term picture is much brighter as projected construction of large gas pipelines in North America will increase consumption of columbium.

GERMANIUM

Johnson Matthey Limited (JM) closed its Trail, British Columbia, minor metals plant at the end of 1990. The B.C. plant, which was acquired from Cominco Ltd. in January 1989, produces a number of high-purity metals and materials including germanium and gallium. The closure was a result of significant operating losses incurred as a result of the collapse of the germanium market. Oversupply and a reduced demand by military contractors were behind the market collapse.

JM's germanium plant, with an output capacity of 5 t/y, purchased its feed in the form of germanium concentrate from Cominco under a long-term contract. Germanium concentrate is produced as a by-product of lead-zinc refining at Cominco.

Other JM operations at the Trail plant are being relocated as part of its restructuring program for the electronic materials division. The gallium arsenide research program will be moved to its subsidiary, Crystar Research Inc. in Victoria, with the tellurium and cadmium operations moving to Spokane, Washington.

In other developments, Hecla Mining Company closed its Apex, Utah germanium and gallium mine and processing facilities in August. The closure of North America's only germanium mine was partly due to the depressed market and partly due to metallurgical problems. Hecla purchased the mine from Musto Explorations Limited of Vancouver in 1989 for US$5.5 million, although Musto continues to retain a 15.5% interest in the project. At capacity, the Apex operation can produce 20 t/y of germanium and 7 t/y of gallium.

The major use for germanium is in defence applications with some 60% used in infra-red optics and the remainder mainly in fibre optics, light detectors, and other high-technology applications.

Prices for germanium in the free market, according to the Metals Bulletin, plummetted to US$390-$410/kg in 1990 from US$590-$600/kg at the end of 1989. This compared to producer quotes of US$1060/kg.

INDIUM

Canada is becoming the world's leading indium supplier with the recent start-up of two major indium plants, each with a production capacity of 30 t/y. For comparison, the total world consumption was about 110 t in 1989.

Cominco Ltd. completed construction of its Trail, British Columbia indium metal plant in May 1989. However, technical problems inhibited high production of indium during the first year of operation. By October 1990, it was reported that the company had solved its tin impurity problems. Cominco's indium production in 1990 is estimated at 10 t of metal.

The Kidd Creek indium recovery plant is a joint venture of Falconbridge Limited and Indium Corp. of America. It was commissioned in the last quarter of 1990. Indium metal is recovered in the form of 99.99% ingots (4N), and then shipped to Indium Corp.'s refinery in Utica, New York for further processing.

In 1989, Johnson Matthey PLC (JM) purchased Cominco's high-purity materials division. This division includes facilities producing high-purity indium in Trail, and in Spokane, Washington. At the end of 1990, JM's high-purity operations were reorganized. The Trail plant was closed and its function was incorporated into the Spokane operations.

The bulk of indium is used in coatings, solders and alloys. Other important uses include semi-conductors and research. Window coatings and windshield defrosters have shown the most increase in recent years. Potential new applications are in high-speed computer chips and in radar transistors for military weapons that can be operated in fog and smoke.

The indium market is expected to continue to grow over the next decade. Development of large volume applications such as window demisters for the automotive industry and window coatings for the housing market should provide a major stimulus for the industry. On the other hand, increased production, particularly from Canada, should help to ease supply concerns and maintain price stability for the remainder of the decade.

During the first quarter of 1990, the producer price continued its downward trend, dropping to US$217.72/kg by April from US$240.35/kg at the beginning of the year. The price decline was due to increased supplies and competition among major producers. Towards year-end, good consumer demand, especially from Japan, resulted in price increases by the major producers. Cominco raised its price for the 99.90% indium ingot to $US250/kg from $US245/kg to be in line with European producers. Japan's offtake was about 56% of the world's indium demand in 1989.

RHENIUM

Rhenium (Re) is a minor by-product of molybdenum, produced from some western Canadian porphyry copper mines. The Island Copper mine in Port Hardy, British Columbia has molybdenum concentrates that grade about 900 ppm Re, high enough to warrant separate payment for the contained rhenium. The Island Copper mine is owned by The Broken Hill Proprietary Company Limited of Australia. Chile, France, Germany, Japan, Sweden and the United States recover rhenium during the processing of molybdenum concentrates.

The most important use for rhenium is in rhenium-platinum catalysts used in the production of low-lead and lead-free high octane gasolines. Rhenium can be alloyed with tungsten or molybdenum to improve the ductility and tensile strength of these metals. To operate jet engines at higher temperatures, researchers are examining rhenium to strengthen nickel-based alloys. Rhenium prices averaged US$700/lb in 1989. Rhenium prices can be volatile and, as a minor by-product of copper and molybdenum production, rhenium production does not depend on price.

SELENIUM AND TELLURIUM

Canada produced an estimated 390 t of refined selenium in 1990. Selenium and tellurium occur in association with copper and they are separated from copper in the electrolytic refining of copper. Selenium content in refined copper is strictly controlled; too much selenium causes breakage when copper is drawn into small diameter wires.

All three copper refineries in Canada produce copper anode slimes containing by-products from the blister copper. Selenium and tellurium, as well as gold, silver and platinum group metals, are such by-products of copper refining. Falconbridge Limited's copper refinery at Timmins, Ontario sends its anode slimes to Noranda Inc.'s CCR copper refinery in Montreal, Quebec for recovery of selenium, tellurium and other by-products.

Noranda's CCR facility takes blister copper containing selenium and tellurium from Noranda's Horne and Gaspé smelters, both located in Quebec, and from Hudson Bay Mining and Smelting Co., Limited's smelter in Flin Flon, Manitoba. Noranda also obtains selenium and tellurium feed contained in domestic and imported scrap. Noranda's reported selenium production capacity is 340 t/y of glass, pigment, commercial and high-purity grades. Noranda's tellurium production capacity is about 35 t/y of commercial grade tellurium powder, stick and lumps.

In Sudbury, Inco Limited operates a copper refinery where it recovers both selenium and tellurium. Inco purifies the selenium and tellurium to a crude stage only (i.e. undewatered); customers complete the final process stage. Inco can produce 45 t/y of selenium cake and 4.5 t/y of tellurium dioxide cake.

Canadian selenium consumption was reported by consumers as 14.8 t in 1989 (preliminary data). This compared with an average consumption of 14 t for the period 1985-88 inclusive.

Tariffs for selenium and tellurium are similar for Most Favoured Nation at 9.2% while General Preferrential Tariffs differ with selenium at 5% and tellurium at 6%. Selenium exports were 202 t in 1988, 131 t in 1989 and rose to 316 t for the first nine months of 1990. The European Communities is the principal destination for Canadian selenium exports. Selenium imports were 4 t for 1988, 5 t for 1989 and 6 t for the first nine months of 1991. Japan is the principal source for Canadian tellurium imports. Statistics for tellurium are combined with those of boron.

WORLD PRODUCTION

World refined selenium production data are incomplete as production data are not available from all major producers. The most important refined selenium producers in 1990 were: Japan (475 t), Canada (390 t), Belgium (275 t) and the United States (260 t). Japan obtains much of its material as selenium contained in imported copper concentrates. Conversely, Canada exports some of its mine production of selenium: selenium is exported in copper concentrates sent to Japan and other countries. Other significant primary and secondary selenium producers in 1990 included: Chile, Finland, the Philippines, Sweden, Yugoslavia and Zambia, who each produced between 25 t and 60 t of refined selenium. Selenium production data from the People's Republic of China, the U.S.S.R., Germany and the United Kingdom are unavailable.

Tellurium statistics are not widely reported. As tellurium is found with selenium in copper ores, major selenium-producing nations also produce tellurium.

USES

The major end uses for selenium are photoreceptors, glass making and pigments for plastics and ceramics. The largest end use for selenium is in the production of photoreceptors for photocopiers and laser printers. Tellurium may be added to increase copying speed of photocopiers, but the photoreceptors are then more prone to damage. Arsenic triselenide photo-receptors are more expensive than other selenium-based photoreceptors, but have important advantages of speed, ability to handle all colours of the visible spectrum, and reduced susceptibility to damage.

The next most important use for selenium is for colour control to produce colourless glasses or to produce specific colours in glasses, plastics and rubbers. In combination with other additives, selenium produces black, topaz, green, pink and ruby glasses. Selenium modifies the colours of cadmium pigments used in plastics, ceramics and rubber.

The principal use for tellurium is to improve machinability in steel or in copper alloys. As well, tellurium is used in some catalysts, in detonators, in thermal imaging and in corrosion resistance for nonferrous metals. The electronic use of tellurium requires purities of 99.99999%.

PRICES

Metal Bulletin's European free market selenium prices for 99.5% material averaged about US$5.45/lb in 1990, decreasing from an average of US$6.60/lb in 1989. Published prices for selenium may not reflect actual transaction prices for selenium sold by the large producers; producer prices may be higher or lower than published prices, depending on tonnage and market conditions. Prices also vary according to the grade of the material: commercial grade selenium (99.5% Se) trades at a lower price than does pigment grade selenium (99.8% Se) or high-purity selenium (99.99% or greater).

Average 1990 tellurium prices were estimated at about US$32/lb for commercial grade material.

OUTLOOK

Selenium production is not simply a function of selenium prices as selenium is produced as a by-product of copper production. This situation also makes prices a challenge to predict. As selenium must be eliminated from the blister copper during the refining stage to maintain quality of the refined copper, selenium recovery tracks copper production, even when selenium prices are low. For example, identification of a new use that could double consumption would cause prices to increase drastically (until the other selenium end users could substitute away from expensive selenium). Conversely, sustained low prices encourage producers to stockpile semi-processed selenium; this can be readily processed in times of higher prices.

Emphasis on recycling will tend to increase the secondary feed to selenium producers. Restrictions on cadmium pigments by environmental regulations have the potential to reduce selenium consumption for such pigments.

STRONTIUM

Canada is the world's leading strontium metal producer. Timminco Limited produces all of Canada's strontium metal at its oxide reduction plant in Westmeath, Ontario. The company has the capacity to produce between 400 and 500 t/y of strontium metal and alloys, depending on operational parameters. The Pechiney Corporation of France is the other major strontium metal producer in the Western World. World production of strontium metal was estimated at 400 t in 1990, compared with 425 t in 1989. Canadian tariffs for strontium are 9.2% for Most Favoured Nation and 6% for General Preferrential.

Timminco produces a 90/10 strontium-aluminum alloy (90% Sr, 10% Al) for use as a modifier in aluminum/silicon casting alloys to increase the as-cast ductility. This permits stronger aluminum alloy castings with increased machinability, allowing aluminum castings to compete with steel for some automotive applications. Timminco also produces strontium metal in other forms such as crowns (97.5% Sr) and rods and billets (minimum 98% Sr).

Strontium compounds such as strontium carbonate and strontium nitrate are used in much larger quantities than is strontium metal. Strontium carbonate is used in television face plates in Japan and North America to absorb X rays. Strontium nitrate is used in pyrotechnics to give a brilliant crimson colour.

Strontium metal prices averaged US$7.90/lb in 1990, down from US$8.20/lb in 1989.

TANTALUM

Canada is the second largest primary tantalum producer in the world after Australia. The Bernic Lake mine of Tantalum Mining Corporation of Canada Limited (TANCO) in Manitoba was operating at capacity in 1990. Tantalum production at Bernic Lake was restarted in 1988, after a six-year suspension.

In addition to tantalum, TANCO produces low-iron, ceramic-grade spodumene concentrates, and cesium and rubidium ores. The addition of the spodumene circuit, which started operation in 1986, has made TANCO more competitive in the tantalum market. TANCO has instituted a secondary mining program to reduce its large pillars, which has raised the average mill-feed grade and kept costs down.

Major events during 1990 in the international tantalum industry were the closing of Fansteel, Inc. of the United States, and the commissioning of Pan West Tantalum Pty. Ltd. at Wodgina, Australia. Fansteel, one of the pioneers in tantalum and columbium processing and fabrication, closed its North Chicago, Illinois and Muskogee, Oklahoma plants. Late in 1989, the company sold its majority interest in V Tech-Fansteel Inc. of Japan to Hermann C. Starck Berlin, which produces tantalum metal powders.

The tantalum market improved slightly during the first half of 1990, but prices remained about 30% below the early 1989 levels. The free market tantalum prices according to Metals Week, started the year at US$25-$26/lb of Ta_2O_5, and rose steadily to US$34-$36/lb by July. However, prices dropped slightly during the second half, closing the year at US$32-$34/lb.

Capacitors, used in computers, telecommunications and electronics, account for about half of the tantalum consumption. Other important uses include tantalum carbides, chemical equipment and superalloys. Potential new uses include armour-piercing penetrator military weapons.

TITANIUM METAL

Valued for its high strength, light weight and corrosion resistance, titanium metal is produced primarily from rutile and synthetic rutile. Virtually all ilmenite goes into pigments, but it can also be upgraded for metal production.

Canada's main titanium-based industries comprise ilmenite mining and smelting and titanium oxide pigment production. Other activities include titanium metal fabrication of finished parts, coating of welding rods, and the manufacture of titanium carbide and nitride coated parts. As well, titanium-bearing master alloys are used to make specialty steel and aluminum alloys. Canada does not have any capacity for producing titanium sponge or granules or ferrotitanium. Hence, Canada is an importer of titanium ores, concentrates, unwrought titanium (both alloyed and not alloyed), titanium turnings, ferrotitanium and ferrosilico-titanium mainly from the United States, Europe and Japan.

At the end of 1989, the demand for titanium sponge surpassed that at the peak in 1985. Despite decreased military orders, titanium metal demand remained at relatively high levels due to the record number of orders from the commercial aircraft industry. Demand for titanium in non-aerospace uses is also reported to be rising, particularly for pulp and paper machinery, for medical usage in implants and orthopaedic applications, powder metallurgy and petrochemical industries.

In the first quarter of 1990, the increasingly bullish tone of the titanium sands, ferrotitanium and scrap markets began to pull up the prices of titanium sponge. High quality sponge price was quoted at US$6.00/lb and titanium scrap price was quoted at US$2.50/lb. In the following quarter and until year-end, the titanium scrap market softened considerably, while titanium sponge, although relatively steady, felt the pinch. Titanium sponge price quotes in the last quarter ranged from US$1.81 to $2.04/lb and titanium scrap price was quoted at US93¢/lb. In a nutshell, the demand for titanium products was waning as the economic uncertainties grew stronger. By the end of 1990, the market was flat rather than expanding.

Part of the decline can be traced to the long strikes at Boeing and British Aerospace Plc and the reduction in military spending that has not been completely offset by orders from the commercial sector.

Boeing's order for 68 new planes will bolster titanium demand from U.S. titanium suppliers. Every Boeing model has used proportionately more titanium than its predecessor except the 767, which was designed when titanium was perceived to be in short supply.

Note: Information contained in this review was current as of mid-January 1991.

TABLE 1. ANTIMONY TARIFFS

Item No.	Description	Canada			United States	EEC
		MFN	GPT	USA	Canada	MFN
2617.10	Antimony ores and concentrates	Free	Free	Free	Free	Free
2825.80	Antimony oxides	Free	Free	Free	Free	11%
8110.00.10	Unwrought antimony; not alloyed; powders, not alloyed	4%	Free	1.6%	Free	Free
8110.00.20	Unwrought antimony, alloyed; waste and scrap; powders, alloyed; articles of antimony	10.2%	6.5%	4%	Free	Free-8%

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States effective January 1, 1990; Official Journal of the European Communities, Vol. 33, No. L247, 1990, "Conventional" column.

TABLE 2. CANADA, ANTIMONY PRODUCTION, IMPORTS, EXPORTS AND CONSUMPTION, 1988-90

Item No.		1988		1989		1990p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Production							
	British Columbia	336	947	263	650	524	1 106
	New Brunswick	2 789	7 014	2 532	6 253	119	250
	Northwest Territories	19	55	18	43	9	18
	Yukon	x	x	4	11	2	5
	Manitoba	x	x	–	–	–	–
	Total	3 171	8 094	2 818	6 957	653	1 379
Imports						(Jan.-Sept.)	
2617.10	Antimony ores and concentrates						
	United States	76	184	19	47	23	74
	People's Republic of China	61	180	37	82	20	39
	Total	137	364	56	130	43	114
2825.80	Antimony oxides						
	United States	806	2 826	899	3 166	554	1 922
	United Kingdom	536	2 516	320	1 442	374	1 643
	Belgium	102	466	103	459	25	68
	People's Republic of China	–	–	–	–	22	54
	Total	1 444	5 809	1 322	5 068	975	3 668
2918.13.10.10	Antimony potassium tartrates						
	United States	12	27	16	65	49	127
	Spain	3	5	–	–	8	19
	Other countries	10	22	8	21	5	15
	Total	25	54	24	86	62	161
8110.00.10	Unwrought antimony; not alloyed; powders, not alloyed						
	People's Republic of China	73	220	144	337	44	114
	United States	32	96	68	180	29	75
	United Kingdom	–	–	18	29	–	–
	Total	105	316	230	547	73	190
8110.00.20.10	Unwrought antimony; powders; articles of antimony						
	United States	22	57	7	...	5	29
	Other countries	1	3	6	33	6	26
	Total	23	60	13	34	11	55
8110.00.20.20	Antimony waste and scrap						
	People's Republic of China	...	8	–	–	34	92
	United States	1	...	1	1	12	43
	Zaire	1	10	–	–	–	–
	Total	2	18	1	1	46	135
Exports							
2617.10	Antimony ores and concentrates						
	United Kingdom	2 820	4 604	1 784	3 442	415	845
	United States	491	172	–	–	28	35
	Other countries	522	1 093	587	980	–	–
	Total	3 833	5 869	2 371	4 422	443	880
2825.80	Antimony oxides						
	United States	23	24	–	–	–	–
	Total	23	24	–	–	–	–
8110.00	Antimony and articles thereof, including waste and scrap						
	Austria	–	–	–	–	200	254
	United States	55	153	68	181	–	–
	Other countries	75	243	175	402	1	165
	Total	130	396	243	583	201	420

TABLE 2 (cont'd)

	1988	1989p[4]
	(kilograms)	
Consumption[1,2]		
Antimony metal used for, or in the production of:		
Antimonial lead	56 131	66 147
Babbitt	28 249	72 261
Other uses[3]	77 011	82 066
Total	161 391	220 474
Held by consumers on December 31[2]	6 861	17 023

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Antimony content of primary and secondary antimonial lead alloys. [2] Available data, as reported by consumers. [3] Includes solder, type metal and miscellaneous uses. [4] Increase in number of companies being surveyed.
p Preliminary; – Nil; . . . Amount too small to be expressed; x Confidential.
Note: Numbers may not add to totals due to rounding.

TABLE 3. CANADA, CONSUMPTION AND CONSUMERS' STOCKS OF ANTIMONY,[1] 1975 AND 1980-89

	Consumption		On Hand at End of Year	
	Antimony Metal	Antimonial-Lead Alloy[2]	Antimony Metal	Antimonial-Lead Alloy[2]
	(kilograms)			
1975	454 164	723 155	116 760	170 478
1980	369 732	643 983	42 389	51 405
1981	209 829	691 180	35 105	151 400
1982	161 034	605 502	39 799	76 979
1983	169 648	560 705	24 381	130 104
1984	342 705	648 413	33 524	23 319
1985	184 993	826 846	24 512	20 298
1986	539 655	759 876	28 422	104 360
1987	540 147	692 750	21 172	164 782
1988	161 391	927 196	6 861	144 049
1989p[3]	220 474	1 089 683	17 023	138 428

Source: Energy, Mines and Resources Canada.
[1] Available data, as reported by consumers. [2] Antimony content of primary and secondary antimonial-lead alloys. [3] Increase in number of companies being surveyed.
p Preliminary.

TABLE 4. ARSENIC TARIFFS

Item No.	Description	Canada			United States
		MFN	GPT	USA	Canada
2811.29.10.20	Arsenic trioxide	9.2%	Free	3.6%	Free

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States effective January 1, 1990.

TABLE 5. CANADA, ARSENIC PRODUCTION AND TRADE, 1988-90

Item No.		1988		1989		1990p	
		(kilograms)	($000)	(kilograms)	($000)	(kilograms)	($000)
Production							
	Arsenious trioxide						
	Northwest Territories	x	2 366	x	1 286	x	288
	Total	x	2 366	x	1 286	x	288
Exports						(Jan.-Sept.)	
	Arsenic						
	United States	28 865	529	80 609	277	40 395	720
	West Germany	307	49	118 871	184	206	67
	Netherlands	–	–	–	–	6 000	54
	Other countries	2 338	57	8 979	78	4	27
	Total	31 510	635	208 459	539	46 605	870
Imports							
2804.80	Arsenic						
	United States	44 747	122	37 827	149	111 183	299
	People's Republic of China	–	–	29 304	49	39 759	209
	Japan	–	–	–	–	5 744	20
	Total	44 747	122	67 132	198	156 686	529
2811.29.10.10	Arsenic pentoxide						
	United States	–	–	363 765	269	750 347	582
	United Kingdom	–	–	184	. . .	–	–
	Total	–	–	363 949	269	750 347	582
2811.29.10.20	Arsenic trioxide						
	France	129 985	129	163 033	150	50 982	45
	United States	2 722	7	13 037	13	1 245	1
	Total	132 708	136	176 070	163	52 227	47

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary; x Confidential; – Nil; . . . Amount too small to be expressed.
Note: Numbers may not add to totals due to rounding.

TABLE 6. BERYLLIUM TARIFFS

Item No.	Description	Canada			United States
		MFN	GPT	USA	Canada
8112.11.10	Unwrought beryllium, not alloyed; powders, not alloyed	4%	Free	Free	5.1%
8112.11.20	Unwrought beryllium, alloyed; waste and scrap; powders, alloyed	10.2%	6.5%	Free	Free-5.1%
8112.19	Beryllium and articles thereof, n.e.s.	10.2%	6.5%	Free	3.3%

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States effective January 1, 1990.
n.e.s Not elsewhere specified.

TABLE 7. CANADA, BERYLLIUM TRADE, 1988-90

Item No.		1988		1989		Jan. - Sept.1990p	
		(kilograms)	($000)	(kilograms)	($000)	(kilograms)	($000)
Exports							
8112.11	Beryllium unwrought; waste and scrap; powders						
	United States	18 278	107	–	–	393	1
	Total	18 278	107	–	–	393	1
8112.19	Beryllium and articles thereof, n.e.s.						
	United States	2 073	45	–	–	1	2
	Panama	–	–	58	3	–	–
	Japan	778	273	–	–	–	–
	Total	2 851	318	58	3	1	2
Imports							
8112.11.10	Unwrought beryllium, not alloyed; powders, not alloyed						
	United States	756	24	503	34	246	18
	Total	756	24	503	34	246	18
8112.11.20.10	Unwrought beryllium, alloyed; powders, alloyed						
	United States	1	...	–	–	–	–
	Total	1	...	–	–	–	–
8112.11.20.20	Beryllium waste and scrap						
	United States	1 061	18	2	...	–	–
	Zaire	673	10	–	–	–	–
	Total	1 734	28	2	...	–	–
8112.19	Beryllium and articles thereof, n.e.s.						
	United States	13 923	369	14 736	502	23 119	715
	Brazil	–	–	368	7	–	–
	West Germany	–	–	35	2	–	–
	Total	13 923	369	15 139	512	23 119	715

Source: Statistics Canada.
p Preliminary; – Nil; ... Amount too small to be expressed; n.e.s. Not elsewhere specified.
Note: Numbers may not add to totals due to rounding.

TABLE 8. BISMUTH TARIFFS

Item No.	Description	Canada			United States
		MFN	GPT	USA	Canada
2617.90.00.10	Bismuth ores and concentrates	Free	Free	Free	Free
8106.00.10	Unwrought bismuth, not alloyed; powders, not alloyed	Free	Free	Free	Free
8106.00.20	Unwrought bismuth, alloyed; waste and scrap; powders, alloyed; articles of bismuth	10.2%	6.5%	4%	Free

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States effective January 1, 1990.

TABLE 9. CANADA, BISMUTH PRODUCTION AND TRADE, 1988-90, AND CONSUMPTION 1987-89

Item No.		1988		1989		1990p	
		(kilograms)	($000)	(kilograms)	($000)	(kilograms)	($000)
Production, all forms[1]							
	New Brunswick	158 590	2 464	142 869	2 110	89 000	796
	British Columbia	18 805	292	13 000	192	10 000	89
	Yukon Territory	150	2	833	12	2 000	13
	Northwest Territories	–	–	25	. . .	. . .	. . .
	Ontario	3 360	52	–	–	–	–
	Manitoba	2	. . .	–	–	–	–
	Total	180 907	2 811	156 727	2 315	100 000	899
Exports						(Jan.-Sept.)	
8106.00	Bismuth and articles thereof, including waste and scrap						
	United States	76 845	970	27 258	433	114 357	685
	Japan	5 009	94	–	–	–	–
	Other countries	21 338	40	500	. . .	–	–
	Total	103 192	1 104	27 758	433	114 357	685
Imports							
2617.90.00.10	Bismuth ores and concentrates						
	United States	54	. . .	813	10	6	. . .
	Total	54	. . .	813	10	6	. . .
8106.00.10	Unwrought bismuth, not alloyed; powders, not alloyed						
	United States	40 549	423	15 203	287	12 739	224
	People's Republic of China	9 898	162	–	–	867	13
	South Korea	550	8	–	–	–	–
	Total	50 997	593	15 203	287	13 606	237
8106.00.20.10	Unwrought bismuth, alloyed; powders, alloyed, articles of bismuth						
	United States	6 330	203	10 012	225	12 279	228
	Total	6 330	203	10 012	225	12 279	228
8106.00.20.20	Bismuth waste and scrap						
	United States	578	. . .	2 107	33	9 807	147
	Zaire	673	10	–	–	–	–
	Total	1 251	10	2 107	33	9 807	147

	1987	1988	1989p[3]
		(kilograms)	
Consumption, refined metal (available data)			
Fusible alloys and other alloys	4 547[a]	6 709[a]	15 890
Other uses	(2)	(2)	268
Total	4 547	6 709	16 158

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Refined bismuth metal from Canadian ores, plus recoverable bismuth content of bullion and concentrates exported. (2) Included in fusible alloys.
[3] Increase in number of companies being surveyed.
[a] Includes "other uses" to avoid disclosing confidential data; p Preliminary; – Nil; . . . Amount too small to be expressed.

TABLE 10. CANADA, BISMUTH PRODUCTION AND CONSUMPTION, 1975 AND 1980-90

	Production all Forms[1]	Consumption[2]
	(kilograms)	
1975	156 605	29 267
1980	149 366	10 271
1981	167 885	10 094
1982	189 000	10 074
1983	253 023	7 241
1984	166 000	9 398
1985	201 489	7 284
1986	152 930	6 617
1987	165 282	4 547
1988	180 907	6 709
1989	156 727	16 158[p3]
1990[p]	100 000	. .

Source: Energy, Mines and Resources Canada.
[1] Refined bismuth metal from Canadian ores, plus recoverable bismuth content of bullion and concentrates exported. [2] Refined bismuth metal reported by consumers. [3] Increase in number of companies being surveyed.
[p] Preliminary; . . Not available.

TABLE 11. COBALT TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2605.00	Cobalt ores and concentrates	Free	Free	Free	Free
2822.00.10	Cobalt hydroxides	Free	Free	Free	1.5¢/kg
2822.00.90	Cobalt oxides, commercial cobalt oxides	9.8%	Free	3.9%	1.5¢/kg
2827.34	Cobalt chloride	12.5%	8%	5%	2.5%
2833.29.00.40	Cobalt sulphate	9.2%	6%	3.6%	0.8%
2836.99.00.20	Cobalt carbonates	12.5%	8%	Free	Free
2915.23	Cobalt acetates	12.5%	8%	5%	2.5%
8105.10.10	Cobalt mattes and other intermediate products; unwrought cobalt, alloyed; waste and scrap; powders, alloyed	10.2%	6.5%	4%	3.3%
8105.10.20	Unwrought cobalt, not alloyed; powders, not alloyed	Free	Free	Free	Free
8105.90.10	Cobalt bars and rods, not alloyed	6.8%	Free	2.7%	3.3%
8105.90.90	Cobalt and articles thereof, n.e.s.	10.2%	6.5%	4%	3.3%

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, effective January 1, 1990.
n.e.s. Not elsewhere specified.

TABLE 12. CANADA, COBALT PRODUCTION AND TRADE, 1989 AND 1990, AND CONSUMPTION, 1987-89

Item No.		1989		1990p	
		(kilograms)	($000)	(kilograms)	($000)
Production[1] (all forms)					
	Ontario	1 987 704	38 774	1 961 000	44 490
	Manitoba	356 685	7 007	330 000	8 000
	Total	2 344 389	45 781	2 291 000	52 490
Exports				(Jan.-Sept.)	
2605.00	Cobalt ores and concentrates				
	United States	20 605	73	–	–
	Japan	1 030	21	–	–
	Total	21 635	94	–	–
2822.00	Cobalt oxides and hydroxides; commercial cobalt oxides				
	United Kingdom	367 224	7 503	291 014	5 980
	Hong Kong	–	–	5 140	107
	Australia	4 155	92	5 054	78
	Other countries	36	1	–	–
	Total	371 415	7 597	301 208	6 167
2915.23	Cobalt acetates	11 420	76	499	6
8105.10	Cobalt , unwrought, matte and other intermediate products, waste, scrap and powders				
	United States	1 360 395	22 324	15 064	309
	Norway	1 359 116	23 948	–	–
	United Kingdom	219 609	3 619	–	–
	Belgium	153 000	2 302	–	–
	Other countries	72 242	2 425	–	–
	Total	3 164 362	54 618	15 064	309
8105.90	Cobalt and articles thereof, n.e.s.				
	Argentina	–	–	249	10
	United States	21 344	418	–	–
	Other countries	50 025	676	–	–
	Total	71 369	1 094	249	10
Imports					
2605.00	Cobalt ores and concentrates				
	United States	1 029	22	19 839	437
	Total	1 029	22	19 839	437
2822.00.10	Cobalt hydroxides				
	Belgium	6 6 81	95	32 435	536
	United States	1 380	25	5 420	119
	Finland	7 750	124	3 200	48
	Total	15 811	245	41 055	703
2822.00.90.10	Cobalt oxides				
	Belgium	5 100	92	6 000	109
	Finland	–	–	1 600	29
	United Kingdom	250	5	400	8
	United States	8 216	146	104	2
	Total	13 566	244	8 104	149
2822.00.90.20	Commercial cobalt oxides				
	Belgium	3 105	48	–	–
	United States	39	1	–	–
	Total	3 144	49	–	–
2827.34	Cobalt chlorides				
	United States	257 753	958	222 072	775
	Belgium	220	1	400	2
	West Germany	1 676	23	–	–
	Total	259 649	983	222 472	777

TABLE 12 (cont'd)

Item No.		1989 (kilograms)	1989 ($000)	Jan.-Sept. 1990p (kilograms)	Jan.-Sept. 1990p ($000)
Imports (cont'd)					
2833.29.00.40	Cobalt sulphate				
	Belgium	26 924	132	27 000	138
	United States	33 197	217	13 779	96
	Other countries	17	1	3 262	16
	Total	60 138	350	44 041	250
2836.99.00.20	Cobalt carbonates				
	United States	23 612	363	14 485	244
	Other countries	788	12	6 410	93
	Total	24 400	375	20 895	337
2915.23	Cobalt acetates				
	United States	10 565	73	11 064	63
	United Kingdom	283	3	–	–
	Total	10 848	76	11 064	63
8105.10.10.10	Unwrought cobalt; powders; mattes and other intermediate products				
	United States	29 504	957	17 066	672
	Other countries	1 861	73	978	49
	Total	31 365	1 030	18 044	721
8105.10.10.20	Cobalt waste and scrap				
	Zaire	369 600	6 288	319 200	5 547
	Netherlands	–	–	33 600	593
	Other countries	61 411	755	50 942	1 161
	Total	431 011	7 043	403 742	7 301
8105.10.20.10	Unwrought cobalt, not alloyed				
	United States	724	23	22 259	407
	Norway	7 396	147	12 000	387
	Belgium	32	1	33	2
	Zaire	67 200	1 104	–	–
	Total	75 352	1 276	34 292	796
8105.10.20.20	Cobalt powders, not alloyed				
	United States	45 929	1 344	13 969	539
	Belgium	3 844	143	3 074	115
	West Germany	16	1	54	2
	Norway	69 238	249	–	–
	Total	119 027	1 738	17 098	657
8105.90.10	Cobalt bars and rods, not alloyed				
	United States	1 269	188	406	30
	West Germany	612	22	341	24
	Total	1 881	211	747	55
8105.90.90	Cobalt and articles thereof, n.e.s.				
	United States	55 244	3 647	51 753	3 292
	Japan	1 582	58	513	19
	Other countries	650	24	4	1
	Total	57 476	3 729	52 270	3 312

	1987	1988	1989p
	(kilograms)		
Consumption[2]			
Cobalt contained in:			
Cobalt metal and metallic compounds	46 029	69 153	68 585
Cobalt pigments, feed and ground coat frit	13 622	15 342	9 107
Cobalt salts and driers and other uses[3]	60 543	74 795	69 607
Total	120 194	159 290	147 299

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Production (cobalt content) from domestic ores. [2] Available data reported by consumers. [3] Other uses include glass and chemicals.
p Preliminary; – Nil; n.e.s. Not elsewhere specified.
Note: Numbers may not add to totals due to rounding.

TABLE 13. CANADA, COBALT PRODUCTION, TRADE AND CONSUMPTION, 1975 AND 1980-90

		Exports			Imports	
	Production[1]	Cobalt Metal	Cobalt Oxides and Hydroxides	Cobalt Ores[2]	Cobalt Oxides and Hydroxides[3]	Consumption[4]
	(tonnes)					
1975	1 354	431	561	. .	. .	123
1980	2 118	325	1 091	2	26	105
1981	2 080	677	601	24	20	101
1982	1 274	585	212	2	30	81
1983	1 410	885	192	45	30	101
1984	2 123	1 487	373	14	27	113
1985	2 067	1 551	268	36	192	101
1986	2 297	1 805	374	20	31	96
1987	2 490	1 875	440	45	38	120
1988	2 398	3 062r	953	19	37	159
1989	2 344	3 262r	371	22	33	147
1990p	2 291	3 039	391	–	72	n.a.

Sources: Energy, Mines and Resources Canada; Statistics Canada.
1 Production from domestic ores and cobalt content of intermediate products exported, including cobalt content of Inco Limited and Falconbridge Limited shipments to overseas refineries. 2 Cobalt content. 3 Gross weight.
4 Consumption of cobalt in metal, oxides and salts.
p Preliminary; r Revised; – Nil; . . Not available; n.a. Not applicable.

TABLE 14. WESTERN WORLD COBALT PRODUCTION BY PRIMARY PRODUCERS, 1987-90

	1987	1988	1989	1990[1]
	(tonnes)			
Falconbridge Limited	1 575	1 951	1 946	909
Gécamines-Commercialisation	12 000	10 032	9 311	4 500
Inco Limited	1 584	1 410	1 510	801
Outokumpu Oy	1 234	1 132	1 295	600
Sherritt Gordon Limited	920	927	613	346
Sumitomo Metal Mining Co. Ltd.	126	109	102	62
Zambia Consolidated Copper Mines Limited	4 490	4 997	4 490	2 194
Other	–	–	–	–
Total	21 929	20 558	19 267	9 412

Source: Cobalt Development Institute.
1 January to June.
– Nil.

TABLE 15. NIOBIUM TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2615.90.00.10	Niobium ores and concentrates	Free	Free	Free	Free
8112.91.10.40	Niobium (columbium), unwrought metal, not alloyed; powders, not alloyed	4%	Free	1.6%	2.9%
8112.91.20.14	Niobium (columbium), unwrought metal, alloyed; waste and scrap; powders, alloyed	10.2%	6.5%	4%	2.9%
8112.99.90.40	Niobium (columbium), other	10.2%	6.5%	4%	3.3%
7202.93	Ferro-niobium	10.2%	6.5%	4%	3.9%

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, effective January 1, 1990.

TABLE 16. CANADA, COLUMBIUM (NIOBIUM) IMPORTS, 1988-90

Item No.		1988		1989		Jan.-Sept. 1990p	
		(kilograms)	($000)	(kilograms)	($000)	(kilograms)	($000)
Imports							
2615.90.00.10	Niobium ores and concentrates						
	Brazil	–	–	20 215	316	44	2
	United States	11 712	4	18 012	15	–	–
	Total	11 712	4	38 228	332	44	2
7202.93	Ferro-niobium						
	Brazil	383 161	2 572	489 560	4 551	543 052	5 554
	United States	796 120	6 188	577 245	5 644	380 473	3 967
	Total	1 179 281	8 761	1 066 806	10 196	923 526	9 522
8112.91.10.40	Niobium (columbium), unwrought metal, not alloyed; powders, not alloyed						
	United States	426	22	99	7	580	43
	Total	426	22	99	7	580	43
8112.91.20.14	Niobium (columbium), unwrought metal, alloyed; waste and scrap; powders, alloyed						
	United States	147	7	227	15	472	33
	Total	147	7	227	15	472	33
8112.99.90.40	Niobium (columbium), other						
	United States	8 391	902	5 573	511	4 501	406
	Total	8 391	902	5 573	511	4 501	406

Source: Statistics Canada.
p Preliminary; – Nil.
Note: Numbers may not add to totals due to rounding.

TABLE 17. CANADA, COLUMBIUM (NIOBIUM) PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975 AND 1980-90

	Production[1]	Imports: Primary Forms and Fabricated Metals		Exports[2] Columbium Ores and Concentrates to United States	Consumption[3] Ferrocolumbium and Ferrotantalum-columbium (Cb and Ta-Cb content)
	Cb_2O_5 content	Columbium	Columbium Alloys		
	(kilograms)				
1970	2 129 271	. .	. .	576 227	132 449
1975	1 661 567	. .	. .	9 682	215 910
1980	2 462 798	877	156	655 721	486 251
1981	2 740 736	913	303	419 865	455 500
1982	3 086 000	805	59	291 193	356 000
1983	1 744 722	967	396	543 599	359 000
1984	2 766 805	1 045	236	1 132 892	482 000
1985	3 182 900	889	499	1 279 764	447 000
1986	3 346 100	706	963	1 292 623	438 000
1987	2 769 800	3 922	6 302	2 035 510r	574 000
1988	3 367 200	See Table 16	See Table 16	1 662 000	663 000
1989	3 502 800	See Table 16	See Table 16	2 213 000	670 000
1990p	3 394 000	See Table 16	See Table 16	. .	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada; U.S. Department of Commerce.

[1] From 1970 through 1984, the data represent producers' shipments of columbium ores and concentrates and primary products, Cb_2O_5 content. From 1985 onward, the data represent company published information. [2] From U.S. Department of Commerce, Imports of Merchandise for Consumption, Report FT 135 for 1970-87. From U.S. Department of Commerce, Minerals Yearbook, Columbium and Tantalum, for 1988-89. Quantities in gross weight of material. [3] Available data as reported by consumers.

p Preliminary; r Revised; . . Not available.

TABLE 18. GALLIUM TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
8112.91.10	Gallium, unwrought metal, not alloyed; powders, not alloyed	4%	Free	1.6%	2.2%
8112.91.20.11	Gallium, unwrought metal, alloyed; waste and scrap; powders, alloyed	10.2%	6.5%	4%	2.2%
8112.99.90.10	Gallium, n.e.s.	10.2%	6.5%	4%	3.3%

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States effective January 1, 1990.
n.e.s. Not elsewhere specified.

TABLE 19. CANADA, GALLIUM IMPORTS, 1989 AND 1990

Item No.		1989		Jan.-Sept. 1990p	
		(kilograms)	($000)	(kilograms)	($000)
8112.91.10.10	Gallium, unwrought, not alloyed; powders				
	United States	290	52	81	20
	Total	290	52	81	20
8112.91.20.11	Gallium, unwrought, alloyed; waste and scrap; powders, alloyed				
	Japan	–	–	44	11
	United States	57	14	6	1
	Total	57	14	50	12
8112.99.90.10	Gallium and articles thereof, n.e.s.				
	United States	111	27	68	16
	United Kingdom	2	...	–	–
	Total	113	28	68	16

Source: Statistics Canada.
p Preliminary; – Nil; ... Amount too small to be expressed; n.e.s. Not elsewhere specified.

TABLE 20. GERMANIUM TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2617.90.90	Germanium ores and concentrates	Free	Free	Free	Free
2825.60.00.10	Germanium oxides	Free	Free	Free	2.2%
8112.30.10	Unwrought germanium, not alloyed; powders, not alloyed	4%	Free	1.6%	2.2%
8112.30.20	Unwrought germanium, alloyed; waste and scrap; powders, alloyed; articles of germanium	10.2%	6.5%	4%	3.3%

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States effective January 1, 1990.

TABLE 21. GERMANIUM TRADE, 1988-90

		1988		1989		Jan.-Sept. 1990	
		(kilograms)	($000)	(kilograms)	($000)	(kilograms)	($000)
Imports							
2825.60.00.10	Germanium oxides						
	United States	6 504	103	2 217	44	564	11
	United Kingdom	–	–	9	. . .	–	–
	Total	6 504	103	2 226	45	564	11
8112.30.10	Unwrought germanium, not alloyed; powders, not alloyed						
	United States	6 671	366	2 911	354	2 971	686
	Hong Kong	–	–	–	–	449	231
	Belgium	–	–	–	–	596	78
	Total	6 671	366	2 911	354	4 017	996
8112.30.20.10	Unwrought germanium; powders; articles of germanium						
	United States	1 349	81	963	309	6 177	2 998
	Belgium	15	22	92	7	–	–
	Total	1 364	103	1 055	317	6 177	2 998
8112.30.20.20	Germanium waste and scrap						
	United States	1 782	242	97	31	467	128
	Netherlands	302	242	–	–	–	–
	Zaire	673	10	–	–	–	–
	Total	2 758	495	97	31	467	128
Exports							
8112.30	Germanium						
	United States	194	67	302 525	1 893	–	–
	Japan	. . .	1	–	–	–	–
	Total	194	69	302 525	1 893	–	–

Source: Statistics Canada.
– Nil; . . . Amount too small to be expressed.
Note: Numbers may not add to totals due to rounding.

TABLE 22. INDIUM TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EEC MFN	Japan[1] MFN
8112.91.10.30	Unwrought indium, not alloyed; powders, not alloyed	4%	Free	1.6%	Free	2.2%	3.7%
8112.91.20.13	Unwrought indium, alloyed; waste and scrap; powders, alloyed	10.2%	6.5%	4%	Free	2.2%	3.7%
8112.99.90.30	Indium and articles thereof, n.e.s.	10.2%	6.5%	4%	Free	3.8%	6.5%

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States effective January 1, 1990; Official Journal of the European Communities, Vol. 33, No. L247, 1990, "Conventional" column; Custom Tariff Schedules of Japan, 1990.
[1] GATT rate is shown; lower tariff rates may apply circumstantially.
n.e.s. Not elsewhere specified.

TABLE 23. TANTALUM TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2615.90.00.20	Tantalum ores and concentrates	Free	Free	Free	Free
8103.10.10	Unwrought tantalum, not alloyed; powders, not alloyed	4%	Free	1.6%	2.2%
8103.10.20	Unwrought tantalum, alloyed; waste and scrap; powders, alloyed	10.2%	6.5%	4%	2.2%
8103.90	Tantalum and articles thereof, n.e.s.	10.2%	6.5%	4%	3.3%

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, effective January 1, 1990.
n.e.s. Not elsewhere specified.

TABLE 24. CANADA, TANTALUM PRODUCTION AND TRADE, 1988-90

Item No.		1988		1989		1990p	
		(kilograms)	($000)	(kilograms)	($000)	(kilograms)	($000)
Production[1]							
	Manitoba	17 989	1 695	96 842	10 540	100 000	8 439
	Total	17 989	1 695	96 842	10 540	100 000	8 439
Imports						**(Jan.-Sept.)**	
2615.90.00.20	Tantalum ores and concentrates						
	United States	14 075	20	53	3	73	4
	Total	14 075	20	53	3	73	4
8103.10.10	Unwrought tantalum, not alloyed; powders, not alloyed						
	United States	1 262	862	1 557	834	5 544	2 742
	Total	1 262	862	1 557	834	5 544	2 742
8103.10.20.10	Unwrought tantalum, alloyed; powders, alloyed						
	Canada	450	45	–	–	–	–
	United States	49	4	39	4	5 550	511
	Total	499	50	39	4	5 550	511
8103.10.20.20	Tantalum waste and scrap						
	United States	20 676	1 261	6 910	887	3 512	373
	People's Republic of China	–	–	480	85	–	–
	Taiwan	1 409	170	–	–	–	–
	Zaire	10 779	161	–	–	–	–
	United Kingdom	1 251	101	–	–	–	–
	Total	34 115	1 693	7 390	973	3 512	373
8103.90	Tantalum and articles thereof, n.e.s.						
	United States	20 835	3 555	13 803	3 384	4 516	795
	Puerto Rico	–	–	103	12	–	–
	Total	20 835	3 555	13 906	3 396	4 516	795
Exports							
8103.10	Unwrought tantalum; including bars and rods obtained simply by sintering; waste and scrap; powders						
	United States	251 437	461	62 714	41	1 415	25
	Japan	314	36	100	25	–	–
	Other countries	200	23	59	20	–	–
	Total	251 951	520	62 873	86	1 415	25
8103.90	Tantalum and articles thereof, n.e.s.						
	United States	1 705	294	967	121	1 960	478
	Total	1 705	294	1 094	169	1 960	478

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Producers' shipments of tantalum ores and concentrates and primary products, Ta_2O_5 content.
p Preliminary; – Nil; n.e.s. Not elsewhere specified.
Note: Numbers may not add to totals due to rounding.

TABLE 25. CANADA, TANTALUM PRODUCTION, TRADE AND CONSUMPTION, 1975 AND 1980-90

Year	Production[1] Ta_2O_5 Content	Imports, Primary Forms and Fabricated Metals: Tantalum	Imports, Primary Forms and Fabricated Metals: Tantalum Alloys	Consumption Ferrocolumbium and Ferrotantalum-columbium, Cb and Ta-Cb Content
	(kilograms)			
1975	178 304	. .	. .	215 910
1980	115 261	21 280	12 112	486 251
1981	103 949	2 769	5 043	455 500
1982	59 276	1 759	1 146	356 000
1983	–	1 742	332	359 000
1984	–	4 489	1 499	482 000
1985	39 457	2 370	1 354	447 000
1986	38 846	2 137	1 918	438 000
1987	36 478	16 341	3 211	574 000
1988	17 989	14 075	. .	663 000
1989	96 842	53	. .	670 000
1990p	100 000	73	. .	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Producers' shipments of tantalum ores and concentrates and primary products, Ta_2O_5 content.
– Nil; . . Not available; p Preliminary.

TABLE 26. TITANIUM TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EEC MFN	Japan[1] MFN
2614.00	Titanium ores and concentrates	Free	Free	Free	Free-3%	Free	Free
2823.00	Titanium oxides	10% BPT Free	Free	7%	4.8%	6%	6%
3206.10	Pigments and preparations based on titanium dioxides	10% BPT Free	Free	4%	3.6%	6%-6.9%	3.9%-4.8%
7202.91	Ferrotitanium and ferrosilico-titanium	10.2%	6.5%	4%	2.2%	4.9%	3.7%
8108.10.10	Unwrought titanium, not alloyed; powders, not alloyed	4%	Free	1.6%	9%	5%	5.1%
8108.10.20	Unwrought titanium, alloyed; waste and scrap; powders, alloyed	10.2%	6.5%	4%	Free-9%	5%	5.1%
8108.90.10	Titanium bars and rods, not alloyed	10.2%	6.5%	7.1%	12%	7%	6.5%
8108.90.20	Titanium plates, sheets, strip and foil, not alloyed	10.2%	6.5%	7.1%	12%	7%	6.5%
8108.90.30	Titanium anodes	10.2%	6.5%	7.1%	12%	7%	6.5%
8108.90.40	Titanium tubes and pipes, not alloyed	10.2%	6.5%	7.1%	4.4%	7%	6.5%
8108.90.50	Titanium castings	10.2%	6.5%	7.1%	4.4%	7%	6.5%
8108.90.90	Titanium and articles thereof, n.e.s.	10.2%	6.5%	7.1%	4.4%	7%	6.5%

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States, effective January 1, 1990; Official Journal of the European Communities, Vol. 33, No. L247, 1990, "Conventional" column; Custom Tariff Schedules of Japan, 1990.

[1] GATT rate is shown; lower tariff rates may apply circumstantially.

n.e.s. Not elsewhere specified.

TABLE 27. CANADA, TITANIUM PRODUCTION, TRADE AND CONSUMPTION, 1988-90

Item No.		1988		1989		1990p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Production (shipments)							
	Titanium dioxide, slag	x	x	x	x	x	x
Exports						(Jan.-Sept.)	
2614.00	Titanium ores and concentrates						
	Japan	114 256	6 164	19 884	1 635	180 355	12 150
	West Germany	112 886	6 221	571	1	60 732	5 939
	Netherlands	5 467	243	11 058	1 161	37 949	1 712
	United States	29 445	1 318	13 505	1 534	12 003	1 077
	Austria	27 689	1 297	–	–	16 000	846
	Brazil	34 650	2 262	34 650	2 183	–	–
	Other countries		3 843	40 626	4 258	–	–
	Total	360 856	21 348	120 294	10 772	307 039	21 726
2823.00	Titanium oxides						
	United States	25 490	39 199	29 288	48 788	3 813	6 521
	Iran	–	–	–	–	53	172
	United Kingdom	87	235	224	599	58	157
	Netherlands	–	–	129	415	36	113
	Tokelau	–	–	–	–	36	111
	Other countries	165	374	1 500	4 253	182	522
	Total	25 742	39 808	31 141	54 055	4 178	7 596
3206.10	Pigments and preparations based on titanium dioxide						
	United States	6 328	13 532	12 713	28 868	30 935	60 277
	Saudi Arabia	–	–	53	115	247	651
	Japan	18	42	–	–	105	259
	Other countries	216	160	328	1 038	297	902
	Total	6 562	13 734	13 094	30 021	31 584	62 089
8108.10	Unwrought titanium; waste and scrap; powders						
	United States	181	991	160	1 131	202	869
	United Kingdom	48	226	22	165	22	113
	India	13	30	37	129	–	–
	Japan	25	586	–	–	–	–
	South Korea	. . .	8	–	–	–	–
	Total	267	1 843	219	1 425	224	983
8108.90	Titanium and articles thereof, n.e.s.						
	United States	94	2 043	164	5 684	542	15 106
	Belgium	3	94	1	90	2	115
	Other countries	4	167	25	798	5	189
	Total	101	2 304	190	6 572	549	15 410
Imports							
2614.00	Titanium ores and concentrates						
	Australia	28 461	14 013	41 443	20 395	24 141	13 586
	United States	1 462	1 308	1 500	1 419	1 104	989
	Sierra Leone	–	–	4 807	3 263	–	–
	India	–	–	5 601	2 765	–	–
	Other countries	2 131	562	4 895	317	–	–
	Total	32 054	15 883	58 246	28 159	25 245	14 576
2823.00	Titanium oxides						
	United States	4 600	9 973	3 573	7 753	1 753	3 886
	France	824	2 559	65	183	500	1 201
	West Germany	1 948	4 801	1 281	2 762	475	1 124
	United Kingdom	624	1 843	361	958	237	640
	Italy	17	64	16	49	91	232
	People's Republic of China	635	1 259	192	379	79	156
	Belgium	380	748	213	431	51	108
	Other countries	1 418	4 220	686	1 739	73	226
	Total	10 446	25 467	6 387	14 254	3 259	7 573

TABLE 27 (cont'd)

Item No.		1988		1989		Jan.-Sept. 1990p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Imports (cont'd)							
3206.10	Pigments and preparations based on titanium dioxide						
	United States	10 792	21 501	13 606	28 565	11 044	23 654
	West Germany	237	618	143	477	76	318
	France	352	644	458	941	50	131
	Finland	16	84	–	–	26	90
	Japan	1	3	1	4	14	75
	Spain	57	103	–	–	18	47
	Other countries	539	1 297	460	1 192	4	14
	Total	11 994	24 250	14 668	31 179	11 232	24 329
7202.91	Ferrotitanium and ferrosilico-titanium						
	United States	544	1 465	260	2 096	284	2 242
	United Kingdom	103	532	172	1 457	124	799
	Total	647	1 998	432	3 553	409	3 041
8108.10	Unwrought titanium; waste and scrap; powders						
	United States	404	4 331	797	9 146	657	8 044
	United Kingdom	–	–	50	769	32	486
	Other countries	32	405	14	108	1	16
	Total	436	4 736	861	10 023	690	8 546
8108.90	Titanium and articles thereof, n.e.s.						
	United States	1 032	26 215	1 480	39 783	1 025	38 209
	Belgium	14	856	19	1 695	32	5 225
	Japan	137	2 861	155	3 708	124	3 320
	United Kingdom	34	1 336	53	1 532	54	1 661
	Other countries	29	956	55	2 497	11	780
	Total	1 246	32 224	1 762	49 215	1 246	49 195
Consumption[1]							
Ferrotitanium, gross weight		248	..	398	..	..	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Available data as reported by consumers.
p Preliminary; – Nil; x Confidential; .. Not available; ... Amount too small to be expressed.
Note: Numbers may not add to totals due to rounding.

Stone

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Production of all types of stone in 1990, including dimension stone, chemical and metallurgical grades, pulverized stone and crushed material, decreased about 5% according to preliminary figures. The value of production, at nearly $651 million, was down marginally compared to the previous year.

Additional data, along with more descriptive information, particularly on normal stone aggregates including crushed stone and sand and gravel, as well as on lightweight aggregates, are included in a separate chapter entitled "Mineral Aggregates."

Dimension stone relates to a variety of rock types that may be cut, shaped or simply selected for use in a broad range of construction/engineering, architectural or monumental purposes. The types of stone available from local sources is obviously controlled by the geology, but mainly includes granite, limestone, marble, sandstone and slate, as summarized in the first few tables. The term "granite," as commercially used, includes true granite, granodiorite, gneiss and other medium- to coarse-grained igneous rocks. However, black granite includes anorthosite and other dark coloured igneous rocks.

CANADIAN DEVELOPMENTS

The dimension stone industry has enjoyed rapid expansion in terms of output and trade. With up-to-date technology and aggressive marketing, Canadian companies mainly involved with construction-quality stone have become an important part of this international industry. A wide variety of granite in particular has attracted attention, with most activity centred in Quebec (80%-90%) and Ontario. Limestone, marble, sandstone and slate are also important in several parts of Canada (Figure 1). In the case of rough granite used in the construction sector, the value of production has increased thirteenfold from 27 000 t valued at less than $1.2 million in 1978 to 100 000 t valued at nearly $15.8 million in 1988 (Figure 2 and Table 5). The most recent trends, along with preliminary figures for 1989 and 1990, are shown in Figure 3.

Although granite used for monumental/ornamental purposes has declined in relative importance during the past few years, output based on official statistics has remained stable.

Granicor inc./Columbia Granite Inc., operating in Quebec, has opened several new quarries to provide a range of rough granite both for its own fabricating plants as well as for export markets. Also, members of the Quebec Granite Producers Association, including Polycor Inc., Granit Bussière Inc., A. Lacroix Ltée, Dumas et Voyer Ltée, Granilac Inc., as well as others, continue to develop new sources of stone. In northwestern Ontario, Nelson Granite Limited expanded its efforts to acquire access to rough granite for construction needs, thus complementing present requirements mainly for the manufacture of monuments by affiliate companies in Ontario and New Brunswick. Canital Granite Ltd., located in Winnipeg, continued efforts to develop its own sources of granite in Manitoba and Ontario. The company doubled its handling capacity with a new 30-blade block cutter. Pacific Granistone Manufacturing Inc., situated in Delta, British Columbia, reactivated the former CANROC plant and began fabricating a wide selection of North American granites for commercial and residential uses.

Several projects relating to the fabrication of thin custom-cut panels and the automated manufacture of granite tiles using the latest European technology contributed to the value of output in this sector. More details concerning fabrication are provided under the appropriate provincial headings.

Stone

The use of limestone and marble in construction has also increased, particularly during the last four years. However, up-to-date data are not available.

Provincial authorities continue to assess their stone resources and, with the rejuvenated interest in much of the historical record, early works such as those by W.A. Parks[1] and M.F. Goudge[2] have become classics and remain applicable in numerous regions. Many programs were assisted initially through federal-provincial Mineral Development Agreements as part of Economic and Regional Development Agreements (ERDAs). Promotional literature and display samples make up part of these projects.

Atlantic Provinces

Limestone

Occurrences of limestone in the Atlantic provinces are common and have been systematically catalogued in the past.[3,4,5] Deposits of commercial importance are being worked in three of the four provinces.

In Newfoundland, outside of periodic operations to secure limestone aggregate for highways, the main exploitation has been by North Star Cement Limited at Corner Brook.[6] Recently, in western Labrador, the Iron Ore Company of Canada (IOC) brought into production a dolomitic marble for use in self-fluxing "dolomitic-type" iron ore pellets.[7] In 1990, The Newfoundland Resources & Mining Company Limited (NRMC), as described in the "Mineral Aggregates" chapter, commissioned its tidewater property on the Port-au-Port Peninsula to quarry and ship limestone aggregates. Plans call for shipping 1-2 Mt/y, increasing to more than 4 Mt/y within five years.

In Nova Scotia, limestone occurs in the central and eastern parts of the province and is quarried for numerous uses. In New Brunswick, quarries operate at three locations: Brookville, Elm Tree and Havelock. Most uses relate to crushed stone for construction, ground material for agricultural application, lime manufacture and as a flux material. Efforts in both provinces were directed mainly toward assessing opportunities associated with the crushed stone sector.

Granite

Occurrences of granite in the Atlantic region have been described by Carr.[8] In Nova Scotia, a blue-grey granite produced near Nictaux is used mainly in the monument industry. Activity relating to granite, as well as to other types of stone, was summarized in two recent publications.[9,10] Construction Aggregates Ltd., owned by Lone Star Industries, Inc. of Greenwich, Connecticut, continued shipping high-quality granite aggregate from the company's Strait of Canso quarry. The Kelly Rock Limited project, with plans to develop a quarry to produce crushed granite at Kelly's Mountain, Cape Breton Island, was on hold pending environmental reviews.

Granite is quarried intermittently from a number of deposits in New Brunswick.[11] A red, fine-to-medium-grained granite is produced near St. Stephen, and fine-grained, pink, grey and blue-grey granites are available in the Hampstead (Spoon Island) district. In the Bathurst area, a brown-to-grey, coarse-grained granite is quarried on demand, as is a salmon-coloured, medium-grained granite near Antinouri Lake and a black, ferro-magnesian rock in the Bocabec River area. Red granite is available in the St. George district.

In Newfoundland, the Mount Peyton Granite Co. Ltd. quarried some "black granite" from the Mt. Peyton gabbro in central Newfoundland, as well as some pink granite from the Pass Island granite on the south coast. Blocks were sent to two fabricators for cutting and polishing tests. Interest continued in the Lumsden coarse-grained, megacrystic granite situated on the northwest coast and a red granite near the village of Seal Cove on the south-central coast. On the northern Labrador coast, several companies have expressed interest in the Nain anorthosite complex, although there have been no major commitments to date. The complex hosts occurrences of an attractive dark-coloured chatoyant labradorite from which several test blocks were quarried.[7]

Sandstone and Slate

Production of slate by Random Slate Inc. (formerly Island Tile & Slate Limited) has been very intermittant since start-up in 1986 at the Nut Cove quarry, Trinity Bay, Newfoundland. Prospective developers agree that there is good quality green- and purple-coloured raw material available, in addition to the availability of material for manufacturing red and grey slates. In Nova Scotia, medium-grained buff sandstone is quarried at Wallace for use as heavy riprap and for dimension stone. This stone enjoyed widespread use in the past and is now also important for restoration projects.

In New Brunswick, a red, fine-to-medium-grained sandstone has been quarried in Sackville for use in construction. Deposits are exploited intermittently throughout Kent and Westmorland counties for local projects and highway work.

Quebec

Limestone

Limestone occurs in the St. Lawrence and Ottawa River valleys and in the Eastern Townships. Limestone blocks and other shapes are produced for construction uses in the Montreal region and at various locations throughout the province. Marble has been produced in the Eastern Townships and the Lac St-Jean areas.

Granite

As a result of demand arising from improved marketing and advanced processing technology, about 25 companies quarry granite mainly in the Rivière-à-Pierre, the Lac St-Jean and the Appalachian regions. Activity has increased substantially in the two years since detailed reports became available.[12,13] These companies now account for about 50 quarries classified as producers of granite for construction, monuments and/or furniture. Tulinor Inc. opened its granite tile manufacturing plant in Grande-Bergeronnes, which is designed to produce about 60 000 m^2/y. Also, Granitslab International Inc. of Stanstead, Quebec, opened a granite-cutting and polishing plant to supply local and export markets for granite slab.

Detailed current statistics on the production of fabricated products is lacking; however, the value of production of shaped, construction-quality granite finished in Quebec, from both domestic and imported block, is estimated to have increased more than tenfold in the period 1980-90.

Sandstone

Of several operations producing from sandstone resources in Quebec, only Les Carrières Ducharme Inc. in Hemmingford, Huntingdon County, is listed as producing flagstone and construction blocks.

Ontario

Limestone

Although limestones in Ontario range in age from Precambrian through Devonian, major production comes from Ordovician, Silurian and Devonian deposits. A major provincially funded, three-volume study entitled "Limestone Industries of Ontario," was completed in 1989 to assess the geological resources, economic factors and the related industries mainly associated with limestone, dolostone and marble.[14]

Arriscraft Corporation quarries a blue-grey-to-buff-coloured dolomitic limestone from the Amabel formation near Wiarton. Sold under the name of Adair marble, this attractive stone has been used increasingly for up-scale construction projects including the new Canadian Chancery in Washington, D.C.

Marble

Limestone and marble are often confused, the latter being the metamorphosed equivalent of the former and usually including both dolomitic and calcitic varieties. As an industrial term, marble is used for recrystallized calcareous rock capable of taking a polish.

In the past, only a few uses for domestic marble have been reported.[15] In 1990, Two Island Marble Corporation began a small-scale quarrying and cutting operation in the Renfrew area of eastern Ontario.

International Larder Minerals Inc. of Toronto continued negotiations with a view to establishing an agglomerated marble tile plant at Madoc.

Steep Rock Calcite, a wholly-owned subsidiary of Pleuss-Staufer AG of Switzerland operating at Tatlock and Perth, is the main producer of high-purity carbonate fillers in Ontario.

Granite

Granites occur in northern, northwestern and southeastern Ontario.[16,17,18,19,20,21,22] Several companies were active, with Nelson Granite Limited being the major producer of pink granite near Vermilion Bay where there are exceptionally large reserves. Canital Granite Ltd., of Winnipeg, has quarried a yellow-brown granite north of Kenora in northwestern Ontario. Canadian Shield Quarries Ltd., a member of Société d'Exploration Minière Vior Inc., has been active in the Sudbury area where deposits of gabbroic anorthosite "black granite" are attracting much attention. Positano Granite, a division of Poscan Ltd., has quarried a white and black gabbro east of Sudbury in northern Ontario. Detailed activity throughout the province is highlighted in an annual directory.[23]

Sandstone

Sandstone quarried near Toronto, Ottawa and Kingston has been used widely in Ontario as building stone.[24] Medina sandstone is fine-to-medium-grained and varies from grey, through buff and brown to red, with some mottled units. Potsdam stone is medium-grained and varies from grey-white through salmon-red to purple, and mottled. Current uses are as rough building stone, mill blocks from which sawn pieces are obtained, ashlar, flagstone and as a source of silica for ferrosilicon and glass.

Western Provinces

Limestone

From east to west through the southern half of Manitoba, rocks of Precambrian, Ordovician, Silurian, Devonian and Cretaceous ages occur. Limestones of commercial importance occur in the three middle periods and range from magnesian limestone through dolomite to high-calcium limestones.[2,25] A fairly recent publication includes current developments relating to limestone as well as to other types of stone.[26]

Tyndall Stone, a mottled dolomitic limestone often referred to as "tapestry" stone, is the best known Manitoba limestone. It is quarried by Gillis Quarries, Limited at Garson, about 50 km northeast of Winnipeg, and more than 25 000 m^2 were used recently on the new Canadian Museum of Civilization very attractively situated on the Ottawa River in Hull, Quebec. Limestone from Moosehorn, 160 km northwest of Winnipeg, and from Mafeking, 40 km east of the Saskatchewan border and 160 km south of The Pas, is transported to Manitoba and Saskatchewan centres for use in the metallurgical, chemical, agricultural and construction industries.

The eastern ranges of the Rocky Mountains contain Cambrian to Triassic limestones. Major deposits characterized by a wide variety of types occur in Devonian and Carboniferous rocks.[27] In southwestern Alberta, high-calcium limestone is mined at Exshaw, Kananaskis and Crowsnest, chiefly for the production of cement and lime, for metallurgical and chemical uses, and for use as a crushed stone. Similar uses are made of limestone quarried at Cadomin, near Jasper.[6]

In British Columbia, large volumes of limestone are mined each year for cement and lime manufacture, for use by the pulp and paper industry and for various construction applications.[6] Quarries on Texada Island, British Columbia, have for many years provided limestone to markets in Vancouver and in Washington State by virtue of their quality and position relative to tidewater shipping facilities. Deposits on Aristazabal Island have been developed for the export market. Other operations at Terrace, Clinton, Westwold, Popkum, Dahl Lake, Doeye River and Cobble Hill have produced stone for construction and for filler use.[28]

Granite

In Manitoba, at Lac du Bonnet located northeast of Winnipeg, two companies quarry pink-to-reddish granite which is mainly shipped to Quebec and the United States for finishing. A new plant in Winnipeg, Canital Granite Ltd., is now utilizing local block from near Medika, Manitoba, as well as stone from nearby Ontario to produce thin-cut tile for exterior cladding. The dimension stone resources of the Medika, Manitoba area were documented in 1990.[29]

In Saskatchewan and Alberta, granite is not quarried on a regular basis. Most recent work to evaluate potential reserves in Saskatchewan has been undertaken by the Saskatchewan Geological Survey.[30,31,32]

In British Columbia, a medium-grained, light-grey-to-blue-grey granodiorite has been quarried from Nelson Island and other areas. Although small quantities of stone are supplied from local sources, the industry has not flourished since the 1930s. In 1990, a processing plant in Vancouver owned by Pacific Granistone Manufacturing Inc. was reactivated to serve western North American and Pacific Rim markets using local as well as imported granite block. The company also began cutting granite slabs available on a wholesale basis. A publication by the British Columbia Ministry of Energy, Mines and Petroleum Resources highlights current and past quarrying along with uses relating to granite, marble, flagstone, jade and rhodonite.[33]

Sandstone

Sandstone for building and ornamental uses quarried near Banff, Alberta, is hard, fine-grained, medium-grey and is referred to as "Rundal Stone."

SPECIFICATIONS

Several test methods apply to dimension stone but generally begin with compressive strength (ASTM C170) and absorption (ASTM C97). The compressive strength is defined as the maximum load per unit area that can be applied before the rock fails, reported in pounds per square inch (psi) and in megapascals (MPa). Absorption is defined as the percentage of water by weight that is absorbed over a 48-hour period.

CONSUMPTION AND MARKETS

Most dimension stone, including granite, limestone, marble, sandstone and slate, is used in construction-oriented projects. Chemical-related uses mainly apply to limestone along with its large-scale consumption in the cement, lime, glass and metal-smelting industries.

Granite, as a dimension stone, is processed mainly for interior and exterior floor- and wall-cladding, modular block panelling and for monuments. Increasingly, a broader range of colour and texture or fabric is being sought by developers and architects. Detailed consumption data for rough and finished granite, as well as for other types of stone, are not available. However, trends can be established based on production, imports and less well-defined export data. During the period 1980-89, production of rough granite approximately doubled and imports of roughly trimmed and cut granite block (codes 2516.11 and 2516.12) more than doubled according to recent estimates and revisions (Table 9). Exports of rough granite have increased about eightfold since 1985 in response to demand in Japan, the United States and Italy. Exports of granite monumental or building stone (code 6802.23 – cut or sawn, and code 6802.93 – worked) were mainly to the United States, and since 1983 this large market has been the main reason for the installation of increased fabricating capacity.

Some specific uses for stone in the chemical field are: neutralization of acid waste liquors; extraction of aluminum oxide from bauxite; manufacture of soda ash, calcium carbide, calcium nitrate and carbon dioxide; in pharmaceuticals; as a disinfectant; in the manufacture of dyes, rayons, paper, sugar and glass; and in the treatment of water. Dolomitic limestone is used in the production of magnesium chloride and other magnesium compounds.

Agricultural limestone is used to control soil acidity and to add calcium and magnesium to the soil. Limestone and lime are used as soil stabilizers, particularly on highway construction projects.

Stone

Dolomite is the source of magnesium metal produced by Haley Industries Limited at Haley, Ontario; the company also uses a high-calcium lime from southeastern Ontario in the production of calcium metal. Dead-burned dolomitic limestone for use as a refractory is produced at Dundas, Ontario by Steetley Quarry Products Inc. In additon, a magnesite deposit at Eon Mountain in British Columbia has been quarried by Baymag Mines Co. Limited since 1982 to produce caustic magnesia, refractory grade MgO, and more recently, fused magnesia.

TARIFFS AND TRADE

The remaining tariffs between Canada and the United States on all square or rectangular block or slab, along with tariffs relating to articles of granite, simply cut or sawn, were phased out in 1989. Tariffs relating to other types of worked stone, simply cut or sawn, as well as to tiles and similar articles, will be phased out in 1993. Some natural stone products classified as millstones or grindstones are subject to a later phase-out expiring in 1998.

OUTLOOK

The dimension stone industry, given new technology relating to quarrying, fabrication and installation, along with continuing favourable economic conditions, is expected to continue to grow. Although the most rapid expansion has been associated with new quarries and fabricating plants in Quebec, modernization by several producers across Canada has increased the availability of high-quality finished products at competitive prices. Markets for building stone face competition from substitutes such as aluminum, concrete, glass and ceramics. However, use of modern gang saws for cutting thin panels for cladding fitted to steel or concrete construction units is expected to continue improving cost effectiveness. For aesthetic reasons, demand for natural materials, along with manufactured products at least partially based on these, is expected to expand as new markets are developed. Efforts continue on behalf of the industry to illustrate to developers and architects the availability in Canada of a wide range of architectural stone.

REFERENCES

[1] Parks, W.A., Building and Ornamental Stones of Canada, Canada Department of Mines, Mines Branch, Ottawa, Nos. 100, 203, 279, 388 and 452, Volume 1 (1912) to Volume V (1971), OUT OF PRINT.

[2] Goudge, M.F., Limestones of Canada, Canada Department of Mines, Mines Branch, Ottawa, Nos. 733, 742, 755, 781, 811, Part 1 (1934) to Part V (1946), OUT OF PRINT.

[3] DeGrace, John R., Limestone Resources of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, St. John's, Newfoundland, Report 74-2, 1974.

[4] Shea, F.S. and Murray, D.A., Limestones and Dolomites of Nova Scotia, Department of Mines, Halifax, Nova Scotia, Part I, Bulletin No. 2, 1967 and Part II, Bulletin No. 2, 1975.

[5] Hamilton, J.B., Limestone in New Brunswick, Department of Natural Resources, Mineral Resources Branch, Fredericton, New Brunswick, Mineral Resources Report No. 2, 1965.

[6] Vagt, G.O., Cement, Canadian Minerals Yearbook, 1989, Energy, Mines and Resources Canada, Mineral Policy Sector, Ottawa, Ontario.

[7] Dean, P.L., Meyer, J.R. and Howse, A.F., Industrial Minerals Operations in Newfoundland and Labrador, Newfoundland/Labrador Department of Mines and Energy, 1987.

[8] Carr, G.F., The Granite Industry of Canada, Canada Department of Mines and Technical Surveys, Mines Branch, Ottawa, Ontario, No. 846, 1955.

[9] Dickie, G.B., Building Stone in Nova Scotia, Nova Scotia Department of Mines and Energy, Halifax, Information Circular 12, 1988.

10 Nova Scotia Department of Mines and Energy, 1989, Nova Scotia Dimension Stone - for Designers, Developers and Quarriers, p. 24.

11 New Brunswick Department of Natural Resources and Energy, Minerals Division, 1989, New Brunswick Stone - Decorative and Architectural, Miscellaneous Report No. 7, p. 23.

12 Nantel, S., Carrières de Granite Architectural et Ornamental Exploitées au Québec, PR088-03, 1988.

13 Menard, D., List of Quebec Companies Involved with Granite, Ministère de l'Energie et des Ressources, Service du Développement minier, 1989.

14 Ontario Ministry of Natural Resources, Limestone Industries of Ontario - A Three Volume Study of the Geology, Resources and Related Industries, 1989.

15 Hewitt, D.F., Building Stones of Ontario, Part III, Marble, Ontario Department of Mines, Toronto, Industrial Mineral Report No. 16, 1964.

16 Hewitt, D.F., Building Stones of Ontario, Part V, Granite and Gneiss, Ontario Department of Mines, Toronto, Industrial Mineral Report No. 19, 1964.

17 Verschuren, C.P., van Haaften, S. and Kingston, P.W., Building Stones of Eastern Ontario, Southern Ontario - 1985; Ontario Geological Survey, Open File Report 5556, 116 p.

18 Beard, R.C. and Kennedy, M.C., Building and Ornamental Stone in Northwestern Ontario, Canadian Institute of Mining and Metallurgy, unpublished, 1987.

19 Verschuren, C.P. and Kingston, P.W., 1987, Criteria for Quarry Development in Southeastern Ontario, Canadian Institute of Mining Bulletin, p. 55-60, February issue.

20 Lebaron, P.S., Verschuren, C.P., Papertzian, V.C. and Kingston, P.W., 1989, Building Stone Potential in Eastern Ontario, Ontario Geological Survey, Open File Report 5706, 539 p.

21 Fouts, C.R. and Marmont, C., 1989, Gneisses in the Parry Sound-Muskoka Area: Flagstone Resources, Open File Report 5725, in press.

22 Lacy, J.K., 1989, Building Stone Inventory of the Sudbury Resident Geologist's Area, OGS Open File Report 5721.

23 Ontario Building Stone Producers, Directory, 1990, Ministry of Northern Development and Mines, Mines and Minerals Division.

24 Hewitt, D.F., Building Stone of Ontario, Part IV, Sandstone, Ontario Department of Mines, Toronto, Industrial Mineral Report No. 17, 1964.

25 Bannatyne, B.B., High-Calcium Limestone Deposits of Manitoba, Manitoba Department of Mines, Resources and Environmental Management, Mineral Resources Division, Exploration and Geological Survey Branch, Winnipeg, Publication 75-1, 1975.

26 Gunter, R. and Segard, S., Industrial Minerals of Manitoba, Manitoba Energy and Mines, Minerals Division, Open File Report OF 85-7.

27 Holter, M.E., Limestones Resources of Alberta, Transactions, Canadian Institute of Mining and Metallurgy, Bull. V.76, 1971.

28 McCammon, J.W., Sadar, E., Robinson, W.C., and Robinson, J.W., Geology Exploration and Mining in British Columbia, 1974, British Columbia Department of Mines and Petroleum Resources.

29 Manitoba Energy and Mines, Industrial Minerals Division, 1990, Documentation of Dimension Stone Resources in the Medika Area, (NTS 52E).

30 Thomas, M.W. (1988a): Geological Assessment of Building Stone Potential, Wilson Lake and Bridgeman Lake Plutons–Northern Saskatchewan (NTS 73P/16 and 73P/10): in Summary of Investigations 1985, Sask. Geol. Surv., Misc. Rep. 88-4, p. 119-124.

31 ________ (1988b): Building Stone Reconnaissance Project 1988: Geological Traversing in Six Precambrian Plutons, Northern Saskatchewan; unpublished report, in Saskatchewan Geological Survey, Industrial Mineral File No. S-35a, 58 p.

32 Saskatchewan Energy and Mines, Geology Division, 1989, Stone in Saskatchewan, 25 p.

33 White, G.V. and Hora, Z.D., British Columbia Dimension Stone, Ministry of Energy, Mines and Petroleum Resources, Mineral Resources Division, Geological Survey Branch, Victoria, Information Circular 1988-6.

Note: Information contained in this review was current as of mid-January 1991.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2514.00	Slate, whether or not roughly trimmed or merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape				
2514.00.10	Crude or roughly trimmed	Free	Free	Free	Free
2514.00.20	Merely cut, by sawing or otherwise, into blocks or slabs	5.5%	3.5%	Free	Free
2514.00.90	Other, including powder and waste	10.2%	6.5%	Free	Free
25.15	Marble, travertine, ecaussine and other calcareous monumental or building stone of an apparent specific gravity of 2.5 or more, and alabaster, whether or not roughly trimmed or merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape				
2515.11.00	Crude or roughly trimmed				
2515.11.10	Marble	Free	Free	Free	Free
2515.11.20	Travertine	Free	Free	Free	Free
2515.12.00	Merely cut, by sawing or otherwise into blocks or slabs				
2515.12.10	Marble	4%	Free	Free	Free
2515.12.20	Travertine	4%	Free	Free	Free
2515.20	Ecaussine and other calcareous monumental or building stone; alabaster				
2515.20.10	Crude or roughly trimmed	Free	Free	Free	Free
2515.20.20	Merely cut, by sawing or otherwise into blocks or slabs	5.5%	3.5%	Free	Free
25.16	Granite, porphyry, basalt, sandstone and other monumental or building stone, whether or not roughly trimmed or merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape				
	Granite				
2516.11.00	Crude or roughly trimmed	Free	Free	Free	Free
2516.12.00	Merely cut, by sawing or otherwise into blocks or slabs	5.5%	Free	Free	Free
	Sandstone				
2516.21.00	Crude or roughly trimmed	Free	Free	Free	Free
2516.22.00	Merely cut, by sawing or otherwise, into blocks or slabs	5.5%	3.5%	Free	Free
2516.90	Other monumental or building stone				
2516.90.10	Crude or roughly trimmed	Free	Free	Free	Free
2516.90.20	Merely cut, by sawing or otherwise, into blocks or slabs	5.5%	3.5%	Free	Free

TARIFFS (cont'd)

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
25.17	Pebbles, gravel, broken or crushed stone, of a kind commonly used for concrete aggregates, for road metalling or for railway or other ballast, shingle and flint, whether or not heat-treated; macadam of slag, dross or similar industrial waste, whether or not incorporating the materials cited in the first part of the heading, tarred macadam granules, chippings and powder, of stones of heading No. 25.15 or 25.16, whether or not heat-treated				
2517.10.00	Pebbles, gravel, broken or crushed stone, of a kind commonly used for concrete aggregates, etc.	Free	Free	Free	Free
2517.20.00	Macadam of slag, dross or similar industrial waste	Free	Free	Free	Free
2517.30.00	Tarred macadam	10.2%	6.5%	Free	Free
	Granules, chippings and powder, of stones of heading No. 25.15 or 25.16, whether or not heat-treated				
2517.41.00	Of marble	Free	Free	Free	Free
2517.49	Other				
2517.49.10	Limestone roofing granules	Free	Free	Free	Free
2517.49.90	Other	10.2%	6.5%	4%	Free
6801.00.00	Setts, curbstones and flagstones of natural stone (except slate)	5.5%	Free	2.2%	2.5%
6802.10	Tiles, cubes and similar articles, whether or not rectangular (including square), not more than 7 cm; artificially coloured granules, chippings and powder				
6802.10.10	Roofing granules, artificially coloured	Free	Free	Free	4.1%
6802.10.90	Other	12.5%	8%	5%	4.1%
	Other monumental or building stone and articles thereof, simply cut or sawn, with a flat or even surface				
6802.21	Marble, travertine and alabaster	5.7%	3.5%	2.2%	
6802.21.10	Travertine	5.7%	3.5%	2.2%	3.6%
6802.21.50	Other	5.7%	3.5%	2.2%	1.2%
6802.22.00	Other calcareous stone	8%	5%	3.2%	3.6%
6802.23.00	Granite	5.5%	Free	Free	Free
6802.29.00	Other stone	8%	5%	3.2%	4.5%
	Other				
6802.91	Marble, travertine and alabaster	9%	Free	3.6%	1.6%-3.6%
6802.92.00	Other calcareous stone	9.9%	6.5%	3.9%	3.6%
6802.93.00	Granite	10.2%	6.5%	Free	Free
6802.99.00	Other stone	10.2%	6.5%	4%	3.9%
6803.00	Worked slate and articles of slate or of agglomerated slate				
6803.00.10	Roofing slate	Free	Free	Free	3.9%
6803.00.90	Other	10.2%	6.5%	4%	2.2%
6804.10.00	Millstones and grindstones for milling, grinding or pulping	10.2%	Free	7.1%	Free
6804.23.00	Of natural stone	10.2%	Free	7.1%	Free

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States effective January 1, 1990.

Stone

TABLE 1. CANADA, STONE EXPORTS AND IMPORTS, 1988-90

Item No.		1988		1989		Jan.-Sept. 1990p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Exports							
2514.00	Slate, whether or not roughly trimmed or merely cut, etc.	105	11	330	133	4	. .
2515.11	Marble and travertine, crude or roughly trimmed	556	332	179	72	4 685	33
2515.12	Marble and travertine, merely cut, by sawing or otherwise into blocks, etc.	764	1 147	21	24	538	1 082
						(cubic metres)	
2516.11	Granite, crude or roughly trimmed	14 396r	2 309	31 852	5 759	18 706	10 695
2516.12	Granite, merely cut, by sawing or otherwise into blocks, etc.	72 544r	13 853r	74 543	11 393	4 154	2 278
2516.21	Sandstone, crude or roughly trimmed	8 300	37	–	–	50	2
						(tonnes)	
2516.22	Sandstone, merely cut, by sawing or otherwise into blocks, etc.	1 935	64	20	3	1	3
2516.90	Monumental or building stone, n.e.s.	6 378	554	247	214	888	91
2517.10	Pebbles, gravel broken or crushed stone used for aggregates, etc.	1 753 804r	11 472r	1 023 880	9 428	886 894	5 588
2517.41	Marble granules, chipping and powder of 25.15 or 25.16 heat-treated or not	1 908	502	–	–	160	25
2517.49	Granules, chippings and powder n.e.s. of 25.15 or 25.16 heat-treated or not	149 405	1 015	49 996	703	8 026	162
6801.00	Setts, curbstones and flagstones of natural stone (except slate)	. .	57	–	–	–	–
6802.10	Tiles, etc. rectangular or square not more than 7 cm, etc., artificially coloured granules, chippings and powder	649	629	. .	143	. .	39
6802.21	Monumental or building stone, cut or even, marble, travertine and alabaster	. .	560	. .	17	. .	98
6802.22	Monumental or building stone, cut or sawn, flat or even, other calcareous stone	. .	18	–	–	–	–
6802.23	Monumental or building stone, cut or sawn, flat or even, granite	. .	11 396	. .	8 637	. .	1 582
6802.29	Monumental or building stone, cut or sawn, flat or even, n.e.s.	. .	199	. .	314	. .	30
6802.91	Worked monumental or building stone, n.e.s., marble, travertine or alabaster	. .	390	. .	336	. .	605
6802.92	Worked monumental or building stone, n.e.s., calcareous stone, n.e.s.	. .	1	–	–	. .	8
6802.93	Worked monumental or building stone, n.e.s., granite	. .	13 178	. .	17 505	. .	20 759
6802.99	Worked monumental or building stone, n.e.s.	. .	435	. .	81	. .	733
6803.00	Worked slate and articles of slate or agglomerated slate	. .	34	–	–	. .	3
6804.10	Millstones and grindstones for milling, grinding or pulping	. .	6 028r	. .	10 025	. .	6 480
6804.23	Millstones, grindstones, etc. of natural stone	. .	277	. .	288	. .	815
Imports							
2514.00	Slate, whether or not roughly trimmed or merely cut, etc.	3 112r	640r	2 497	909	1 088	429
2515.11	Marble and travertine, crude or roughly trimmed	4 969r	1 744r	2 263	680	1 449	340
2515.12	Marble and travertine, merely cut, by sawing or otherwise into blocks, etc.	4 801r	2 972r	2 678	1 527	1 773	975
2516.11	Granite, crude or roughly trimmed	41 462r	8 830r	50 640	10 710	35 439	8 341
2516.12	Granite, merely cut, by sawing or otherwise into blocks, etc.	4 820r	2 346r	1 619	1 029	733	480
2516.21	Sandstone, crude or roughly trimmed	875r	104	2 168	239	2 397	294

TABLE 1 (cont'd)

Item No.		1988		1989		Jan.-Sept. 1990p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Imports (cont'd)							
2516.22	Sandstone, merely cut, by sawing or otherwise into blocks, etc.	15 901r	2 361r	12 920	2 618	8 049	1 637
2516.90	Monumental or building stone, n.e.s.	11 023r	1 525r	8 107	1 714	7 493	1 275
2517.10	Pebbles, gravel broken or crushed stone used for aggregates, etc.	594 793r	3 546r	739 220	4 292	836 963	4 564
2517.41	Marble granules, chipping and powder of 25.15 or 25.16 heat-treated or not	31 705r	3 217r	34 469	4 329	36 681	4 434
2517.49	Granules, chippings and powder n.e.s. of 25.15 or 25.16 heat-treated or not	133 571r	2 065r	123 476	1 535	94 277	1 141
6801.00	Setts, curbstones and flagstones of natural stone (except slate)	..	1 174r	..	1 059	..	653
6802.10	Tiles, etc. rectangular or square not more than 7 cm, etc., artificially coloured granules, chippings and powder	33 701	4 006r	31 238	4 439	26 056	3 377
6802.21	Monumental or building stone, cut or even, marble, travertine and alabaster	..	2 160r	..	2 769	..	2 577
6802.22	Monumental or building stone, cut or sawn, flat or even, other calcareous stone	..	365r	..	264	..	431
6802.23	Monumental or building stone, cut or sawn, flat or even, granite	..	2 199r	..	1 128	..	1 529
6802.29	Monumental or building stone, cut or sawn, flat or even, n.e.s.	..	798r	..	477	..	316
6802.91	Worked monumental or building stone, n.e.s.	..	39 824r	..	51 687	..	38 310
6802.92	Worked monumental or building stone, n.e.s., calcareous stone, n.e.s.	..	130	..	566	..	1 076
6802.93	Worked monumental or building stone, n.e.s., granite	..	15 550r	..	25 603	..	24 517
6802.99	Worked monumental or building stone, n.e.s.	..	702r	..	853	..	935
		(sq metres)		**(sq metres)**		**(sq metres)**	
6803.00	Worked slate and articles of slate or agglomerated slate	39 256	2 374r	30 191	3 404	19 277	2 730
6804.10	Millstones and grindstones for milling, grinding or pulping	..	2 156r	..	2 018	..	1 290
6804.23	Millstones, grindstones, etc. of natural stone	..	2 267r	..	2 597	..	1 475

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary; r Revised; .. Not available; – Nil; n.e.s. Not elsewhere specified.

TABLE 2. CANADA, TOTAL PRODUCTION OF STONE, 1988-90

	1988		1989		1990p	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
By province[1]						
Newfoundland	1 127r	7 488r	862	5 199	1 156	6 155
Nova Scotia	6 567	34 453	6 732	33 718	5 298	28 698
New Brunswick	2 445	15 266	2 365	18 976	2 756	17 290
Quebec	46 450	234 775	42 584	230 455	41 923	248 116
Ontario	56 673r	309 031r	58 250	330 353	53 416	308 119
Manitoba	2 878r	12 567r	2 857	12 566	2 488	9 554
Saskatchewan	–	–	–	–	–	–
Alberta	298r	2 774r	374	3 619	345	3 914
British Columbia	3 571	21 264	3 421	22 922	3 641	22 478
Northwest Territories and Yukon	116r	374r	727	4 344	1 022	6 550
Total	120 126r	637 993r	118 172	662 151	112 046	650 874
By use[2]						
Dimensional stone			..	..	..	..
Rough	202	20 833	..	..	..	..
Monumental and ornamental stone (n.f.)	66	8 943	..	..	..	..
Other (flagstone, curbstone, paving blocks, etc.)	62	4 010	..	..	..	..
Chemical and metallurgical						
Cement plants, Canada	12 539	25 623	..	..	..	..
Cement plants, foreign	577	1 550	..	..	..	..
Lining, open-hearth furnaces	–	–	..	..	..	..
Flux in iron and steel furnaces	1 233	5 543	..	..	..	..
Flux in nonferrous smelters	53	1 161	..	..	..	..
Glass factories	198	3 734	..	..	..	..
Lime plants, Canada	2 346	14 141	..	..	..	..
Lime plants, foreign	477	2 130	..	..	..	..
Pulp and paper mills	226	1 932	..	..	..	..
Sugar refineries	33	230	..	..	..	..
Other chemical uses	1 452	9 828	..	..	..	..
Pulverized stone						
Whiting (substitute)	39	2 346	..	..	..	..
Asphalt filler	137	727	..	..	..	..
Dusting, coal mines	2	85	..	..	..	..
Agricultural purposes and fertilizer plants	1 142	14 804	..	..	..	..
Other uses	419	12 397	..	..	..	..
Crushed stone for						
Manufacture of artificial stone	57	1 072	..	..	..	..
Roofing granules	398	7 523	..	..	..	..
Poultry grit	40	966	..	..	..	..
Stucco dash	28	1 774	..	..	..	..
Terrazzo chips	9	571	..	..	..	..
Rock wool	–	–	..	..	..	..
Rubble and riprap	1 645	9 899	..	..	..	..
Concrete aggregate	10 179	56 136	..	..	..	..
Asphalt aggregate	8 268	43 545	..	..	..	..
Road metal	61 491	279 261	..	..	..	..
Railroad ballast	2 629	16 718	..	..	..	..
Other uses	29 065	130 275	..	..	..	..
Total	135 010	677 757	..	..	..	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Data exclude stone used in the Canadian cement and lime industries. [2] Data include stone used in the Canadian cement and lime industries.
p Preliminary; r Revised; . . Not available; – Nil; n.f. Not finished or dressed.
Note: Totals may not add due to rounding. Due to recent amendments incorporated here, data may not correspond with figures reported in Statistics Canada Cat. No. 26-202 "Canada's Mineral Production - Preliminary Estimates 1990."

TABLE 3. CANADA, PRODUCTION OF LIMESTONE, 1987-89

	1987		1988		1989	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
By province[1]						
Newfoundland	379	4 463	768	5 221	413	2 713
Prince Edward Island	–	–	–	–	–	–
Nova Scotia	210	2 181	156	1 891	177	1 934
New Brunswick	627	6 012	724	6 403	525	6 030
Quebec	33 562	148 515	35 440	157 562	32 752	152 910
Ontario	49 349	242 125	53 192r	274 709r	56 136	306 278
Manitoba	3 049	11 445	2 321r	8 831	2 396	10 138
Saskatchewan	2	4	–	–	–	–
Alberta	212	1 429	261	2 565	328	3 365
British Columbia	2 123	11 112	1 910	11 692	1 823	12 855
Northwest Territories and Yukon	245	1 037	14r	220r	309	1 918
Total	89 759	428 325	94 787r	469 094r	94 859	498 141
By use[2]						
Dimensional stone						
Rough	54	1 895	53	2 220	. .	. .
Monumental and ornamental stone (n.f.)	. . .	40	. . .	40	. .	. .
Other (flagstone, curbstone, paving blocks, etc)	20	1 790	24	1 875	. .	. .
Chemical and metallurgical					. .	. .
Cement plants, Canada	12 274	25 566	12 318	25 044	. .	. .
Cement plants, foreign	724	1 864	575	1 495	. .	. .
Lining, open-hearth furnaces	–	–	–	–	. .	. .
Flux in iron and steel furnaces	1 192	4 663	1 232	5 543	. .	. .
Flux in nonferrous smelters	67	1 352	53	1 161	. .	. .
Glass factories	196	3 509	198	3 734	. .	. .
Lime plants, Canada	3 134	16 271	2 346	14 141	. .	. .
Lime plants, foreign	585	2 221	455	2 051	. .	. .
Pulp and paper mills	260	1 914	226	1 932	. .	. .
Sugar refineries	45	223	33	230	. .	. .
Other chemical uses	780	4 446	1 452	9 828	. .	. .
Pulverized stone						
Whiting (substitute)	34	2 021	39	2 346	. .	. .
Asphalt filler	40	306	64	526	. .	. .
Dusting, coal mines	6	178	2	85	. .	. .
Agricultural purposes and fertilizer plants	1 307	15 094	1 077	13 747	. .	. .
Other uses	57	957	68	1 134	. .	. .
Crushed stone for						
Manufacture of artificial stone	–	–	–	–	. .	. .
Roofing granules	95	1 580	87	1 373	. .	. .
Poultry grit	40	816	37	740	. .	. .
Stucco dash	19	1 234	24	1 588	. .	. .
Terrazzo chips	–	–	–	–	. .	. .
Rock wool	–	–	–	–	. .	. .
Rubble and riprap	386	2 116	756	4 515	. .	. .
Concrete aggregate	9 118	45 127	8 032	42 821	. .	. .
Asphalt aggregate	7 417	35 732	5 342	27 860	. .	. .
Road metal	47 735	210 970	54 459	247 519	. .	. .
Railroad ballast	983	4 270	625	3 061	. .	. .
Other uses	18 600	84 007	19 873	91 669	. .	. .
Total	105 167	470 162	109 450	508 280	. .	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Data exclude stone used in Canadian cement and lime industries. [2] Data include stone used in the Canadian cement and lime industries.
. . Not available; – Nil; . . . Too small to be expressed; r Revised; n.f. Not finished or dressed.
Note: Totals may not add due to rounding.

TABLE 4. CANADA, PRODUCTION OF MARBLE, 1987-89

	1987		1988		1989	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
By province						
Newfoundland	–	–	–	–	–	–
Nova Scotia	3	155	3	163	. . .	21
New Brunswick	–	–	–	–	–	–
Quebec	487	7 153	542	7 069	484	7 791
Ontario	222	10 580	218	11 335	168	9 701
Manitoba	–	–	–	–	–	–
Saskatchewan	–	–	–	–	–	–
Alberta	–	–	–	–	–	–
British Columbia	–	–	–	–	–	–
Northwest Territories and Yukon	–	–	–	–	–	–
Total	712	17 887	763	18 567	652	17 513
By use						
Dimensional stone						
Rough	25	. .	–	–	. .	. .
Monumental and ornamental stone (n.f.)	. . .	2	28	1 262	. .	. .
Chemical process stone					. .	. .
Flux in nonferrous smelters	–	–	–	–	. .	. .
Pulp and paper mills	3	48	–	–	. .	. .
Other chemical uses	–	–	–	–	. .	. .
Pulverized stone						
Whiting	–	–	–	–	. .	. .
Agricultural purposes and fertilizer plants	86	1 343	65	1057	. .	. .
Other uses	246	11 059	272	11 201	. .	. .
Crushed stone for						
Artificial stone	27	616	52	1 017	. .	. .
Roofing granules	5	113	3	66	. .	. .
Poultry grit	. . .	19	. . .	17	. .	. .
Stucco dash	3	151	4	186	. .	. .
Terrazzo chips	6	458	9	571	. .	. .
Concrete aggregate	67	636	61	619	. .	. .
Road metal	70	370	73	355	. .	. .
Other uses	171	1 704	196	2 215	. .	. .
Total	712	17 887	763	18 567	. .	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.
. . Not available; – Nil; n.f. Not finished or dressed; . . . Too small to be expressed.
Note: Totals may not add due to rounding.

TABLE 5. CANADA, PRODUCTION OF GRANITE, 1987-89

	1987		1988		1989	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
By province						
Newfoundland	480	3 539	151	1 309	217	1 233
Nova Scotia	2 826	14 609	5 364	27 450	5 570	27 122
New Brunswick	2 023	9 321	1 535	8 186	1 687	12 518
Quebec	6 047	42 733	7 077	53 076	6 549	53 179
Ontario	1 744	16 988	1 885	18 852	1 179	11 806
Manitoba	620	4 495	441	3 714	349	2 405
Saskatchewan	–	–	–	–	–	–
Alberta	–	–	–	–	5	158
British Columbia	3 082	18 377	1 655	9 426	1 593	9 902
Northwest Territories and Yukon	136	597	10	49	307	2 252
Total	16 957	110 660	18 120	122 061r	17 456	120 576
By use						
Dimensional stone						
Rough	69	9 605	100	15 759	. .	. .
Monumental and ornamental stone (n.f.)	39	6 128	46	8 121	. .	. .
Other (flagstone, curbstone, paving blocks, etc.)	4	411	7	538	. .	. .
Chemical and metallurgical						
Lining, open-hearth furnaces	–	–	–	–	. .	. .
					. .	. .
Pulverized stone						
Asphalt filler	62	170	73	201	. .	. .
Crushed stone for						
Artificial stone	4	50	5	55	. .	. .
Roofing granules	300	6 168	291	5 979	. .	. .
Poultry grit	2	157	1	113	. .	. .
Stucco dash	–	–	–	–	. .	. .
Rubble and riprap	1 094	6 877	875	5 371	. .	. .
Concrete aggregate	1 949	11 434	1 615	10 005	. .	. .
Asphalt aggregate	1 837	10 550	2 683	14 315	. .	. .
Road metal	3 623	15 902	5 535	25 901	. .	. .
Railroad ballast	2 923	19 431	2 004	13 657	. .	. .
Other uses	5 050	23 776	4 883	22 047	. .	. .
Total	16 957	110 660	18 120	122 061	. .	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.
r Revised; . . Not available; – Nil; n.f. Not finished or dressed.
Note: Totals may not add due to rounding.

TABLE 6. CANADA, PRODUCTION OF SANDSTONE, 1987-89

	1987		1988		1989	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
By province						
Newfoundland	64	462	177r	844r	228	1 238
Nova Scotia	1 337	6 130	1 007	4 902	973	4 611
New Brunswick	141	81	92	57	90	52
Quebec	1 621	11 086	1 706	12 327	1 501	12 067
Ontario	189	1 595	176	1 559	118	1 086
Manitoba	–	–	–	–	–	–
Saskatchewan	–	–	–	–	–	–
Alberta	1	42	3	151	...	28
British Columbia	7	145	6	147	6	165
Northwest Territories and Yukon	–	–	–	–	–	–
Total	3 360	19 542	3 167r	19 986r	2 917	19 247
By use						
Dimensional stone						
Rough	38	2 123	48	2 793	..	..
Monumental and ornamental stone (n.f.)	23	873	19	782	..	..
Lining, open-hearth furnaces	1	65	3	335	..	..
Other (flagstone, curbstone, paving blocks, etc.)	5	511	–	–	..	..
Chemical process stone					..	..
Cement plants, foreign	2	47	3	54	..	..
Crushed stone for						
Poultry grit	...	5	...	97	..	..
Stucco dash	1	122	–	–	..	..
Rock wool	...	5	–	–	..	..
Rubble and riprap	360	1 119	4	11	..	..
Concrete aggregate	439	2 477	456	2 624	..	..
Asphalt aggregate	204	1 015	137	747	..	..
Road metal	706	3 170	573	2 996	..	..
Railroad ballast	–	–	–	–	..	..
Other uses	1 581	8 011	1 924	9 547	..	..
Total	3 360	19 542	3 167	19 986	..	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
r Revised; .. Not available; – Nil; n.f. Not finished or dressed; ... Too small to be expressed.
Note: Totals may not add due to rounding.

TABLE 7. CANADA, PRODUCTION OF SHALE, 1987-89

	1987		1988		1989	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
By province[1]						
Newfoundland	8	35	31	114	4	15
Nova Scotia	61	58	37	47	11	29
New Brunswick	87	520	94	621	62	375
Quebec	1 014	3 625	1 684	4 741	1 297	4 508
Ontario[2]	909	1 689	1 201	2 576	650	1 481
Manitoba	91	19	115	22	113	23
Saskatchewan	–	–	–	–	–	–
Alberta	37	60	35	58	41	69
British Columbia	–	–	–	–	–	–
Northwest Territories and Yukon	297	531	93	105	110	175
Total	2 503	6 536	3 289	8 284	2 289	6 675
By use[3]						
Dimensional stone[2]	. . .	. . .	. . .	61	. .	. .
Chemical and metallurgical					. .	. .
Cement plants, Canadian	269	734	221	578	. .	. .
Crushed stone for						
Roofing granules	. . .	1	2	11	. .	. .
Rubble and riprap	. . .	. . .	10	2	. .	. .
Concrete aggregate	16	55	14	67	. .	. .
Road metal	818	3 049	850	2 490	. .	. .
Other uses	1 669	3 432	2 412	5 654	. .	. .
Total	2 772	7 270	3 510	8 863	. .	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Data exclude stone used in the Canadian cement and lime industries. [2] Includes slate. [3] Data include stone used in the Canadian cement and lime industries.
. . Not available; – Nil; . . . Too small to be expressed.
Note: Totals may not add due to rounding.

TABLE 8. CANADA, PRODUCTION OF STONE BY TYPES[1], 1980, 1985, 1988 AND 1989

	1980		1985		1988		1989	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
Granite	39 983	140 914	17 219	95 424	18 120	122 061[r]	17 456	120 576
Limestone	58 191	185 085	77 874	317 862	94 787[r]	469 094[r]	94 859	498 141
Marble	316	1 807	571	13 966	763	18 567	652	17 513
Sandstone	3 064	11 540	3 011	15 310	3 167[r]	19 986[r]	2 917	19 247
Shale[2]	1 812	1 810	1 561	3 059	3 289[r]	8 284[r]	2 289	6 675
Total	103 366	341 156	100 236	445 622	120 126[r]	637 993[r]	118 172	662 151

Sources: Energy, Mines and Resources Canada; Statistics Canada
[1] Data exclude stone used in the Canadian cement and lime industries. [2] Includes slate.
[r] Revised.
Note: Totals may not add due to rounding.

TABLE 9. CANADA, ROUGH GRANITE–SUMMARY OF PRODUCTION AND TRADE

	Quantities / Value	Production[1]	Imports[2]	Exports[2]
1980	t	81 000	24 130	5 019[a]
	$ millions	5.6	1.9	0.7
1985	t	104 000	34 468	12 511[a]
	$ millions	12.8	6.2	1.7
1986	t	121 000	33 994	18 450[a]
	$ millions	15.7	6.6	2.7
1987	t	112 000	46 370	37 450[a]
	$ millions	16.1	7.9	6.0
1988	t	153 000	46 282	86 940[r]
	$ millions	24.4	11.2	16.2[r]
1989	t	160 000[e]	52 259[r]	106 395
	$ millions	26.0[e]	11.7	17.2
1990	t	160 000[e]	46 141	84 000[e]
	$ millions	26.0[e]	11.2	18.5

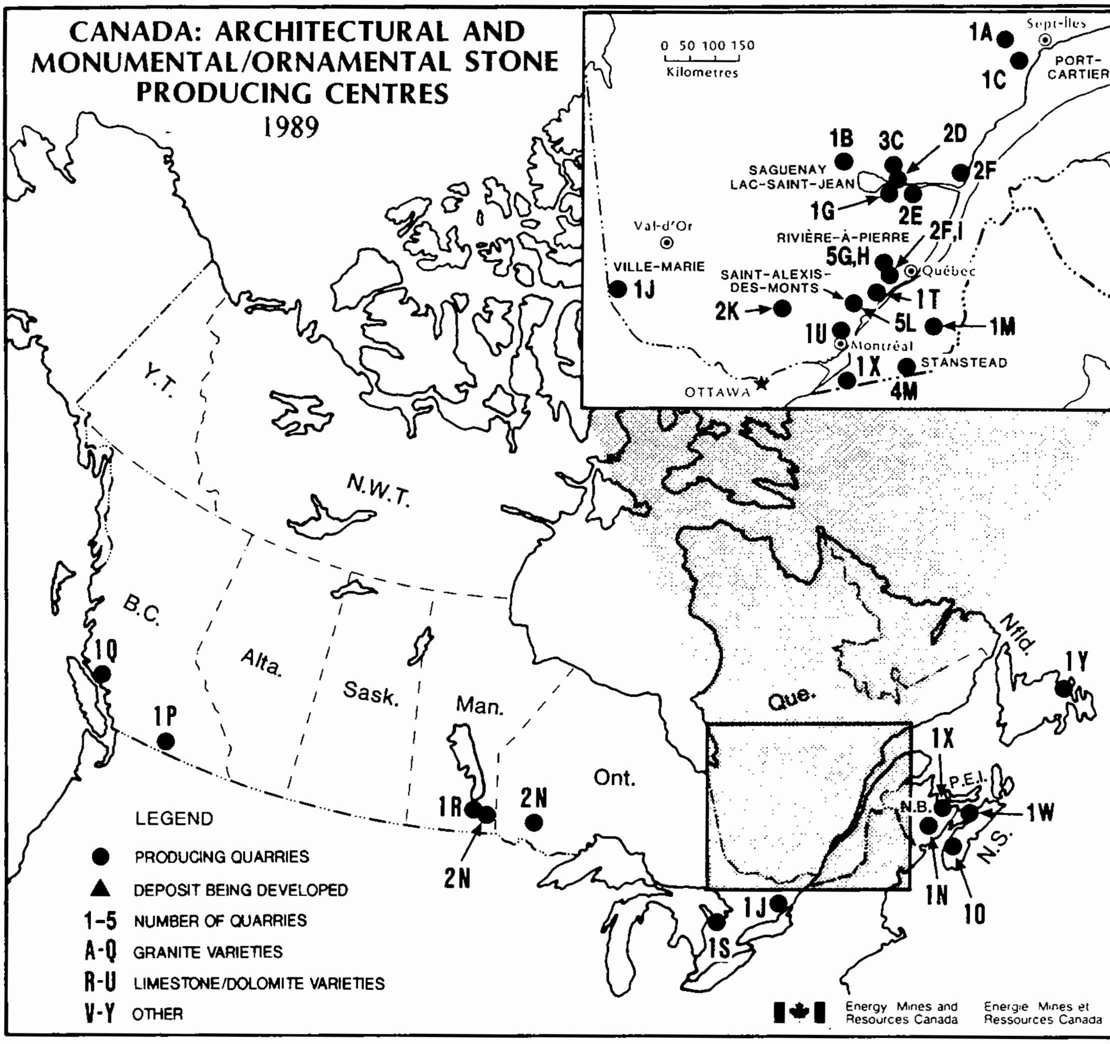
Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Includes rough stone for construction, monumental/ornamental and other uses. [2] Includes codes 2516.11 (roughly trimmed block) and 2516.12 (cut block by sawing or otherwise). Some re-exports to the United States may also be involved.
[a] Coded as building stone, rough (90% is considered to be granite). [r] Revised; [e] Estimated.

TABLE 10. CANADA, VALUE OF CONSTRUCTION BY PROVINCE,[1] 1988-90

	1988			1989			1990		
	Building Construction[2]	Engineering Construction[2]	Total	Building Construction[2]	Engineering Construction[2]	Total	Building Construction[2]	Engineering Construction[2]	Total
					($ millions)				
Newfoundland	919	627	1 546	1 024	578	1 602	1 063	739	1 802
Nova Scotia	1 698	716	2 415	1 836	748	2 585	1 852	875	2 727
New Brunswick	1 352	459	1 811	1 509	539	2 048	1 476	685	2 160
Prince Edward Island	261	91	352	254	96	350	263	105	368
Quebec	15 834	4 731	20 565	16 450	5 547	21 996	16 297	6 565	22 862
Ontario	27 528	7 203	34 731	31 667	7 741	39 408	32 065	8 108	40 173
Manitoba	2 076	1 062	3 138	2 209	1 198	3 407	2 353	1 390	3 742
Saskatchewan	1 958	1 803	3 761	1 954	1 617	3 572	2 152	2 003	4 156
Alberta	4 984	6 803	11 787	5 253	6 541	11 795	5 848	7 485	13 333
British Columbia, Yukon and Northwest Territories	7 274	3 490	10 764	9 119	4 184	13 303	10 526	4 138	4 664
Total	63 885	26 986	90 871	71 276	28 790	100 065	73 895	32 093	105 987

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Actual expenditures 1988, preliminary actual 1989, intentions 1990. [2] Includes total value of new and repair work purchased.
Note: Totals may not add due to rounding.

Figure 1



Source: Mainly Provincial Departments of Mines and Energy

A FINE-GRAINED PINKISH-GREY BANDED GNEISS
B MEDIUM-GRAINED MAHOGANY GRANITE
C COARSE-GRAINED BLACK ANORTHOSITE
D MEDIUM-GRAINED BLACK GABBROIC ANORTHOSITE
E MEDIUM-GRAINED PINKISH-GREY QUARTZ MONZONITE
F FINE-GRAINED PINK GRANITIC GNEISS
G COARSE-GRAINED GREEN CHARNOCKITE
H COARSE-GRAINED PINK-GREY OR BROWN-GREY GRANITE
I MEDIUM GRAINED GREY DIORITIC GNEISS
J MEDIUM-GRAINED RED GRANITE
K FINE-GRAINED PINK APLITE
L COARSE-GRAINED BROWN OR RED QUARTZ MONZONITE
M MEDIUM-GRAINED GREY GRANITE
N MEDIUM-GRAINED PINK GRANITE
O FINE-GRAINED BLUE-GREY GRANITE
P COARSE CORAL PINK GRANITE
Q MEDIUM-GRAINED BLUE-GREY GRANITE
R LIGHT-COLOURED MOTTLED DOLOMITIC LIMESTONE (TYNDALL)
S FINE-MEDIUM CRYSTALLINE BLUE-GREY TO BUFF MARBLE/DOLOSTONE (ARRISCRAFT)
T MEDIUM-GRAINED LIGHT BROWNISH-GREY LIMESTONE (DESCHAMBAULT)
U MEDIUM-GRAINED BLUE-GREY LIMESTONE (CHAZY)
V MEDIUM-GRAINED OLIVE SANDSTONE
W FINE-MEDIUM-GRAINED OLIVE-BROWN AND BLUE-GREY SANDSTONE
X FINE-MEDIUM GRAINED WHITE TO BUFF SANDSTONE (POTSDAM)
Y VERY FINE-GRAINED VARICOLOURED SLATE

Figure 2

CANADA - PRODUCTION OF ROUGH GRANITE
(SOLD AND USED BY PRODUCERS)

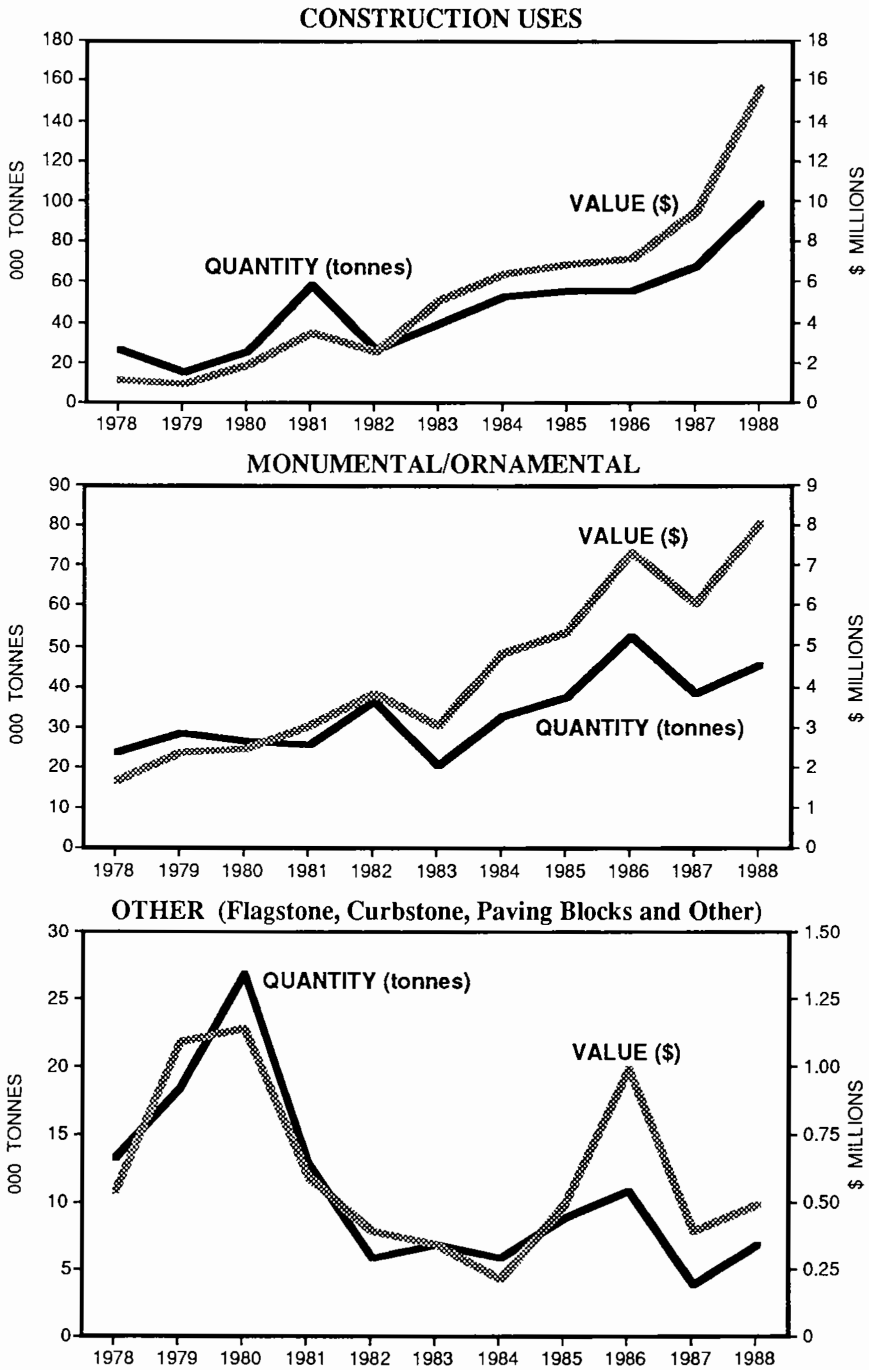
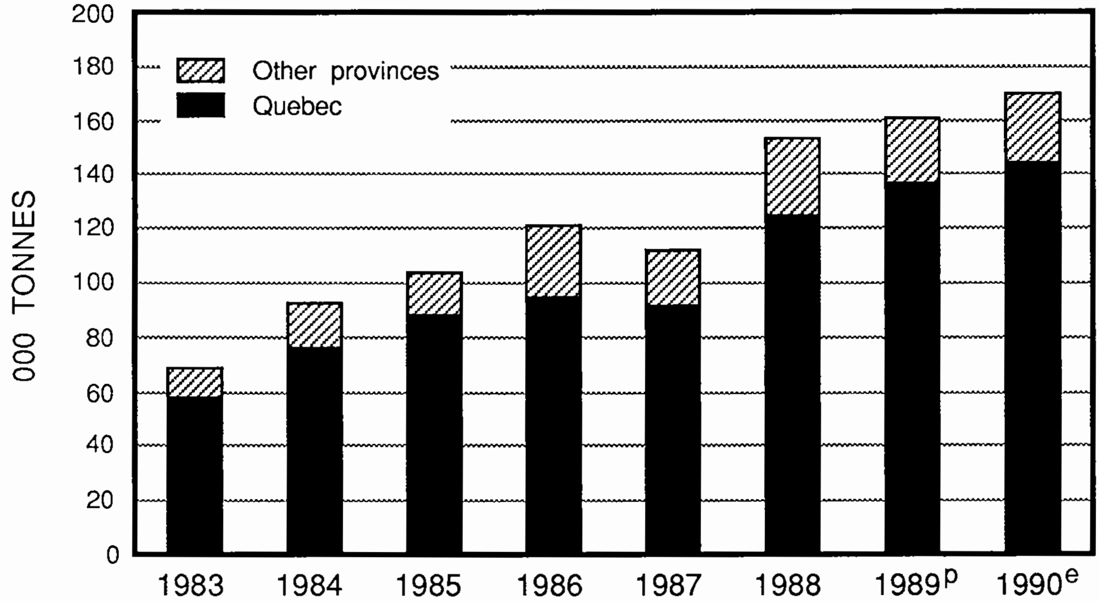
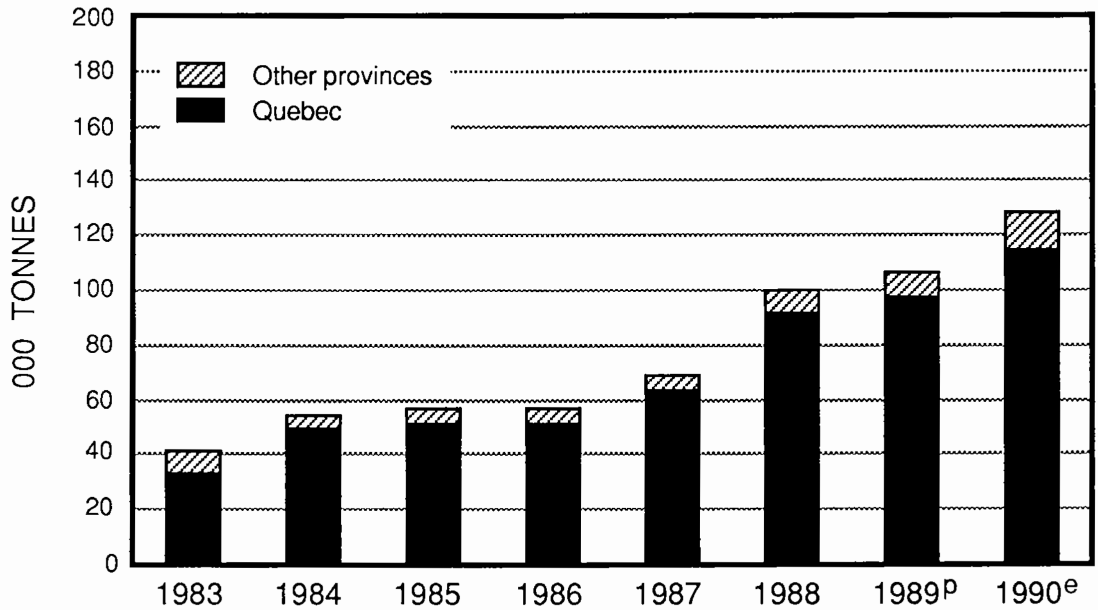


Figure 3

CANADA, TREND IN PRODUCTION OF ROUGH GRANITE



CANADA, TREND IN PRODUCTION OF ROUGH GRANITE DESTINED FOR THE CONSTRUCTION SECTOR



p Preliminary; e Estimate.

Sulphur

1990

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SUMMARY

In 1990, the world sulphur market experienced an increasing tightness due to a much restricted flexibility on the supply side to meet the sustained demand. The resumption of the phosphoric acid sales between Morocco and India led to increased trade in sulphur, strengthening the depressed market that prevailed in 1989. The Iraq invasion of Kuwait during August 1990 impacted both world demand and supply. The former buyers from these two countries sourced their requirements from alternative suppliers, changing world trade patterns. On the supply side, close to 160 000 t/m were withdrawn from the marketplace without sufficient replacements available in the short term. The tightness in the market resulted in upward pressures in prices, which increased from US$80-$87/t at mid-year to close at US$90-$93/t by year-end. During 1990, sulphur production increased in Saudi Arabia and Canada. Output decreased slightly in Kuwait, Poland, the U.S.S.R., West Germany and Iraq while it remained fairly constant in Mexico, France and the United States. International trade rose 7%, with major gains occurring in North Africa (mostly in Morocco). Sulphur markets remained depressed in Brazil, South Africa and Australia. Producers' stocks decreased 12% to meet world demand; withdrawals were mostly from Canada, accounting for 92% of total remelts.

Canadian elemental sulphur production increased 1.7% to 5.92 Mt and shipments rose significantly by 14%, mostly due to higher exports to the United States and Morocco. In 1990, Canadian production accounted for 14.8% of world elemental sulphur production while Canadian exports accounted for 38.4% of world trade. By year-end, Canadian stocks amounted to 3.3 Mt, contributing to 34% of world producers' inventories.

DEVELOPMENTS IN CANADA

Elemental Sulphur

In 1990, production of elemental sulphur in Canada increased 1.7% to 5.92 Mt. Production from natural gas processing accounted for 88%, while the remainder was from oil sands plants (8.5%) and oil refineries (3.5%). Gas-recovered sulphur in Alberta amounted to 4.78 Mt, of which close to 165 000 t were incremental production from the tie-ins of new gas fields and from expansions at several gas-processing units. Gas production from established reserves continued to decrease; lower operating rates during 1990 were reported at East Crossfield, Strachan, Kaybob I/II, Hanlan Robb and East Calgary. The consequent reduced output was offset by higher operating rates registered at Bigstone, Ram River, Kaybob III, Brazeau and Waterton. Sulphur production from oil sands remained stable despite a 50% operating rate occurring at Syncrude during January and February of 1990; however, both oil sands plants ran at higher than average rates during the second half. In British Columbia, sulphur production from gas processing remained strong at 420 000 t, accounting for 7% of total Canadian sulphur production; higher output at Pine River offset the reduced recovery reported at Fort Nelson. The output of sulphur from Canadian oil refineries rose 24% to 205 000 t with most of the increase due to larger production from the heavy oil upgrader operated by Consumers' Co-operative Refineries Limited in Regina, Saskatchewan. In 1989, sulphur shipments from refineries amounted to 166 571 t, of which 128 154 t were produced in eastern Canada. Domestic sales totalled 137 031 t while exports amounted to 29 540 t, accounting for 17% of total sales.

Shipments of elemental sulphur were estimated at 7.0 Mt, an 11% increase from 1989. Most of the increase was registered in exports. Sulphur deliveries in Canada remained in the 750 000-800 000 t/y range. The domestic market for fertilizers was soft in the first half but rebounded during the second half. Sales were brisk as a result of flat domestic consumption and higher exports to the United States.

Exports to the United States have been estimated at 1.4 Mt in 1990, a 27% increase over 1989. Offshore sales rose 10% to 4.84 Mt.

On a nine-month basis for 1990, Canada's exports of sulphur increased 18% to 4.6 Mt compared to 3.9 Mt in the same period last year. Canada sold sulphur to 27 countries. In 1990, the United States remained the dominant export destination for Canadian sulphur, accounting for 24% of our exports, followed by North Africa (22%), Asia (17%), Western Europe (9%), South America (8%), Oceania (7%), Council for Mutual Economic Assistance (COMECON) countries (5%), and the Middle East (5%). Half of our exports of sulphur were delivered to five countries in 1990 compared to six countries in 1989, as a result of the relative importance taken by exports to the United States and Morocco. Notable increases in sales were registered for Morocco (+200%), France (+60%), the U.S.S.R. (+30%) and the United States (+25%). Losses in sales occurred in Australia (-50%), China (-50%), Brazil (-30%) and South Korea (-25%). Higher expectations in sales to the U.S.S.R. at the beginning of the year were not realized, and Canada's exports were comparable to those of last year; however, Canada remained the second most important sulphur supplier to the Soviet Union with a 45% share, behind Poland (50%). Canadian suppliers retained a strong presence in Oceania with a 99% share and in Latin America with a 50% share. An erosion of market shares was reported in Asia and North Africa as important tonnages from Middle East suppliers were shipped to Morocco, Tunisia and India. In Asia, Indonesia and South Korea remained Canada's major destinations. China did not re-enter the marketplace as strong as last year when its imports totalled 214 000 t, of which 150 000 t were from Canada. In 1990, Canada exported only about 50 000 t to China, a 66% drop from 1989.

Canadian sulphur stocks in early January were estimated at around 4.5 Mt, distributed amongst 18 sites in Alberta. During 1990, remelts were carried out to supplement production in order to meet the requirements for sales in the domestic and export markets. Withdrawals in 1990 totalled close to 1.2 Mt, leaving about 3.3 Mt by year-end; close to 1.0 Mt are considered as contaminated basepads, and about 0.6 Mt are located in remote sites (Zama, Rainbow Lake, etc.). Additions to stocks were reported at Kaybob I/II, Kaybob III and Syncrude while withdrawals occurred at more than 20 sites. Major remelts were from Ram River, accounting for 45% of total withdrawals, followed by Bigstone (13%) and Waterton (8%). The average remelt rate for the January-November period has been estimated at 86 000 t/m, but late in 1990, remelt rates above 105 000 t/m were registered. By the end of 1990, eight sites in Alberta accounted for 80% of remaining stocks.

The sulphur industry in Canada maintained close to 1300 direct jobs, including sulphur forming, handling, transportation, sales and marketing. In 1989, Canada's sulphur capacity was estimated at 30 650 t/d, accounting for one third of total worldwide capacity. Canadian producers operated at 53% of capacity with an average rate of 16 344 t/d.

On the domestic scene, the most prevalent development that dominated the year was the Caroline project. Discovered by Shell Canada Limited in 1986, the Caroline gas field (35% H_2S) holds sulphur reserves estimated at 25 Mt. In 1989, Husky Oil Ltd., one of the major stakeholders in the project, withdrew its support to the initial development plan, and filed an application to the Alberta Energy Resources Conservation Board (AERCB) for $660 million for a 4240 t/d expansion at its Ram River gas-processing plant. Shell Canada Limited initiated its own plan that includes the construction of a new 1.4 Mt/y gas plant, 14 km south of Caroline, and a 40-km underground pipeline to carry liquid sulphur to Shantz. In April 1990, the AERCB started public hearings to evaluate both applications. Shell Canada Limited owned close to 62% of Caroline gas while Husky Oil Limited owned about 11%; the remaining 27% was distributed amongst 15 other companies. At the end of August, the

AERCB gave approval to Shell's $825 million application for the development of the Caroline sour gas reserves. Construction started in October; activities at Caroline in 1990 involved site preparation for the gas plant, the compression stations and the sulphur-forming facility. Sulphur recovery will be designed to capture a minimum of 99.8% of sulphur dioxide emissions to meet AERCB specifications. Liquid sulphur will be formed using the Sandwick Rotoform process for producing small pellets. Start-up of the operation is scheduled for early 1993. Shell Canada Limited has expressed its interest to purchase the shares owned by Dekalb Energy Canada Ltd. (0.7%) and Gulf Canada Resources Limited (8.5%). Late in 1990, Shell reported the discovery of a new sour gas reservoir in the vicinity of the Caroline field; the gas would have a 46%-48% H_2S content.

In September 1990, Shell Canada Limited, Mobil Oil Canada, Ltd., PanCanadian Petroleum Limited and Norcen Energy Resources Limited commissioned the $65 million Bearberry pilot plant near Sundre, Alberta. The 224 t/d recovery plant is to process 90% H_2S sour gas for extracting sulphur. The five-year project will permit them to evaluate the technical and economical feasibility of commercial sulphur extraction from super sour gas. Bearberry sulphur reserves have been estimated at 70-100 Mt. Shell Canada Limited has considered tying in both the Bearberry and the Caroline projects. Commercial development of the Bearberry field would add sulphur capacity in the range of 1.2-1.4 Mt/y by the end of the century.

Consumers' Co-operative Refineries Limited shut down its heavy oil upgrader near Regina, Saskatchewan, in January. A power failure resulted in damages to the catalyst. The facility resumed operation in mid-February, and ran at full capacity during the remaining ten months.

Husky Oil Operations Ltd. continued the construction of a $1.27 billion heavy oil upgrader at Lloydminster, Saskatchewan. During 1990, construction was 25% completed with mechanical completion due in mid-1992. The sulphur recovery unit will have a capacity of 70 000 t/y.

The $4.1 billion Other Six Leases Operations (OSLO) mega-project suffered a setback in February 1990 when the federal government withdrew its support. With an emerging oil shortage, further interests were manifested during the year by other parties. The project's stakeholders, led by Imperial Oil Limited, have decided to install the planned upgrader facility at Redwater, near Edmonton, Alberta. The completion date for the project remained unclear and could vary between 1997 and 2004. The sulphur capacity would be around 250 000-260 000 t/y. During 1990, a five-year pilot project, dubbed OSLO New Ventures was announced in order to evaluate various bitumen extraction methods. The project is to be carried out at Suncor Inc.'s plant near Mildred Lake, Alberta. Start-up is scheduled for 1992.

Esso Resources Canada Limited succeeded in tying in the OBED gas field near Edson, Alberta to Chevron Standard Limited's Kaybob III processing plant in October; the initial completion date was scheduled for 1989 but technical problems triggered a two-year overhaul and delayed its commissioning. Incremental sulphur production is projected in the range of 300 000-350 000 t/y.

Petro-Canada Inc. and Amoco Canada Resources Ltd. completed the 385 t/d expansion project at Brazeau River, Alberta in early March; incremental production was recorded in the first quarter as the operating rate rose from 2000 t/m to 10 800 t/m of sulphur. Petro-Canada Inc. and Phillips Petroleum Resources, Ltd. completed a 82 t/d expansion at Wildcat Hills, Alberta, and the operating rate rose from 2800 t/m to close to 5000 t/m by mid-year.

Syncrude Canada Ltd. resumed operation in early January 1990 at one of its hydrotreaters damaged by an explosion and a fire that occurred at its oil sands plant near Fort McMurray, Alberta late in 1989. The plant operated at 50% of capacity during January and February, but thereafter ran at full capacity during the rest of the year. During 1990, several stakeholders, including Amoco Canada Petroleum Company Ltd., Petro-Canada Resources and the Alberta government, put their Syncrude interests up for sale.

Sulphur

Suncor Inc. announced a $9 million project to use innovative technology to increase its recovery of sulphur dioxide emissions at the oil sands plant in Mildred Lake, Alberta. The new technology developed by Union Carbide Corporation uses recyclable inorganic solvents to recover up to 98% of SO_2 emissions. During 1990, Suncor Inc. expressed its intention to sell 49% of its share in the oil sands operation.

Shell Canada Limited will be installing a new technology to cut SO_2 emissions by half at its Burnt Timber plant in Alberta. A new super-Claus unit is expected to be completed by mid-1991. The suitability of this technology will be evaluated for Shell's plant in Waterton.

Westcoast Energy Inc. started construction late in 1990 for expanding the processing capacity of the McMahon plant at Taylor, British Columbia. Completion of the 120 t/d expansion is due by the end of 1991. Westcoast's plant at Pine River is likely to be expanded in the mid-1990s while two new gas fields, Sukunka and Bullmoose, are expected to be tied in in early 1992; incremental production is estimated in the vicinity of 100 000 t/y.

Gulf Canada Limited and Unocal Canada Limited are to complete the connection of the Fir-Spotter gas field to Amoco Canada's gas plant at Kaybob I/II in Alberta by May 1991; the sulphur recovery is expected to increase by 152 000 t/y. D.M. Wolcott & Associates Ltd. is expected to commission a 40 000 t/y expansion at West Pembina, Alberta by early 1991.

Sulchem Products (1989) Limited commissioned a new sulphur-refining plant at Crossfield, Alberta. The 100 000 t/y operation is to produce granulated plant nutrient and micronized industrial products.

During the year, several developments occurred in the oil and gas industry that impacted on the sulphur sector. Placer Dome Inc. sold its oil and gas operations (Placer Cego Petroleum Holdings Limited) to Opus Acquisition Corp., owned by Amerada Hess Corporation and Poco Petroleums Ltd. Brymore Energy Ltd. sold its sulphur division to International Commodities Export Corporation of Canada Ltd. Encor Energy Corporation Inc. and Amoco Canada Petroleum Company Ltd. entered into a joint operating and services agreement for properties held in western Canada. Dome Petroleum Limited transferred its sulphur offshore tonnages, formerly handled by Cansulex Limited, to Amoco Canada Petroleum Company Ltd. effective January 1, 1991.

The Government of British Columbia completed the privatization of marketing operations of the British Columbia Petroleum Corporation (BCPC); contracts were sold to Canwest Gas Supply (1989) Ltd., and included the sulphur sales/purchase agreements between BCPC and Petrosul International Ltd. The Alberta Energy Resources Conservation Board clarified its position on plant proliferation after it released its decision relative to the Caroline project. The policy statement concluded that its primary objective is to ensure that applicants have investigated all the technical and economic feasibility of using existing plants when examining potential gas-processing options. The Canadian government is contemplating legislation to reduce the sulphur content in diesel fuel by October 1993. The proposed specifications would limit the sulphur content to 0.05% by weight, compared to the current limit of 0.5%. The present sulphur levels across Canada range from 0.14% to 0.23%. The new specifications would result in the recovery of close to 18 000 t/y of sulphur from oil refineries.

Sulphuric Acid

In 1990, the market for sulphuric acid remained flat with sustained performance in the oil refining and pulp and paper sectors offsetting some slowdowns in the fertilizer, titanium dioxide and inorganic sectors. Consumption also declined in the aluminum and uranium sectors; operations were shut down in several high-cost uranium mines in Ontario while reductions occurred at lower-cost mines in Saskatchewan. During 1990, acid exports continued to be strong with increased volumes reaching the U.S. markets without too much disruption in the pricing structure.

The production of sulphuric acid from smelters was estimated at 2.73 Mt, a 20% increase from 1989. Reduced outputs in

New Brunswick and British Columbia were offset by increased production in Quebec and Ontario. Most of the increase resulted from new additional production of acid from the Horne smelter in Rouyn-Noranda, Quebec. The smelter acid producers operated at 71% of capacity. In 1990, the production of liquid sulphur dioxide from smelters declined by 8%; however, Canadian sales remained strong due to sustained consumption in the domestic markets and tight demand in the United States. Canada exported close to 40% of its liquid sulphur dioxide production. The Canadian demand remained strong in the pulp and paper sector, which accounted for close to 80% of total consumption of liquid SO_2.

In 1989, the apparent consumption for sulphuric acid in Canada was estimated at close to 3.0 Mt of which 48% was acid produced from smelters; the remaining 52% was supplied by sulphur-burning operations. Sulphuric acid consumption in eastern Canada amounted to 1.33 Mt, accounting for 45% of total consumption. Agricultural chemicals accounted for 45% of sulphuric acid consumption, followed mainly by inorganic chemicals (18%), uranium mining (10%) and pulp and paper (9.5%).

Noranda Minerals Inc. started up its new acid plant at the Horne copper smelter in Rouyn-Noranda, Quebec. The $160 million plant has a reported design capacity of 400 000 t/y and will allow Noranda to cut SO_2 emissions by 50% by 1994. Noranda is to invest $16 million to install a concentrate injection system in the converter section of the smelter, allowing a further 20% recovery of SO_2 and dust emissions by 1995. Impure acid was produced during the first half of 1990 and was delivered to the Florida acid market. Standard grades of acid were available by the second half for export sales.

Inco Limited is expected to commission its first of two oxygen flash furnaces in 1991 at the Copper Cliff smelter operations in Ontario. A new 2900 t/d acid plant is expected to come on stream at the same time. Inco will continue to maximize pyrrhotite rejection in the milling operation prior to smelting; this would lead to lowering sulphur input into the smelter by the equivalent of 100 000 t/y of SO_2. The second oxygen furnace is due for completion in 1993. Emissions at the Copper Cliff smelter complex will be reduced by 60% to meet the 265 000 t/y target by 1994. Studies are being carried out for achieving an emissions level of 175 000 t/y by the year 2000. Inco Limited also announced plans for an expansion at the Thompson nickel mines in Manitoba. Modifications are to increase mining productivity by 1997. By 1994, a change in the feed mix could likely modify the SO_2 emissions volumes as richer ores will be extracted. The operation has to comply with emissions reduction targets of a maximum of 225 000 t/y by 1994. The Thompson smelter has been able to meet current emissions standards through sulphide rejections. Changes in the milling techniques resulted in the rejection of about 45% of pyrrholite.

Early in 1990, Brunswick Mining and Smelting Corporation Limited faced problems with the quality of raw feedstock and operated at very low levels at its Belledune plant in New Brunswick. The smelting operations shut down in July as a result of a strike. The fertilizer plant was idle for the remainder of the year due to a lack of sulphuric acid. The company is expected to spend close to $100 million within the next three years for upgrading the mine, the mill and the acid plant.

Cominco Ltd. faced technical problems at its new lead smelter in Trail, British Columbia. The newly commissioned operation has been shut down since March 1990 to allow changes to be made to the boiler, the reactor and the drossing units. The old smelter was reactivated and has been operating at 80% capacity since April. The new smelter is expected to restart late in 1991. During two weeks in July, a strike affected the operations, including the fertilizer production at Trail. The construction of new phosphoric acid evaporate and upgrading units was completed. The company has announced its plan to expand the liquid sulphur dioxide capacity at Trail by 40%, to reach 100 000 t/y by 1991.

Hudson Bay Mining and Smelting Co., Limited is expected to put in place a project to cut sulphur dioxide emissions at its Flin Flon smelter in Manitoba. The $170 million proposal involves a zinc pressure leaching process and a converter for the copper smelter. The changes are designed to allow the operations to reduce SO_2 emissions by 25% to meet government regulations by 1994.

Sulphur

Tioxide Canada Inc. announced its intention to convert its sulphate route titanium dioxide plant at Tracy, Quebec, into a finishing plant. The conversion, due for completion by June 1991, will result in phasing out one of the two sulphate route titanium pigment plants in Canada. The Tioxide plant was an important sulphuric acid consumer in Quebec, using close to 90 000 t/y of acid. Kronos Canada, Inc., formerly NL Chem Canada Inc., still has two titanium dioxide plants using respectively the sulphate and the chloride routes. Both companies have to comply with stringent pollution controls over their liquid acid effluents generated by the sulphate route. The project for a new recycling unit using the demonstrated technology from a nearby pilot plant has been postponed because of depressed market conditions.

WORLD DEVELOPMENTS

Elemental Sulphur

In 1990, two major events marked the world sulphur market. The settlement of the phosphoric acid contract dispute between Morocco and India led to the resumption of normal world trade conditions. World demand for fertilizers decreased by 2% in 1990; however, elemental sulphur trade rose 7%, of which Morocco accounted for half of the total increase. The Iraq invasion of Kuwait exacerbated the tightening of the marketplace during the second half of 1990 as both countries accounted for close to 12% of world exports in 1989. Major buyers, which included Tunisia, Morocco, Jordan, Turkey, Romania, Egypt and India, had to find alternative sources of supply or had to reduce their intakes for their annual requirements. The situation has translated into shifts in world trade patterns. Saudi Arabia and Canada moved more tonnages than anticipated to these countries during the second half of 1990.

Higher shipments arrived in Morocco, Tunisia, the United States, the U.S.S.R., Mexico and Senegal while lower imports were reported in Brazil, South Africa, China and Australia. North Africa was supplied mostly by Saudi Arabia, Poland and Canada. Japan made some in-roads into the Asiatic sulphur trade, increasing its exports by 40% in 1990; shipments were mostly to South Korea, to the detriment of Canadian suppliers. Western Europe, excluding Poland, shipped mostly within Europe and to North Africa. Middle East suppliers exported mainly to Asia (India) and North Africa. North American producers, including Mexico, sold to most regions and maintained a strong presence in Oceania and Latin America.

In 1990, world sulphur production was estimated at 39.5 Mt, an amount similar to the 1989 level. Sulphur output rose in Western Europe (3%), Asia (3%) and the Middle East (2.5%), but declined slightly in Eastern Europe (3%) and North America (1%).

Producers' stockpiles declined 12% to 8.8 Mt as withdrawals were made to balance the world deficit between supply and demand. Most suppliers withdrew stocks with the exception of Iraq and the United States. Major remelts occurred in Canada, accounting for 92% of total withdrawals during 1990. World inventories will reach working levels in 1991 with the anticipated depletion of the Canadian stocks. Only France and Saudi Arabia appear to have some flexibility, but are somewhat limited due to restraining logistics.

United States

The United States was the world's largest sulphur producer as well as a major Frasch-producing country. The United States accounted for one quarter of world production in 1990. Production of elemental sulphur remained flat at 10.3 Mt; sulphur recovered from oil- and gas-processing plants accounted for two thirds. Frasch output was estimated at 3.73 Mt in 1990; Frasch production was reported low during the first half but rose 20% to reach an average output of 330 000 t/m thereafter. Sulphur production from natural gas processing registered a slight decline that was almost totally offset by increases in sulphur recovered from oil refining. Sulphur recovered from petroleum refining accounted for 63% of total recovered sulphur output. Other-forms-of-sulphur (e.g. acid) increased marginally to 1.275 Mt and accounted for approximately 10% of overall sulphur-in-all-forms production. In 1990, sulphur was produced at 173 plants operating in 32 states. The U.S. annual production capacity for sulphur-in-all-forms was estimated at 12.67 Mt at the beginning of 1990. Apparent consumption increased marginally to 12.9 Mt for use mostly in fertilizers (70%), chemicals (12%) and petroleum refining (7%). Higher consumption of sulphur was reported in central Florida for the production of phosphate-based fertilizers for which close to 5 Mt are consumed annually. Exports remained low compared to 1988 levels as they were estimated at 1.0 Mt for 1990. Major export destinations included Brazil, Belgium, Mexico, Morocco and India. Imports rose 18% to 2.6 Mt, with higher shipments from Canada (+25%). Shipments from Mexico remained flat. As a result of reduced output, increased imports and flat exports, producers' stocks of elemental sulphur rose slightly to reach 1.5 Mt at year-end; Frasch producers' stocks were estimated at 1.3 Mt, accounting for 87% of total American stocks.

Freeport-McMoRan Resource Partners, Ltd. continued the development of the Main Pass Block 299 project, 30 km offshore of the mouth of the Mississippi River in the Gulf of Mexico. Discovered in 1988, Main Pass Block 299 contains massive sulphur reserves estimated at 68 Mt. The US$554 million project is a joint venture between Freeport McMoRan Resource Partners, Ltd. (58.3%), IMC Fertilizer Group, Inc. (25%) and Felmont Oil Corporation (16.7%). The project involved the construction of 15 offshore sulphur mining platforms for a total design capacity of 2.0-2.5 Mt/y to come on stream by 1992/93. Freeport completed the installation of a new boiler at its Caminada offshore Frasch operation in the Gulf of Mexico; the new boiler expanded the water boiling capacity by 25% and resulted in increasing sulphur output from 600 000 t/y to 850 000 t/y by year-end. Starting in 1990, Caminada sulphur reserves were estimated at 5.2 Mt; 1990 production was about 0.7 Mt. Freeport's other Frasch mines, Garden Island Bay and Grand Isle, faced continuing declines in output and are expected to shut down during 1991 due to depletions of reserves. Combined productions amounted to 0.7 Mt in 1990, compared to 1.05 Mt last year. Texasgulf Inc.'s Boling Dome mine in New Gulf, Texas, produced close to 150 000 t and had proven reserves of about 1.0 Mt; its Commanche Creek mine near Fort Stocton, Texas, remained shut down during 1990. Pennzoil Sulphur Co. ran its Culberson Frasch mine at two thirds of capacity during the first five months of 1990 and expanded its operating rate thereafter; Pennzoil's sulphur production was close to 2.1 Mt in 1990, a 5% increase over 1989.

Mitsubishi Chemical Industries Ltd. of America faced some delays in its plans for a new copper smelter near Houston, Texas; the new smelter, with a 400 000 t/y acid plant, is now expected to come on stream by 1993. Boliden Intertrade Ag of Sweden completed the acquisition of the Tennessee Chemical Company based in Copperhill, Tennessee. Cyprus Minerals Company announced a US$90 million modernization at its Miami smelter in Arizona; completion of the project is due for mid-1992.

The amendments to the Clean Air Act became law in November 1990, following the proposals made by the Bush Adminstration last summer. The new law calls for two-stage reductions in sulphur dioxide emissions by a total of 10 Mt below the 1980 level by January 1, 2000. Emissions will be capped thereafter. The acid emissions will be cut from close to 110 coal-fired electric plants, mostly based in the Midwest. The reductions in SO_2 emissions will result in a drastic decline in transborder emissions that flow into eastern Canada. The implementation of these regulations would result in the production of the equivalent of up to 1 Mt/y of sulphur products. Canada and the United States announced in July the start of negotiations for a bilateral accord on transboundary air quality.

U.S.S.R.

The U.S.S.R. remained the world's second largest producer of brimstone, with a 15% share in world production. In 1990, elemental sulphur production dropped to 5.9 Mt due to lower output registered at Frasch mines, in particular in the Ukraine. Gas recovered sulphur was the major source of sulphuric acid production accounting for 43%. The gas projects at Astrakhan continued to face technical and environmental problems. Astrakhan I was reported to run at one third of capacity with an expected output in the vicinity of 700 000-800 000 t for 1990. Repairs have intensified at the plant for resumption of operations at 75%

capacity during 1991. Reconstruction at Astrakhan II is expected next year for commissioning by 1993. The third stage of the Astrakhan complex was put on the shelf. The Tengiz oil and gas projects, near the northeast coast of the Caspian sea, faced some delays. The 450 000 t/y Tengiz I plant is not to be commissioned before 1991; modifications were necessary due to higher-than-expected sulphur content (18%-25% H_2S) in oil-associated gas. Developments at Tengiz phases II and III stopped; completion is now scheduled for 1992/93. The Orenburg gas plant underwent modifications to accommodate higher gas streams to come from the Karazeganah field; incremental sulphur production is projected to be about 800 000 t/y, due by 1992. In 1990, contracts for liquid and solid sulphur facilities have been awarded for exports to start in 1992 with an installed capacity of 1.5 Mt/y. Virtually all Soviet sulphur supply was used domestically and Soviet production was supplemented with imports from Poland and, as in 1989, from Canada.

During 1990, the U.S.S.R. continued to face oil and gas production problems due to technical and economic factors. The drive for hard currencies was a major incentive for maintaining production and exports. In the short term, the primary objective is to increase exports with higher energy deliveries; however, the trend in declining oil production that started in 1988 continued as the industry faced low drilling productivity, shortages of equipment and ecological problems. In 1990, the increase in gas production was smaller than planned. Limited gas deliverability has created local shortages since falling fuel oil, coal and electricity production led to higher domestic requirements for gas.

Poland

Poland was the fourth major world producer of elemental sulphur, accounting for 12% of world production, and remained the second largest exporter of elemental sulphur after Canada. Production in 1990 decreased 10% to 4.54 Mt, with most of the decline arising from the Frasch operations. Delays in tapping the reserves of Jeziorko and Oziek are expected to maintain Polish production below 5.0 Mt/y for the next three years. Sulphur reserves at Grzybow continued to decline. The commissioning of the Oziek mine is expected in 1992/93 with a target production of 1.2 Mt/y by 1995. In 1990, domestic consumption decreased drastically as a result of a sharp decline in fertilizer consumption and production, leading to a small increase in sulphur exports. Poland exported close to 80% of its production and shipped mostly to the U.S.S.R., Czechoslovakia, India and Morocco. In 1990, exports to the COMECON countries accounted for 43%, followed by North Africa (20%), Western Europe (18%), Asia (12%) and Latin America (6%). Lump sulphur exports are expected to be replaced by prills by 1994, due to environmental problems associated with dust. Poland is also expected to sell its sulphur on the open market instead of getting into contracts with COMECON countries, with a switch to payment in hard currencies.

Mexico

Mexico was the world's fifth largest producer of brimstone, accounting for 6% of world production. Mexico produced 2.1 Mt of sulphur in 1990, about the same level as in 1989. Frasch production declined marginally and accounted for 71%. Sulphur production from oil refining rose 20% in 1990, as the monthly operating recovery increased from 38 000 t/m to 49 000 t/m. Technical problems were encountered at Jaltipan during the second quarter of 1990. Recent exploration activity for increasing current reserves resulted in the discovery of two new orebodies, Potrehillos with 1.5 Mt reserves near Jaltipan, and Sehualaca with 3.7 Mt reserves near Coachapa. The development of these orebodies is expected by 1991 and 1992 respectively, in order to compensate for anticipated declines in production from Jaltipan, Coachapa and Texistepec. Modifications were carried out at the Coachapa steam plant in order to provide adequate heating for the Otapan mine, 13 km from the Coachapa mine. Sulphur recovered from petroleum refining is expected to increase by 1991 as a result of the completion of several projects by Petroleos Mexicanos in Salina Cruz and Tula.

Saudi Arabia

Saudi Arabia was the sixth largest sulphur producer in the world with a 4% share. In 1990, Saudi sulphur production remained stable at 1.6 Mt. Close to 85% came from natural gas processing at Uthmaniyah, Shedgum and Berri, while the remainder was recovered from oil refineries at Jubayl, Yanbu and Rabigh. The Saudi sulphur refineries ran at a rate of 82% of capacity, estimated at 1.66 Mt/y. Saudi Arabia exported virtually all of its production; in 1990, exports rose 40%-45% as a result of important sales agreements contracted with North African phosphoric acid producers. Exports were shipped at a monthly rate of 127 000 t/m during the first nine months of 1990, mainly to Morocco (43%), Tunisia (17%) and India (23%). Stockpiles at Berri remained unchanged at close to 2.1 Mt. Saudi Arabia has remelt and pelletizing capacities at 50 000 t/m and 130 000 t/m respectively. No withdrawals have been reported; however, some stocks have been poured at the Rabigh oil refinery. Saudi Arabia increased its oil production for exports in order to meet world demand; associated gas is expected to generate additional sulphur output. Activities at the Jubal port are restricted by military use and will inhibit sulphur shipments. Saudi Basic Industries Corp. is expected to commission a new 1.3 Mt/y phosphate fertilizer operation by 1991 to manufacture urea, NPK, diammonium phosphate and triple superphosphate.

Iraq

Iraq, ranked as the seventh major world producer of brimstone, produced 1.35 Mt in 1989 and was forecast to produce close to 1.55 Mt in 1990. Sulphur extracted at the Mishraq Frasch mine accounted for 93% of total Iraqi output, the remainder being recovered from two natural gas plants at B'aiji and Kirkuk. Planned expansions at Mishraq and Kirkuk are likely to be delayed; however, production at Mishraq was reported to be running at one third of capacity during the second half of 1990. Domestic consumption was estimated at 400 000 t. Iraq exported close to 600 000 t during the first eight months of 1990, after which exports ceased due to the United Nations' imposed economic sanctions. Main markets for Iraq in 1989 were Egypt (22%), Jordan (19%), India (11%), Tunisia (11%) and Turkey (9%).

Kuwait

Kuwait produced close to 560 000 t of sulphur in 1989. Production in 1990 was estimated at 200 000 t. Kuwaiti operations at the oil refineries of Mina Al Ahmadi, Shuaiba and Mina Abdulla ceased in August. Last year, the operations ran at 50% of sulphur recovery capacity, estimated at 1.14 Mt/y. All Kuwaiti production was exported. Exports in 1989 totalled 540 000 t and were mainly shipped to India (33%), Tunisia (31%), Morocco (23%) and Jordan (16%).

France

France ranked amongst the top ten world producers with a 3% share of world production. Sulphur was recovered from the Lacq gas field and from oil refining. In 1990, sulphur production rose 11% to 975 000 t, of which 28% was from oil refining. Sulphur produced from the Société Nationale Elf Aquitaine's Lacq operations is expected to increase from 0.65 Mt/y to 0.83 Mt/y by 1994, and then to decrease to 0.4 Mt/y by 2000. Sulphur stocks were estimated at 1.75 Mt, a 3% decrease from 1989; these stocks are considered long-term strategic resources. Domestic consumption remained strong, at around 1.5 Mt, but is expected to decline in the next few years. Imports were from Poland (40%), Canada (30%), West Germany (20%) and the United States (10%). Major exports destinations included North Africa (62%) and the United Kingdom (28%).

PRICES

Expected price increases, as signalled by firming spot price indications late in 1989, were not realized in the first half of 1990. Contract prices were anticipated to increase as a result of the settlement in the trade dispute between Morocco and India. Contract prices for offshore exports of elemental sulphur from Vancouver remained static during the first half of 1990, ranging between US$77 and $87/t. Spot quotations were stable at US$80-$86/t during the same period, resulting in a marginal premium (US$1-$2/t) between spot and contract prices. Quotations for contract prices (f.o.b. Vancouver) started to increase as the Middle East situation developed. Prices rose 10% to gradually reach US$90-$93/t at year-end. Tightness in the market generated more volatility in the spot quotations which increased gradually from US$85-$90/t to close at US$110-$115/t late in December, a 30% increase since July. The gap between spot and contract prices widened to US$15/t late in 1990, confirming the tight conditions that are expected to prevail in 1991. Contract prices did rise but at a more subdued pace since most of the suppliers expected a surplus situation that will favour buyers in the 1993-95 period.

With a strong demand in North America, price quotations for liquid sulphur (f.o.b. Alberta) paralleled international trends and increased 30%-35% from US$45-$50/t early in 1990 to US$62-$64/t by year-end. The favourable netbacks achieved in the North American market during 1990 are expected to continue in 1991, resulting in increased sales to the United States being projected for 1991.

USES

About 60% of all of the sulphur consumed in the world is used in the production of fertilizers such as superphosphates, ammonium phosphate and ammonium sulphate. The second largest consuming sector is the chemical industry where sulphur is used in products ranging from pharmaceuticals to synthetic fibres in plastics and petroleum catalysts. Other consumers of sulphur include the manufacturers of titanium dioxide used in paint, enamels, paper and ink, iron and steel, and nonferrous metals. These consuming industries use sulphur in the form of sulphuric acid which accounts for almost 90% of total sulphur consumption (60% of sulphuric acid consumption is in fertilizers). Products requiring sulphur in the non-acid form include insecticides and fungicides, pulp and paper, photography, leather processing, rayon and rubber.

OUTLOOK

The Middle East crisis and the depletion of Canadian stocks are expected to become the most dominant factors that will impact on the world sulphur markets in 1991. The increasing tightness in the supply of elemental sulphur will likely lead to firmer prices, which could rise above expected levels should the Persian Gulf crisis worsen. The world phosphoric acid market is projected to become more stable during the first half of 1991 as major North African buyers expect reduced demand with good stock levels. Phosphate fertilizer demand is forecast to increase 2.6% in 1991, and 8.8% by 1994. Most of these increases are to occur in India, East Europe and Asia. Fertilizer sulphuric acid demand in 1991 is projected to increase 3.3%, mostly in North Africa and India. On the supply side, the world production of elemental sulphur is set to increase marginally in 1991; few projects are expected to come on stream in producing countries with the exception of Canada and the U.S.S.R. The reactivation of Astrakhan II and Tengiz I in conjunction with expanding production at Orenburg and Astrakhan I will allow the U.S.S.R. to more adequately meet its requirements. The outlook for a tight market in 1991 will call for more remelts to offset the shortfalls in production expected from the Middle East. Withdrawals from Canada and Saudi Arabia are anticipated during 1991. The world inventories are likely to reach a working level that would result in lessening the buffer that the marketplace has been benefitting from since 1979. Sulphur contract prices are forecast to be stabilizing during the first half of 1991.

Canadian production of natural gas is expected to continue as a result of growing domestic and export sales. Export shipments will grow at a higher rate due to improved flexibility and deliverability. During the 1990-95 period, expanding natural gas sales will result in higher sulphur output, both in Alberta and in British Columbia.

In the 1990s, the trend for declining sulphur production from existing reserves is likely to continue at an estimated rate of 5% per year up to 1995. However, new gas developments and projected discoveries are expected to offset this decline and increase the sulphur gas-related output by close to 15% between 1990 and 1995. Sulphur recovery capacity from gas processing is forecast to grow up to 6.2 Mt/y by 1995. In 1991, expansions and tying-ins at OBED, Fir-Spotter and Brazeau would add close to 0.5 Mt in incremental production. By 1995, projects at Taylor (British Columbia), Pine River (British Columbia) and Caroline (Alberta) are expected to be commissioned, adding about 1.8 Mt/y in sulphur capacity. Other sulphur-related projects include OSLO and Lloydminster where development becomes attractive as a strategic source of petroleum in the wake of a potential energy shortage. Elemental sulphur production in Canada is forecast to reach 7.2 Mt/y by 1995, of which gas processing will account for 89%, followed by oil sands processing (7%) and oil refining (4%).

During the period 1979-90, Canadian sulphur inventories declined from 21 Mt to 3.3 Mt. With remelts expected during 1991, stocks are projected to bottom out at 2.3 Mt by year-end, of which 50% will be difficult to recover. Since the bulk of incremental production (i.e. Caroline) is not expected before 1993, the sulphur availability from Canada will be slightly reduced during the 1992-93 period. In 1991, the sulphur available for exports to both the United States and offshore markets has been forecast at 6.8 Mt.

The recovery of sulphur products (sulphuric acid, sulphur dioxide and elemental sulphur) from smelters is likely to increase significantly by 1994 with the implementation of the sulphur dioxide emissions abatement programs in Manitoba, Ontario and Quebec. Current plans for recovering SO_2 emissions will result in additional sulphur production of approximately 0.3 Mt/y, a 20% increase between 1990 and 1995. Plans for more stringent legislation are being evaluated for further nationwide reductions to be met by 2000.

With growing production and steady consumption of sulphur, the supply availability for exports will permit Canada to maintain a strong presence in the world trading of sulphur. The structure of the Canadian industry is undergoing important changes as suppliers are contemplating the benefits of establishing a new consortium for offshore sales.

Note: Information contained in this review was current as of mid-January 1991.

TARIFFS

Item No.	Description	Canada			United States
		MFN	GPT	USA	Canada
2503.00	Sulphur of all kinds, other than sublimed sulphur, precipitated sulphur and colloidal sulphur				
2503.10.00	Crude or unrefined sulphur	Free	Free	Free	Free
2503.90.00	Other	Free	Free	Free	Free
2802.00.00	Sulphur, sublimed or precipitated; colloidal sulphur	Free	Free	Free	Free
2807.00.00	Sulphuric acid; oleum	Free	Free	Free	Free
2811.23.00	Sulphur dioxide	Free	Free	Free	2.5%

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States effective January 1, 1990.

TABLE 1. CANADA, SULPHUR SHIPMENTS AND TRADE, 1989 AND 1990

Item No.		1989		1990p	
		(tonnes)	($000)	(tonnes)	($000)
Shipments[1]					
	Sulphur in smelter gases[2]	808 789	86 909	929 339	93 411
	Elemental sulphur[3]	6 868 930	501 518	7 167 920	448 825
	Total sulphur content	7 677 719	588 427	8 097 259	542 236
Imports				(Jan.-Sept.)	
2503.10	Sulphur, crude or unrefined				
	United States	2 498	522	2 247	510
	Total	2 498	522	2 247	510
2503.90	Sulphur, n.e.s.				
	United States	15 813	1 781	8 566	1 964
	Total	15 813	1 781	8 566	1 964
2802.00	Sulphur sublimed or precipitated; colloidal sulphur				
	United States	1 755	617	1 037	338
	Other countries	90	78	39	29
	Total	1 845	695	1 076	367
2807.00	Sulphuric acid; oleum				
	United States	28 397	2 709	53 639	4 079
	Other countries	36	4	24	3
	Total	28 433	2 713	53 663	4 082
2811.23	Sulphur dioxide				
	United States	470	167	669	208
	Total	470	167	669	208
Exports					
2503.10	Sulphur, crude or unrefined				
	United States	1 033 990	82 078	1 074 864	103 815
	Morocco	355 444	38 233	623 532	65 999
	Indonesia	256 078	32 394	224 704	22 819
	Brazil	467 908	56 552	211 394	22 584
	Australia	468 331	57 070	211 180	22 118
	Tunisia	218 948	22 684	199 582	22 001
	U.S.S.R.	385 408	39 274	213 059	20 469
	Mexico	216 240	30 269	180 879	19 947
	Israel	218 684	24 873	179 678	18 678
	South Korea	234 275	29 201	168 261	17 187
	South Africa	270 163	29 931	168 631	16 327
	India	304 703	31 667	137 615	13 984
	Taiwan	168 026	19 730	132 958	13 617
	France	69 824	7 619	103 473	11 907
	Other countries	801 690	94 622	782 362	80 528
	Total	5 469 712	596 197	4 612 172	471 980
2503.90	Sulphur, n.e.s.				
	United States	37 380	1 583	9 101	1 122
	Other countries	6 967	986	1 500	135
	Total	44 347	2 569	10 601	1 257
2802.00	Sulphur, sublimed or precipitated; colloidal sulphur				
	United States	280	63	136	66
	Total	280	63	136	66
2807.00	Sulphuric acid; oleum				
	United States	627 035	22 789	897 268	32 264
	Other countries	190	56	46	28
	Total	627 224	22 845	897 314	32 292
2811.23	Sulphur dioxide				
	United States	77 871	9 065	44 465	8 089
	Total	77 871	9 065	44 465	8 089

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Data compiled regardless of origin (i.e. domestic and foreign source materials). [2] Sulphur in liquid SO_2 and H_2SO_4 recovered from the smelting of metallic sulphides and from the roasting of zinc-sulphide concentrates. [3] Producers' shipments of elemental sulphur produced from natural gas; also included are small quantities of sulphur produced in the refining of domestic crude oil, synthetic crude oil and remelts from vatted stocks.
p Preliminary; n.e.s. Not elsewhere specified.
Note: Totals may not add due to rounding.

Sulphur

TABLE 2. CANADA, SOUR GAS AND OIL SANDS SULPHUR EXTRACTION PLANTS, 1988-90

Operating Company	Source Field or Plant Location	H_2S in Raw Gas	Daily Sulphur Capacity[1] 1988	1989	1990
	(Alberta, except where noted)	(percent)		(tonnes)	
Sour Gas					
Alberta Energy Company Ltd.	Sinclair - Hythe	3	256	256	256
Amerada Hess Corporation	Olds - Garrington	15	389	389	389
Amoco Canada Petroleum Company Ltd.	Bigstone Creek	16	385	385	385
Amoco Canada Petroleum Company Ltd.	Brazeau River	0.8	110	110	110
Amoco Canada Petroleum Company Ltd.	Caroline - Garrington	n.r.	–	10.4	10.4
Amoco Canada Petroleum Company Ltd.	Caroline-Harmattan	0.8	8	8	8
Amoco Canada Petroleum Company Ltd.	East Crossfield-Elkton	34	1 797	1 797	1 797
Amoco Canada Petroleum Company Ltd.	Edson - Pine Creek	1.4	289	289	289
Amoco Canada Petroleum Company Ltd.	Kaybob South I/II	11	1 086	1 086	1 090
Amoco Canada Petroleum Company Ltd.	Lone Pine Creek	10	283	283	283
Amoco Canada Petroleum Company Ltd.	W. Pembina-Brazeau	n.r.	340	340	520
Amoco Canada Petroleum Company Ltd.	Zama	8	74	74	74
Canadian Occidental Petroleum Ltd.	East Calgary-Crossfield	17	1 696	1 696	1 696
Canadian Occidental Petroleum Ltd.	Mazeppa	36	577	577	577
Canadian Occidental Petroleum Ltd.	Okotoks	34	431	431	431
Canadian Occidental Petroleum Ltd.	Paddle River	0.1	19	19	19
Chevron Canada Resources Limited	Kaybob South III	16	3 557	3 557	3 557
Encor Energy Corp. Inc.	Teepee Creek	8	30	30	30
Esso Resources Canada Limited	Bonnie Glen	0.4	12.5	12.5	34.5
Esso Resources Canada Limited	Joffre	3.4	17	23.5	23.5
Esso Resources Canada Limited	Quirk Creek	9	299	299	298
Esso Resources Canada Limited	Redwater	2.6	11	11	11
Gulf Canada Limited	Brazeau River-Nordegg	1.3	42	42	42
Gulf Canada Limited	Homeglen-Rimbey	1	128	128	128
Gulf Canada Limited	Nevis	4	197	197	197
Gulf Canada Limited	Strachan	9	953	953	953
Gulf Canada Limited	Hanlan Robb	9	1 092	1 092	1 092
Home Oil Company Limited	Carstairs	0.5	65	65	65
Husky Oil Ltd.	Rainbow Lake	2	139	139	139
Husky Oil Ltd.	Ram River (Ricinus)	19	4 572	4 572	4 572
Husky Oil Ltd.	Windfall - Whitecourt	21	1 330	1 330	1 330
Mobil Oil Canada, Ltd.	Harmattan-Elkton-Leduc	46	490	490	490
Mobil Oil Canada, Ltd.	Lone Pine Creek	10	157	157	157
Mobil Oil Canada, Ltd.	Wimborne	13	182	182	182
Norcen Energy Resources Limited	Minnehik-Buck Lake	0.1	45	45	45
Pembina Corporation	Turner Valley	2.5	11	16	16
Petro-Canada Inc.	Brazeau	7	444	444	447.3
Petro-Canada Inc.	Gold Creek	3	43	43	43
Petro-Canada Inc.	Wildcat Hills	4	177	280	280
Poco Petroleum Ltd.	Sturgeon Lake	9	98	98	98
Saratoga Processing Company Limited	Savannah Creek (Coleman)	24	389	389	389
Shell Canada Limited	Caroline-Bearberry	90	–	–	224
Shell Canada Limited	Burnt Timber Creek	13	489	489	489
Shell Canada Limited	Jumping Pound	6	597	597	597
Shell Canada Limited	Progress	0.7	15	15	15

TABLE 2 (cont'd)

Operating Company	Source Field or Plant Location	H_2S in Raw Gas	Daily Sulphur Capacity[1] 1988	1989	1990
	(Alberta, except where noted)	(percent)		(tonnes)	
Sour Gas (cont'd)					
Shell Canada Limited	Rosevear South	8	171	171	171
Shell Canada Limited	Simonette River	16	95	95	95
Shell Canada Limited	Waterton	19	3 107	3 107	3 107
Suncor Inc.	Rosevear	8	110	110	110
Westcoast Energy Inc.	Fort Nelson, B.C.	n.r.	1 100	1 100	1 100
Westcoast Energy Inc.	Taylor Flats, B.C.	3	460	460	460
Westcoast Energy Inc.	Pine River, B.C.	n.r.	1 055	1 055	1 055
Oil Sands					
Suncor Inc.	Mildred Lake	n.a.	441	441	441
Syncrude Canada Ltd.	Fort McMurray	n.a.	1 255	1 255	1 255

Source: Alberta Energy Resources Conservation Board publications, October 1990.
[1] Maximum design capacity.
n.a. Not applicable; n.r. Not reported; – Nil.

TABLE 3. CANADA, PETROLEUM REFINERY SULPHUR CAPACITIES OPERATING IN 1988-90

Operating Company	Location	Daily Capacity 1988	1989	1990
			(tonnes)	
Canadian Ultramar Limited	St. Romuald, Quebec[1]	40	40	50
Chevron Canada Limited	Burnaby, British Columbia	10	10	10
Consumers' Co-operative Refineries Limited	Regina, Saskatchewan	16	220	220
Imperial Oil Limited	Dartmouth, Nova Scotia	76	76	76
	Edmonton, Alberta	40	40	40
	Port Moody, British Columbia	20	20	20
	Sarnia, Ontario	140	140	140
Irving Oil Limited	Saint John, New Brunswick	100	100	100
McColl-Frontenac Inc.[5]	Nanticoke, Ontario	35	35	35
Petro-Canada Products Inc.	Clarkson-Mississauga, Ontario	44	44	44
	Edmonton, Alberta[2]	56	56	56
	Oakville-Trafalgar, Ontario	40	40	40
	Port Moody, British Columbia[3]	25	0	0
Shell Canada Limited	Burnaby, British Columbia	15	15	15
	Sarnia, Ontario	35	35	35
	Scotford, Alberta	14	14	14
Sulconam Inc.	Montreal, Quebec	300	300	300
Suncor Inc.	Sarnia, Ontario	50	50	50
Total effective capacity[4]		1093	1235	1245

Sources: Mineral Policy Sector, Energy, Mines and Resources Canada; Company interviews, 1990.
[1] 30 t/d capacity on stand-by at St. Romuald, Quebec. [2] Petro-Canada Products Inc. has a 60 t/d back-up desulphurization unit at Edmonton; however, both units cannot run simultaneously. [3] Petro-Canada Products Inc.'s sulphur-processing unit in Port Moody, British Columbia was shut down in 1989. [4] Effective capacity comprises operating productive capacity. [5] Acquired from Texaco Canada Inc. in 1985.

TABLE 4. CANADA, PRINCIPAL SULPHUR DIOXIDE AND SULPHURIC ACID PRODUCTION CAPACITIES, 1990

Operating Company	Plant Location	Raw Material	Annual Capacity		
			Liquefied SO_2	Sulphuric acid[1]	Sulphur equivalent[2]
			(000 tonnes)		
Brunswick Mining and Smelting Corporation Limited	Belledune, N.B.	SO_2 lead & zinc conc.		176	58
Canadian Electrolytic Zinc Limited (CEZ)	Valleyfield, Que.	SO_2 zinc conc.		430	140
Falconbridge Limited	Kidd Creek, Ont.	SO_2 zinc conc.		220	72
	Kidd Creek, Ont.	SO_2 copper conc.		340	111
	Sudbury, Ont.	SO_2 nickel conc.		355	116
Gaspé Copper Mines, Limited	Murdochville, Que.	SO_2 copper conc.		165	54
ICI Canada Inc.	Beloeil, Que.	elem. sulphur		70	23
Inco Limited	Copper Cliff, Ont.	SO_2 pyrrhotite and nickel conc.		550	180
	Copper Cliff, Ont.	SO_2 copper conc.	100	n.a.	50
Kronos Canada, Inc.	Varennes, Que.	elem. sulphur		56	18
Noranda Minerals Inc.	Rouyn-Noranda, Que.	SO_2 copper conc.		400	131
Sulco Chemicals Ltd.	Elmira, Ont.	elem. sulphur		33	11
Subtotal, Eastern Canada			100	2 795	964
Border Chemical Company Limited	Transcona, Man.	elem. sulphur		150	49
Cameco Corporation-Rabbit Lake Operation	Rabbit Lake, Sask.	elem. sulphur		72	23
Cameco Corporation-Key Lake Operation	Key Lake, Sask.	elem. sulphur		72	23
Cominco Ltd.	Trail, B.C.[3]	SO_2 zinc & lead conc.	75	430	206
Esso Chemical Canada	Redwater, Alta.	elem. sulphur		910	297
Marsulex Inc.	Fort Saskatchewan, Alta.	elem. sulphur		160	52
Sherritt Gordon Limited	Fort Saskatchewan, Alta.	elem. sulphur		233	75
Westcoast Energy Inc.	Prince George, B.C.	elem. sulphur	30	75	40
Subtotal, Western Canada			105	2 102	765
Total			205	4 897	1 729

Sources: Mineral Policy Sector, Energy, Mines & Resources Canada; Canadian company interviews 1990.
[1] 100% H_2SO_4. [2] Elemental sulphur equivalent of sulphuric acid is 32.7% and sulphur equivalent of liquefied SO_2 is 50%. [3] Cominco operation at Trail also has a 28 000 t/y production capacity for elemental sulphur, which has been added to the total sulphur equivalent production capacity of Cominco.
n.a. Not applicable.

TABLE 5. CANADA, SULPHUR SHIPMENTS AND TRADE, 1970, 1975 AND 1980-90

	Shipments[1]				Imports[2]	Exports[2]
	Pyrites	In Smelter Gases	Elemental Sulphur	Total	Elemental Sulphur	Elemental Sulphur
	(tonnes)					
1970	159 222	640 360	3 218 973	4 018 555	48 494	2 711 069
1975	10 560	694 666	4 078 780	4 784 006	14 335	3 284 246
1980	14 328	894 732	7 655 723	8 564 783	1 767	6 850 143
1981	5 000	783 000	8 018 000	8 806 000	4 633	7 309 216
1982	9 000	627 000	6 945 000	7 581 000	2 159	6 111 444
1983	–	678 286	6 631 123	7 309 409	2 365	5 670 275
1984	–	844 276	8 352 978	9 197 254	3 019	7 326 847
1985	–	822 359	8 102 163	8 924 522	3 167	7 848 380
1986	–	758 231	6 965 775	7 724 006	10 763	6 257 054
1987	–	783 115	7 322 791	8 105 906	24 711	6 571 800
1988	–	856 496	8 106 641r	8 963 137r	21 825r	7 384 160r
1989	–	808 789	6 868 930	7 677 719	18 311	5 514 059
1990p	–	929 339	7 167 920	8 097 259	..	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
1 Shipment data compiled regardless of origin (i.e. domestic and foreign source materials). 2 Includes only elemental sulphur in a crude or refined form.
p Preliminary; r Revised; – Nil; .. Not available.

TABLE 6. CANADA, SULPHURIC ACID PRODUCTION, TRADE AND APPARENT CONSUMPTION, 1970, 1975 AND 1980-89

	Production	Imports	Exports	Apparent Consumption
	(tonnes - 100% acid)			
1970	2 475 070	9 948	129 327	2 355 691
1975	2 723 202	154 020	225 402	2 651 820
1980	4 295 366	18 048	323 775	3 989 639
1981	4 116 860	82 495	337 518	3 861 837
1982	3 130 854	192 514	259 740	3 063 628
1983	3 686 427	126 573	273 204	3 539 796
1984	4 043 389	28 330	553 780	3 517 939
1985	3 890 092	17 306	744 732	3 162 666
1986	3 536 062	29 127	755 606	2 809 583
1987	3 436 977	44 623	803 178	2 673 422
1988	3 804 856	40 078r	851 622r	2 993 312r
1989	3 559 762	28 433	627 224	2 960 971

Sources: Energy, Mines and Resources Canada; Statistics Canada.
r Revised.

TABLE 7. WORLD PRODUCTION OF SULPHUR, 1987-89

	1987		1988		1989p	
	All-forms[1]	Elemental	All-forms	Elemental	All-forms	Elemental
			(000 tonnes)			
World Total	**58 167**	**37 536**	**60 377**	**39 448**	**61 220**	**39 975**
Western World	**35 765**	**25 799**	**36 755**	**26 691**	**38 180**	**27 875**
Western Europe	**7 682**	**3 441**	**7 853**	**3 461**	**7 747**	**3 470**
Finland	507	50	569	45	679	45
France	1 243	1 063	1 154	974	1 067	874
West Germany	1 983	1 293	2 046	1 294	2 121	1 326
Italy	691	241	721	280	734	285
Norway	242	12	201	8	232	15
Spain	1 223	25	1 375	51	1 219	65
Others	1 793	701	1 787	809	1 695	860
Africa	**1 075**	**185**	**1 027**	**195**	**1 048**	**225**
South Africa	855	175	803	185	815	215
Others	220	10	224	10	233	10
Asia, Middle East	**6 332**	**4 248**	**6 872**	**4 848**	**7 613**	**5 510**
Japan	2 476	1 020	2 530	1 090	2 656	1 176
Saudi Arabia	1 450	1 450	1 450	1 400	1 500	1 500
Others	3 406	2 768	2 892	2 358	3 457	2 834
Oceania	**254**	**44**	**280**	**60**	**280**	**60**
North America	**17 267**	**15 238**	**17 665**	**15 635**	**18 372**	**16 228**
Canada	6 729	5 876	6 919	6 017	6 780	5 830
United States	10 538	9 362	10 746	9 618	11 592	10 398
Latin America	**3 156**	**2 643**	**3 057**	**2 492**	**3 120**	**2 382**
Mexico	2 391	2 306	2 244	2 144	2 192	2 012
Others	765	337	813	348	928	370
Eastern Europe	**6 766**	**5 165**	**6 914**	**5 239**	**6 800**	**5 110**
Poland	5 098	4 930	5 169	5 004	5 030	4 865
Others	1 668	235	1 745	233	1 770	245
U.S.S.R.	10 857	6 242	11 513	7 178	10 855	6 640
China	4 575	330	4 990	340	5 385	350
Other countries[2]	200	0	205	0	205	0

Source: The British Sulphur Corporation Limited, 1990.
[1] All-forms includes elemental sulphur, sulphur contained in pyrites and contained sulphur recovered from metallurgical waste gases, mostly in the form of sulphuric acid. [2] Includes North Korea, Vietnam and Cuba.
[p] Preliminary.

TABLE 8. CANADA, SULPHURIC ACID, REPORTED CONSUMPTION BY END USE, 1987-89

	1987	1988	1989p
		(tonnes)	
Agriculture chemicals and fertilizers	1 347 767	1 415 404	1 330 022
Industrial inorganic chemicals	446 687	528 750	534 401
Uranium mines	315 445	331 580	300 095
Pulp and paper	282 595	247 506	286 085
Nonferrous smelting and refining	129 022	141 918	122 648
Other mines, metal and nonmetal	39 055	38 353	32 784
Crude petroleum and natural gas	29 689	40 881	50 100
Leather and textile	22 442	21 480	27 951
Soap and cleaning compounds	15 159	17 901	17 242
Plastics and synthetic resins	9 718	9 322	7 358
Iron and steel mills	8 867	14 227	8 960
Electrical products	7 183	10 249	9 748
Food, brewery and distillery	5 276	6 251	654
Other end uses	137 212	167 449	129 585

Source: Reports from producing companies compiled by Mineral Policy Sector, Energy, Mines and Resources Canada.
p Preliminary.

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Tin prices decreased to an average of \$2.82/lb in 1990 from \$3.83/lb in 1989. The price decline was a function of continued weak demand in combination with continuing strong production. Although 1990 statistics were not complete at the time of writing, world mine production was expected to equal the 171 000 t of 1989, largely because falling output in Brazil and southeast Asia was offset by new production in Portugal. Metal consumption declined somewhat from the 1989 level. The Association of Tin Producing Countries (ATPC) decreased its quotas for member countries by 6% and Brazil agreed to decrease exports by a similar amount. The inability of the ATPC to convince Brazil and China to join the organization has led to speculation that an oversupply will continue in the short term.

CANADIAN DEVELOPMENTS

Canadian tin mine production is from the 9000 t/d open-pit operation of Rio Algom Limited near East Kemptville, Nova Scotia. Rio Algom wrote down \$22 million of capital assets in 1990 and made cumulative provisions for eventual mine closure costs, including environmental obligations. Although the company has been plagued by low tin prices, the mine is running efficiently with tin recoveries in the 70% range.

The East Kemptville ore is metallurgically complex and in 1989 Rio Algom added a flotation circuit which, in addition to other improvements in the mill, increased tin recoveries from their former 30% range. Small amounts of copper, zinc and silver are also recovered as by-products. The East Kemptville orebody consists of two zones, the Main zone and the smaller, higher grade Baby zone. In 1990, Rio Algom conducted a diamond drilling program to test for possible extensions of the zones along strike.

In early January 1991, unionized workers at the mine agreed to a tentative three-year labour contract to replace the agreement which expired on January 7, 1991.

As a by-product of the production of indium, Cominco Ltd. produces a small quantity of tin-lead alloy at its smelter in Trail. The alloy is used for solder applications.

Rio Algom exports its tin concentrates to England for further processing. Canada's refined tin requirements are thus provided by imports. Canadian consumption of refined tin for 1989 was 3600 t. Refined tin is imported by the large steelmakers, Stelco Inc. and Dofasco Inc., for the manufacture of tin plate, which is used primarily in can production. Small amounts are also imported by secondary lead refiners for the production of lead-tin alloys and solders.

WORLD DEVELOPMENTS

Brazil

Brazil continued to dominate world tin concentrate production in 1990. The Brazilian National Department of Mineral Production estimated 1990 production to be about 40 700 t, compared to 50 200 t in 1989. Analysts estimate that a further 10 000 t was smuggled out of the country, mainly to Bolivia, during the year.

The rapid rise in tin production in Brazil has resulted from the discovery, in recent years, of large alluvial deposits in the states of Rondonia, Para and Amazonas, in the remote Amazon region. The most significant of these is the large Bom Futuro deposit in the state of Rondonia. Production at Bom Futuro is carried out by thousands of independent miners, "garimpeiros," using simple, manual mining methods. In 1989, Bom Futuro garimpeiros produced 29 000 t of tin in concentrate. Production in 1990, however, was expected to have been much lower due to lower tin prices, uncertainties over the legality of independent mining, and the depletion of higher grade, near-surface ore, which increased mining costs.

The world's largest tin producer, Brazil's Paranapanema SA, reduced production in 1990 by 12% to 17 600 t, due to falling tin prices. Paranapanema's principal mining operation is the Patinga mine in the state of Amazonas. Reserves at Patinga are estimated at 450 000 t of contained tin.

Eight tin smelters operate in Brazil with a combined capacity of 61 000 t/y. Metal production in 1989 was 44 240 t.

Despite being the world's largest producer of tin, Brazil is not a member of the ATPC. Brazil agreed that it would join the ATPC but not until it had been able to control illegal mining activities which resulted in an estimated 10 000 t of tin being smuggled out of the country in 1989, mainly to neighbouring Bolivia. It is also believed that if it agrees to join, Brazil will ask that participation of countries in the association be proportional to their importance as world producers. Despite its problems in curbing illegal mining, Brazil agreed to cut its export quotas in 1991 by 6% to 39 000 t, in keeping with announced cuts by ATPC member countries by 6% for 1991.

China

The need for foreign exchange to support expanding import requirements and to offset its losses of foreign exchange on banned exports has put pressure on China to increase tin exports. It is believed by the ATPC that China exceeded its voluntary export quota of 10 000 t in 1989 by 8000 t. China received no official quota for 1990 but agreed to limit exports at under 15 000 t. The rapid rise in output in recent years from both China and Brazil, which are not members of the ATPC, is considered to be a key factor in prevailing low tin prices.

China was the world's second largest producer of tin concentrates in 1989, accounting for 33 000 t. Tin metal production was 28 300 t, ranking China fourth in the world. Tin deposits in the country are an extension of those in southeast Asia and are concentrated in the provinces of Yunnan, Guangxi, Guangdong, Jiangxi and Hunan, and on Hainan Island.

Indonesia

Indonesia's output of tin in concentrates for 1990 was expected to have been about 30 000 t, compared to a 1989 total of 31 000 t. The reduction in mine output in 1990 came mainly from cutbacks by state-owned P.T. Tambang Timah in high-cost offshore tin dredging operations. The curtailments came as the industry struggled to remain cost competitive in the face of falling tin prices. As a further cost-cutting measure, P.T. Tambang Timah announced that it would move its Djakarta headquarters to its site of operations on Bangka Island.

Malaysia

According to the Malaysian Finance Ministry, production of tin in concentrates by Malaysia was expected to have been about 29 000 t in 1990, a 9.4% decrease from the level of 32 000 t in 1989. At the end of August 1990, a total of 189 tin mines were in operation, down from 260 at the same time in 1989. The closure of higher cost mines is likely to continue in 1991 due to continued low tin prices in the face of rising production costs.

Another blow to Malaysian tin mining has been the suspension of Malaysian ilmenite imports by Japan, due to their high radioactivity. Ilmenite is an important by-product of tin mining in Malaysia.

Production of primary tin metal has increased steadily in recent years. In 1989, Malaysia produced 51 900 t. In 1990, primary tin production was expected to have remained at this level as domestic smelters imported more concentrates to offset declining local mine production.

Bolivia

Bolivia, which produced 15 800 t of tin in concentrates in 1989, has been plagued in recent years by rising production costs from its underground tin mines and by falling tin prices. In its continuing efforts to remain cost competitive, Corporacion Minera de Bolivia (Comibol) closed down the Viloco mine, which was its fourth largest tin operation. In December 1990, Comibol announced that it was seeking bids from private companies to run several of its tin mines, including the Huanuni, Bolivia's largest tin operation. The invitation for increased private involvement is part of the government's plan to modernize the Bolivian mining sector. Comibol would still own the mines.

Bolivia produced 9690 t of primary tin metal in 1989. Despite lower mine production in 1990, tin metal production was expected to remain near the 1989 level due to continuing imports of concentrates, mainly from Brazil.

United States

The United States Defense Logistics Agency resumed sales from its surplus tin stockpile in July 1990. The sales brought renewed fears from ATPC countries that additional tin supply, in an already oversupplied market, would further weaken tin prices. The U.S. Congress authorized the sale of 7000 t of tin from the stockpile in fiscal year 1989/90 ending September 30, but sales fell well short of this target.

Portugal

The Neves-Corvo copper-tin mine of Sociedad Minera de Neves-Corvo (Somincor) began tin concentrate production in May. The mine, which produces tin as a by-product of copper operations, was expected to have produced 2700 t of tin in concentrate in 1990, and to produce 5500 t/y thereafter. All concentrates are exported. The mine has reserves sufficient for 10 years of tin production.

INTERNATIONAL ORGANIZATIONS

The Association of Tin Producing Countries

The Association of Tin Producing Countries (ATPC) is an organization consisting of seven tin-producing states: Malaysia, Indonesia, Thailand, Bolivia, Australia, Zaire and Nigeria. Until recently, the ATPC members represented the majority of world tin mine production. However, with the emergence in recent years of Brazil and China as major tin producers, this has changed. In 1989, ATPC countries represented only 47% of total world tin mine production.

The ATPC began a supply rationalization scheme in March 1987, with the objective of accelerating the absorption of the huge tin inventories caused by the cessation of the buffer stock operations of the International Tin Council and to prevent further price declines. The scheme involved the establishment of an overall export quota among its members of 96 000 t for the 12 months beginning in March 1987. Brazil and China, although not members, also cooperated in limiting their exports initially to 21 000 t and 7000 t, respectively.

In March 1988, it was estimated by the ATPC that the tin inventories had been reduced from 73 000 t to 47 000 t. The export restrictions were renewed for another 12-month period ending in March 1989, at a level of 101 900 t for ATPC members, 26 500 t for Brazil and 10 000 t for China. At the end of 1988, stocks were estimated at 44 000 t.

The export restrictions were again renewed in March 1989 at an increased level of 106 500 t for ATPC members, 31 500 t for Brazil and 10 000 t for China. In April, due to strong price recovery, the ATPC decided to release an additional 8000 t from stocks held by producers. Indonesia, Malaysia and Thailand were allocated 2500 t, 2000 t and 560 t respectively, and Brazil was allocated 2750 t. The gesture reflected a desire by producers to limit the price increases in order to avoid losing the recently hard-gained increases in consumption and to discourage new mine capacity coming into operation.

By the end of 1989, as a result of the sharp decline in price from about US$4.60 to $3.00/lb, ATPC members decided to cut quotas by 5% to 84 200 t for the period March 1-December 31, 1990. Brazil and China did not receive quotas but agreed to cooperate with the ATPC in limiting exports.

Stocks rose in 1990 and, in October, the ATPC undertook a further 6% cut in export quotas for 1991 to a total of 95 800 t for members. Brazil agreed to reduce its quota by 6% to 39 000 t and China pledged to continue limiting exports to 15 000 t.

Tin

The Sixth International Tin Agreement

The Sixth International Tin Agreement (ITA) was an international producer/consumer arrangement aimed at stabilizing the price of tin, mainly through the operation of a buffer stock and by selective use of export controls. The Sixth ITA entered provisionally into force on July 1, 1982, under the direction of the International Tin Council (ITC). On October 24, 1985, the ITC ceased buffer stock operations and defaulted on loans and contracts. ITC creditors took various legal actions against the ITC and its members. After protracted negotiations between ITC members and its creditors, a settlement was reached on March 30, 1990. ITC creditors were paid £182.5 million. The ITC held its last meeting in London on July 31, 1990, at which time the organization was declared dissolved.

Research Organizations

The International Tin Research Institute is entrusted with the task of maintaining and extending the use and effectiveness of tin in modern technology. It is financed by the governments of five of the major tin-producing countries: Indonesia, Malaysia, Nigeria, Thailand and Zaire. Its headquarters and laboratories are in Uxbridge, Middlesex, England.

The South-East Asia Tin Research and Development (SEATRAD) Centre is a regional organization established by the governments of Indonesia, Malaysia and Thailand, with assistance from the Economic and Social Commission for Asia and the Pacific and other United Nations agencies. The purpose of the centre is to promote, conduct and coordinate research and training in relation to the technical and economic aspects of exploration, mining, mineral processing and smelting of tin. The Centre's headquarters and laboratory are located in Ipoh, Malaysia. In addition to the work being conducted in the laboratory, field projects are maintained in various member countries in southeast Asia. The Centre is financed by equal contributions from member countries.

USES

Solder recently surpassed tinplate as the largest market for the metal, accounting in 1988 for over 29% of consumption. Strong growth in the electronics industry, which accounts for over 50% of tin used in solders, has provided a new impetus for tin use. Growth in tin solder is, however, limited by the trend towards the use of less solder per assembly. This trend is more evident in the increasing use of surface-mounted components which permits greater solder savings. A growing trend in North America, due to regulatory actions, is to replace standard lead-tin solder in water pipes with silver-tin solder. The latter has a tin content of 95% versus 50% in the former.

Tinplate is the second most important use of tin. Tinplate use in the canning industry has been under severe competitive pressures from aluminum. Also, thinner tin coatings on food and beverage cans have reduced consumption of tin for tinplate. Tinplate competition also comes from non-tin-coated steels, tin-free steel (TFS) and electrolytic chromium-coated steel (ECCS). In the United States, aluminum has taken over the large metal beverage container market. Similarly, the increasing popularity of the microwave oven has enabled alternate packaging materials, including plastics and cellulose, to increase their market share.

The fastest growing new use for tin has been in chemical applications. Tin is used in an array of inorganic and organic chemicals, for application as PVC (pressure volume control) stabilizers, agricultural pesticides, anti-fouling paints for ships and biocidal compounds for the protection of materials such as paints, textiles and building materials.

Tin is also used for tinning (which includes electronic uses, hot dipping and electroplating in the electronics industry), in the manufacture of pewterware, and in bronze, brass and other tin-containing alloys. Tin-containing alloys are used in construction, machinery and equipment, and consumer durables.

Western World tin consumption was estimated at 177 000 t in 1990 compared to 181 000 t in 1989.

Talc, Steatite and Pyrophyllite

1990

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SUMMARY

Talc, when isolated as a pure mineral, is composed of 63.4% SiO_2, 31.9% MgO and 4.8% H_2O. However, as an industrial commodity, talc seldom approaches this chemical composition. Mineral impurities contributing to a divergence from the composition of pure talc and often appearing in talcose mixtures are tremolite, chlorite, dolomite, calcite, mica and magnesite. Its combination of physical properties such as extreme softness and whiteness, a high fusion point, a low thermal and electrical conductivity, its hydrophobic and organophilic nature, and its chemical inertness, allows talc to be very versatile in its application. Talc products are found in the paint, pulp and paper, ceramic, cosmetic, plastic, chemical, rubber and construction products industries.

Pyrophyllite is a hydrous aluminum silicate containing, in its pure form, 66.7% SiO_2, 28.3% Al_2O_3 and 5.0% H_2O. The mineral possesses physical properties characteristic of talc and, as a result, finds its way into similar applications. Major markets for pyrophyllite are associated with ceramics, refractories and insecticides.

Reported Canadian consumption of ground talc was 70 025 t in 1989, representing a decrease of less than 1% from 1988. Pulp and paper consumed 39.2% of the reported 1989 talc consumption, asphalt roofing 31.4% and paint 9.3%. Industries such as ceramics, rubber, cosmetics, chemicals, refractories, fertilizers and gypsum products consumed the remaining 20.1%.

Preliminary 1990 figures for Canadian shipments of talc, steatite and pyrophyllite showed a 5.4% decrease from those of 1989. Shipments in 1990 totalled 137 000 t compared to 144 828 t in 1989. In 1990, the average unit value for the three commodities (talc, steatite and pyrophyllite) increased by $7 to $112/t reflecting slightly higher prices for talc products.

Imports of crushed or powdered talc for the first nine months of 1990 decreased by 5.6% to 31 857 t while exports remained almost the same at around 30 500 t. Even if these 1990 trade figures represented little change over 1989, it is encouraging to see that the disappointing trend experienced in 1988 and 1989 was stopped. In 1989, imports for the first nine months increased by 16.7% and exports decreased by 20%.

Talc is produced in Canada by three companies: Bakertalc Inc. located in Quebec; Canada Talc Limited located in Ontario; and Luzenac Inc., with a Quebec-based operation originally known as B.S.Q. Talc Inc. and an Ontario-based operation known for years under the name of Steetley Talc Inc. On the production side, no significant changes occurred in the Canadian talc industry in 1990. With overall capacity estimated at 150 000 t/y, processes and product lines remained almost unchanged. Pyrophyllite is produced in Newfoundland by one company, Armstrong World Industries Canada Ltd.

In 1989, world production of talc, steatite and pyrophyllite of 7.98 Mt was about the same as the revised figure for 1988 of 7.99 Mt. The United States, at 1.17 Mt, and India, Brazil and Finland, each at approximately 0.4 Mt, were the four major talc producers in the Western World in 1989. Major producing countries for pyrophyllite in the Western World for that same period were Japan with 1.23 Mt and the Republic of Korea (South Korea), with 0.64 Mt. In North America, the production of pyrophyllite amounted to approximately 120 000 t in 1989.

With an estimated future growth between 4% and 5%, demand for talc in plastics will experience the fastest growth in North America. A greater demand for talc in the pulp and paper

industry may be seen as a result of environmental pressures to recycle waste paper. The installation of de-inking machines should increase the need for talc. A survey carried out by Energy, Mines and Resources Canada (EMR) in 1988 showed that the Canadian pulp and paper industry will use 42 000 t of talc in the year 2000. Such a demand corresponds to a growth of about 4%/y.

In contrast to North America, talc is used extensively as a paper-making pigment in Europe to enhance the quality of paper. Since the technology is already in place, this area may represent an opportunity for Canadian producers. Domestic producers currently supply the pulp and paper industry mainly with a talc utilized as a pitch control agent.

MINERALOGY AND GEOLOGY

Talc is a hydrous magnesium phyllosilicate represented by the chemical formula $Mg_3Si_4O_{10}(OH)_2$. Theoretically, the mineral is composed of 63.4% SiO_2, 31.9% MgO and 4.8% H_2O. In nature, talc is usually intimately associated with numerous other minerals such as dolomite, calcite, quartz and those of the serpentine and amphibole mineral groups. Its colour is characteristically pale green, grey or creamy white. It exhibits a pearly and greasy lustre and presents a soapy feel.

Talc is derived from the alteration (hydration) of non-aluminous magnesium silicate rocks in an intensive metamorphic environment. The most common host rocks for the formation of talc are dolomite and ultramafic rocks. However, talc can also be found associated with mafic igneous rocks and sedimentary rocks. The mineral occurs as veinlets, tabular bodies or irregular lenses.

Steatite or soapstone, the name used in previous EMR mineral yearbooks, is a massive variety of talc containing varying quantities of mineral impurities such as chlorite, dolomite, calcite and quartz and minerals from the serpentine and amphibole groups. Due to its chemical inertness and hydrophobic properties, steatite is known for its durability.

Pyrophyllite is a hydrous aluminum silicate with the chemical formula $Al_2Si_4O_{10}(OH)_2$. Theoretically, it is made up of 28.3% Al_2O_3, 66.7% SiO_2 and 5.0% H_2O. The mineral is formed by the hydrothermal alteration of acid igneous rocks, predominantly those that are andesitic to rhyolitic in composition. It occurs in low- and medium-grade metamorphic rocks rich in aluminum. Pyrophyllite's physical properties are practically identical to those of talc and, for this reason, it finds industrial uses similar to talc.

CANADIAN PROFILE

Consumption

Reported Canadian consumption of ground talc decreased by less than 1% from 1988 to 1989. EMR's nonmetallic mineral 1989 consumption survey shows that pulp and paper accounted for 39.2% of the reported talc consumption, asphalt roofing 31.4% and paint 9.3%. The remaining 20.1% was used by the ceramic, rubber, cosmetic, chemical, refractory, fertilizers and gypsum products industries. All of these figures are almost unchanged from 1988.

Although the reported consumption of talc for 1989 is 70 025 t, the true consumption for that year was probably closer to 90 000 t. Previous years' experience has shown that consumption reported to EMR represents approximately 80% of the total consumption.

Shipments

In 1990, reported Canadian shipments of talc, steatite and pyrophyllite decreased 5.4% from 1989 to about 137 000 t. This small decline can be explained by lower sales in the latter months of 1990 when the recession was starting to have an impact. The average unit value for the products increased by approximately \$7 to \$112/t. This increase in unit value was mainly due to slightly better prices for talc products. To protect the producers' confidentiality, the average unit value is calculated from the values of all three mineral products (talc, steatite and pyrophyllite). Since these values vary considerably from each other, the reader should consider that changes in the average unit value from year to year may sometimes reflect variations in shipments of individual products and are not always indicative of a change in the unit value of talc.

Talc currently is produced in the provinces of Ontario and Quebec, and pyrophyllite in the province of Newfoundland. Preliminary figures for 1990 showed, as indicated above, a slight decrease in total shipments of talc and pyrophyllite from 1989. This small change over last year is observed in all three mineral products. Indeed, detailed tonnage figures provided to EMR for 1990, on a confidential basis, showed a slight decrease from 1989 for each mineral product.

According to the 1989 global production figures, Canada is now the thirteenth largest talc, steatite and pyrophyllite producer in the world. In 1987, Canada ranked fourteenth, after Norway, for these commodities.

Trade

Imports of talc, steatite and pyrophyllite for the first nine months of 1990 were 34 701 t, 287 t and 866 t respectively. When compared to the same period in 1989, total imports of crushed or powdered talc decreased by 5.6% to 31 857 t while, on a value basis, we observe an increase of 150% for steatite imports and a decline of 15% for pyrophyllite imports. Talc imports for the first nine months of 1990 represent little change over those of 1989. However, they mark a stop to significant increases experienced in previous years. In 1989, imports of talc for the same period increased by 16.7% over 1988. All of the pyrophyllite and almost all of the talc came from the United States. However, the United States was responsible for only 35% of the crude steatite imports; the remaining 65% came mainly from Brazil.

Exports of crushed or powdered talc for the first nine months of 1990 were 30 832 t. This represents an increase of 355 t, or less than 1% from the same period in 1988. Talc as well as steatite and pyrophyllite are exported almost exclusively to the United States. Although exports of talc remained constant in 1990 and 1989, the 1990 figures are encouraging since, in 1989, the industry faced a 20% drop in talc exports over 1988.

Deposits

In 1990, there were three Canadian talc producers. On October 1, 1989, Luzcan Inc. (originally B.S.Q. Talc Inc.) and Luzenac Inc. (originally Steetley Talc Inc.) merged to form one company. This company, now with mining properties in Ontario and Quebec, will operate under the name of Luzenac Inc. The Ontario property is an open-pit operation located in Penhorwood Township, 70 km southwest of Timmins. At that locality, talc occurs in talc-magnesite deposits derived from the alteration of ultramafic volcanic rocks. Ore, containing 35% talc, is processed by flotation and is fine-ground at a plant in Timmins to high-purity platy products such as fillers for the paint, paper, plastic and rubber industries. Grades for the cosmetic and pulp industries are also produced. Current capacity at Luzenac's Ontario operation is 55 000-65 000 t/y, depending on product mix. The Quebec property, also an open-pit operation, is located near St-Pierre-de-Broughton. At that locality, Luzenac Inc. mines two deposits from the Pennington dike in the Leeds and Thetford townships. There, talc occurs in ultramafic intrusives, peridotite-serpentinite, and in quartz-carbonate-chlorite schists. Luzenac Inc. produces, from these schists, a ground carbonate-talc product that contains nearly 70% talc. This material is used as a filler in joint cement, auto-body compounds and plastics, and as a dusting agent in asphalt roofing shingles and rubber products. Benefiting from the parent company's expertise, the Quebec plant is also involved in talc-carbonate and talc-chlorite products suitable for paint, flooring and plastics end-uses. The Quebec operation is involved, on a small scale, in the production of steatite refractory slabs and sculpture blocks. Current plant capacity for talc is about 40 000 t/y but it can easily be expanded to 60 000 t/y should market demand so permit.

Bakertalc Inc. produces talc and steatite from an underground operation at South Bolton, Quebec, 95 km southeast of Montreal. Talc, associated with serpentine and magnesite, occurs as dikes and sills in Cambrian and lower Ordovician schists. The ore is extracted from the Van Reet mine and trucked 16 km south to the company's processing plant at Highwater where a high-quality talc grade is produced for use in the pulp and paper industry as well as dry-milled talc grades for use as industrial fillers in paints and plastics. Bakertalc Inc. is also a supplier of steatite slabs and blocks. St-Lawrence Chemical Inc. is the sole distributor of Bakertalc's products. In 1990, Bakertalc was seriously considering merging with International Larder Minerals Inc. For Bakertalc, it would give access to International Larder's talc reserves at Thetford Mines, Quebec and, for International Larder, the merger would provide a means to participate in talc production from Bakertalc's operations at Highwater, Quebec. In the fall of 1990, the company put in place the foundation for a pelletizer. Production of pellets is planned for the spring of 1991. Overall production capacity is estimated at approximately 18 000 t/y, depending on product mix.

Canada Talc Limited operates both underground and open-pit talc orebodies at Madoc, Ontario. The orebodies occur in crystalline dolomite where tabular hydrothermal replacement was the principal alteration mechanism. At that locality, talc is of exceptional whiteness. Mineral impurities consist mainly of sulphides, mica and prismatic tremolite. The company produces both talc and dolomite from its orebodies. Present production capacity for talc is in the order of 30 000 t/y. In 1990, Canada Talc Limited started producing finer ground talc products using a micronizer. Its finer products are used by the plastics industry.

Pacific Talc Ltd. owns a talc deposit located 17 km north of North Bend in southwestern British Columbia. The deposit has an exposed strike length of 500 m and a width varying from 10 to 50 m. Diamond drilling has proven reserves of 1 Mt grading 60% talc. The mineral association consists of an admixture of talc (60%) and magnesite (30%) with minor quantities of chlorite (3%-8%), carbonate (0.5%-2%) and iron oxide (6%). Laboratory studies have shown that the talc can be readily liberated and concentrated by flotation, and pilot plant testing proved that a high-quality paper-grade talc could be produced into wettable talc products in high solids slurry form. Pacific Talc Ltd. received the results of a pre-feasibility study in April 1990. The project plans for an open-pit operation with ore being trucked 70-100 km to a processing plant near Langley, British Columbia. Production for the first year is forecast at 56 000 t rising to 200 000 t in year three. The next step is to raise funds for a final feasibility study which would include a drilling program and continuous testing of a 10-t sample.

Trifco Minerals Ltd. possesses interest in a talc deposit located 35 km east of Quesnel, British Columbia. Additional geological investigations that followed a 1986 drilling campaign enabled the company to estimate reserves from the Do-Do Creek peridotite talc deposit at 410 000 t grading, on average, 50% talc. In 1989 and 1990, trenching exposed new talc mineralizations grading 80%-95% talc. Estimated talc reserves from these mineralizations are 590 000 t. Dolomitic talc was also exposed in the area, grading 40% talc. Reserves of talc from that showing were estimated at 250 000 t. The total talc reserve in the area amounts to roughly 1 Mt.

Carey Canada Inc. announced in 1987 the discovery of a large, high-grade talc deposit located on farmland between the towns of Leeds Station and East Broughton, Quebec. Preliminary diamond drilling results at that time indicated that the deposit possibly contains 8 Mt of ore grading 78%-80% talc. About one half of that tonnage would require no stripping, while the remaining 4 Mt would require limited stripping. Laboratory and pilot plant testing through flotation cells and a micronizer that pulverizes the ore to -2 microns indicated recoveries of 85%-90%, while metallurgical testing showed no associated asbestos or tremolite and revealed the presence of calcite and dolomite in quantities of less than 1%. In 1990, further diamond drilling was carried out by the company on the property to determine more precisely the morphology of the deposit and to obtain better estimates of ore reserves. Preliminary results of this drilling campaign, which was carried out near the surface, are encouraging. Final results are being compiled and should be disclosed in 1991.

Commercial Industrial Minerals Limited (CIML) holds mining leases on a large talc/tremolite deposit near Robertsville, Ontario. In the latter part of the 1980s, the company made modifications to its milling facilities in Clarendon for the production of a wide variety of industrial minerals. However, CIML's current primary product is tremolite. Ore reserves have been estimated at 2 Mt of tremolite and 0.35 Mt of talc.

Armstrong World Industries Canada Ltd. (Newfoundland Minerals Division) mines pyrophyllite from an open-pit operation near Manuels, 19 km southwest of St. John's, Newfoundland. The deposit appears to be the result of a hydrothermal alteration of sheared rhyolite which is found in a zone of extensive fracturing near granite contacts. Reserves are believed to be sufficient for 40 years at current production levels. The ore is crushed, sized and hand-cobbed at the mine site. Production capacity is estimated at about 65 000 t/y. The high-quality crude ore (a pyrophyllite-quartz product with minor sericite) is shipped to the United States where it is finely ground for use in ceramic tiles. Small quantities of some lower-grade pyrophyllite are also used in the local manufacture of joint cement, paint and other products.

WORLD OVERVIEW AND DEVELOPMENTS

In 1989, world production of talc, steatite and pyrophyllite remained almost unchanged from the revised 1988 figures of 7.99 Mt. Talc accounted for approximately 70% of the production, the remaining 30% being mainly pyrophyllite. Asia is responsible for about 40% of world production of talc, steatite and pyrophyllite. However, Asian production includes the majority of the world pyrophyllite production. Asian countries produced 1.9 Mt of pyrophyllite in 1989 with Japan alone showing production figures of 1.23 Mt. North America occupies the second place with roughly 18% of the world production of talc and pyrophyllite, followed by Western Europe, 14%; the U.S.S.R., 7%; and South America, 8%. The four leading producer countries of talc in the Western World are the United States with 1.17 Mt, and India, Brazil, and Finland each with around 0.4 Mt. As mentioned above, Japan is the most important producer country of pyrophyllite with more than 1.0 Mt/y. Other important producer countries of this mineral are the Republic of Korea (South Korea) with 0.64 Mt and the United States with 80 000 t. Canada also produces pyrophyllite. Its production is in the order of 35 000 to 45 000 t/y.

United States

U.S. production of talc and pyrophyllite increased slightly from 1988 to 1989. According to the U.S. Bureau of Mines, production of these minerals reached 1 253 128 t in 1989. Talc and steatite were produced in 10 states by 14 companies operating 23 mines, while pyrophyllite was produced by 4 companies operating 5 mines in 2 states.

In 1989, Cyprus Industrial Minerals Company, the largest U.S. talc producer, completed its acquisition of Windsor Minerals, Inc. from Johnson & Johnson. Their acquisition added talc operations in Vermont and California and production capacity of 200 000 t/y, increasing the company's output of dry ground industrial and cosmetic talcs. In 1989, Cyprus talc production was a record 485 000 t, 78% more than the previous year.

The U.S. Bureau of Mines estimated sales of crude and processed talc and pyrophyllite at 1 145 097 t. This amount represents a 10% increase in volume but a slight decrease in value over 1988. A 7% increase in talc consumption was recorded for 1989. Major consumers were the construction industry with applications in ceramic tiles, sanitary ware, joint compounds, paint, plastics and roofing. End-use distribution consisted of ceramics, 32%; paint, 15%; paper, 14%; roofing, 10%; plastics, 10%; cosmetics, 5%; and insecticides, refractories, rubber and other end uses, 14%.

The U.S. Bureau of Mines reports that pyrophyllite production decreased by 17% in volume in 1989. This important change was mainly due to the closure of one mine in North Carolina. Consumption of pyrophyllite decreased by 11% for the same period. Main uses were ceramics (60%), refractories (18%) and insecticides (9%). The remaining 13% went to paint, plastics, rubber and other industries.

France

Talc production in Europe is dominated by the French company Talcs de Luzenac SA and its subsidiaries. In France, Talcs de Luzenac SA is the only producer of the mineral with an open-pit operation at Trimouns on the northern slopes of the Pyrenees near Ax-les-Thermes. The company has interests in Italy, Austria, the United States and Canada.

Trimouns is Luzenac's most important operation. From that locality, 304 000 t of talc was produced in 1988, a tonnage which represented about 60% of the company's total annual production. From 1984 to 1988, France was importing between 20 000 t and 23 000 t of talc and exporting on average 100 000 t. Its exports in 1988 were higher than average at 141 000 t. France's apparent consumption is around 200 000 t/y.

United Kingdom

Shetland Talc Ltd. was given permission by the Shetland Islands Council to mine a talc-magnesite deposit at Cunningsburgh. Ore reserves are estimated at 19 000 t grading 95% talc with a whiteness of 90 to 92. The company is a joint venture between Anglo-European Minerals Ltd. and Dalriada Mineral Ventures Ltd.

USES AND SPECIFICATIONS

Talc is an extremely versatile mineral which is used primarily in a fine-ground state. Steatite is essentially used in massive or block form. There are many industrial applications of ground talc, although fewer than a dozen countries use talc on a major scale.

In pulp and paper, softness, chemical inertness, high reflectance, hydrophobic and organophilic properties and the particle shape of talc are characteristics that permit its use as a pitch-control agent, as a paper filler and as a coating pigment. For filler applications, maximum particle size should generally not exceed 20 microns, although 40 micron grades are also used for some applications. As a coater, talc particle size must not exceed 10 microns and as a pitch-control agent, it should be as close to one micron as possible.

In ceramics, finely ground talc is used to increase the translucence and toughness of the finished product and to aid in promoting crack-free glazing. Talc must be low in iron, manganese and other impurities which would discolour the fired product. Average particle size for talc used for most ceramics must range between 6 and 14 microns, with 90%-98% of material passing through a 325 mesh screen.

In plastics, talc improves dimensional stability, chemical and heat resistance, impact and tensile strength, and electrical and insulation properties. Talc is used in both thermoplastics and thermosets, primarily in polypropylene, nylon and polyester. Chemical coupling agents are used to enhance the bond between the talc filler and the resin matrix in plastic materials. The mineral must be free of iron impurities and grits, and the average particle size must be less than eight microns.

In paints, high-quality talc is used as a pigment extender. A low carbonate content, a near white colour, a fine particle size with controlled size distribution and a specific oil absorption are required properties. However, due to the large variety of paints, precise specifications for talc pigments are often agreed upon between consumers and suppliers. Paint characteristics which influence the use of talc as a pigment extender are gloss, adhesion, flow, hardness and hiding power.

In pharmaceuticals, high-purity talc is used in preparations and cosmetics mainly because of its softness, its hydrophobic property and its chemical inertness. When finely ground, high-purity talc can be used as a filler in tablets and as an additive in medical pastes, creams and soaps.

In construction, lower-grade talc is used as a dusting agent for asphalt roofing and rubber products, as a filler in drywall sealing compounds, floor tiles, asphalt pipeline enamels, auto-body patching compounds, and as a carrier for insecticides. Other applications include cleaning compounds, polishes, electric cable coatings, foundry facings, adhesives and linoleum backings.

Steatite that can be cut, sawn and easily carved is mainly used in sculpturing. However, the material can also be used as refractory bricks or blocks and, because of its softness and resistance to heat, as marking crayons for metal workers.

Pyrophyllite can be ground and used in much the same way as talc. In ceramics, it imparts a very low co-efficient of thermal expansion to tiles. For that application, the product must be ground to -45 microns and must contain minimal amounts of quartz and sericite impurities. Because of its much lower heating shrinkage than fireclays and its ability to maintain its strength after heating, pyrophyllite is also used by the refractory industry. Foliated or micaceous varieties are utilized as fillers.

PRICES

Canadian talc prices varied according to the degree of processing. In 1990, prices ranged from $60 to $200/t. On average, the unit value for processed talc increased by 9% to $143/t in 1990. This increase can be accounted for by better prices for the pulp and paper grade talc. Roughly 40% of talc consumed in Canada is as a pitch control agent in the pulp and paper industry. The unit value of imported and exported processed talc also increased in 1990, compared to 1989. On average, prices for both imports and exports increased by $5 to $190/t.

Pyrophyllite experienced a very slight drop in price in 1990. Prices for that commodity are now in the $40-$45 range.

OUTLOOK

By the end of 1990 Canadian producers had started to feel the impact of the recession. Shipments of talc to the manufacturing industries (e.g., automobile and construction) dropped significantly in the last quarter of 1990. In the long term, growth is expected to be highest in the plastics industry. The pulp and paper sector, where recycling is becoming increasingly important to protect the environment, will also use larger volumes of talc in the coming years. In that area, talc will be required in the de-inking process.

In 1988, EMR conducted a survey in the pulp and paper industry. Results showed that Canadian consumption of 42 000 t of talc is expected in the year 2000. This figure corresponds to an annual growth of around 4%.

Note: Information contained in this review was current as of mid-January 1991.

PRICES

Talc; F.o.b. mine, bagged, carload lots	US$/short ton
New York	
Ground	90.00
99.5%, 325 mesh	100-110.00
99.5%, 400 mesh, micronized	165
Vermont	
Ground, off-colour	136.00
Talc	
Norwegian, ground (ex-store) United Kingdom	£95-105
Norwegian, micronized (ex-store) United Kingdom	£125-175
French, fine ground c.i.f.	£120-190
Finnish, micronized c.i.f.	£130-160
Italian, cosmetic, c.i.f.	£175
Chinese, normal, ex-store United Kingdom, 200 mesh	£144
Chinese, normal, ex-store United Kingdom, 325 mesh	£150
New York, paint, min. 20 ton lot, 400 mesh	£165
Pyrophyllite	
Australian, bulk, ex-store	
Refractory grade	25-35
Ceramic and filler grades	35-45
United States, min. 20 ton lot, for export, f.o.b.	80-92

Sources: Chemical Marketing Reporter, December 24, 1990 and Industrial Minerals, January 1991.
c.i.f. Cost, insurance and freight; f.o.b. Free on board.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2526	Natural steatite, whether or not roughly trimmed or merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape; talc				
2526.10	Not crushed, not powdered	9.2%	6%	3.6%	0.016¢/kg
2626.10.00.10	Natural steatite	9.2%	6%	3.6%	0.016¢/kg
2526.10.00.20	Talc	9.2%	6%	3.6%	0.016¢/kg
2526.20	Crushed or powdered				
2526.20.10	Talc of particle size not exceeding 20 microns	4%	Free	1.6%	0.9%
2526.20.90	Other	9.2%	6%	3.6%	0.9%
2530.90.40	Pyrophyllite	Free	Free	Free	Free

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States effective January 1, 1990.

TABLE 1. CANADA, TALC, STEATITE AND PYROPHYLLITE SHIPMENTS AND TRADE, 1989 AND 1990 AND CONSUMPTION, 1987-89

Item No.		1989		1990p	
		(tonnes)	($000)	(tonnes)	($000)
Total shipments (talc, steatite and pyrophyllite)		144 828	15 108	137 290	15 365
Imports				(Jan.-Sept.)	
2526.10.00.10	Natural steatite, not crushed, not powdered				
	United States	76	54	102	78
	Other countries	56	40	185	34
	Total	133	95	287	113
2526.10.00.20	Talc, not crushed, not powdered				
	United States	3 717	368	2 834	325
	Other countries	40	20	10	7
	Total	3 758	389	2 844	332
2526.20.10.00	Talc of a particle size not exceeding 20 microns, crushed or powdered				
	United States	25 003	4 923	19 766	3 940
	Other countries	7	4	19	13
	Total	25 010	4 928	19 785	3 954
2526.20.90.00	Other natural talc, crushed or powdered				
	United States	19 412	3 282	12 052	2 089
	Other countries	83	13	20	15
	Total	19 495	3 296	12 072	2 105
2530.90.40.00	Pyrophyllite				
	United States	935	73	866	62
	Total	935	73	866	62
Exports					
2526.10.00	Natural talc, not crushed not powdered				
	West Germany	–	–	37	11
	United States	2 950	32	36	6
	Total	2 950	32	73	18
2526.20.00	Natural talc, crushed or powdered				
	United States	39 864	7 389	30 678	5 837
	Other countries	926	332	154	53
	Total	40 790	7 722	30 832	5 891

		1987	1988	1989p
			(tonnes)	
Reported Consumption[1] (ground talc, available data)				
	Pulp and paper and paper products	24 249	28 689	27 436
	Asphalt roofing products	20 839	21 410	21 989
	Paint and varnish	5 547	6 708	6 538
	Ceramic products	3 000	4 155	4 118
	Rubber products	2 097	2 786	2 308
	Toilet preparations	1 438	1 398	1 550
	Other products[2]	8 783	5 438	6 086
	Total	65 953	70 584	70 025

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Reported from EMR survey on the consumption of nonmetallic minerals by Canadian manufacturing plants. [2] Chemicals, fertilizers, gypsum products, refractory brick and other miscellaneous uses.
p Preliminary; – Nil.
Note: Figures may not add to totals due to rounding.

TABLE 2A. CANADA, TALC STEATITE AND PYROPHYLLITE SHIPMENTS, 1970, 1975 AND 1980-90

	Tonnes
1970	65 367
1975	66 029
1980	91 848
1981	82 715
1982	70 523
1983	97 030
1984	122 992
1985	126 860
1986	123 037
1987	136 418
1988r	146 443
1989	144 828
1990p	137 290

Sources: Energy, Mines and Resources Canada.
p Preliminary; r Revised.

TABLE 2B. CANADA, TALC IMPORTS AND EXPORTS, 1982-89

	Imports	Exports to United States
	(tonnes)	
1982	33 895	9 550
1983	34 808	16 345
1984	38 117	22 512
1985	40 466	26 912
1986	38 745	33 997
1987	48 595	35 232
1988	38 409	42 472
1989	48 263	46 808

Sources: Statistics Canada for Imports and U.S. Bureau of Mines, Minerals Yearbook for Export.
Note: Figures include natural and crushed/powdered talcs.

TABLE 3. WORLD PRODUCTION OF TALC, STEATITE AND PYROPHYLLITE, 1985-89

	1985	1986	1987	1988	1989[e]
			(000 t)		
Japan[1,2,3]	1 434	1 334	1 297	1 294	1 286
United States[1,3]	1 151	1 181	1 163	1 237	1 252
People's Republic of China	875[rv]	1 000[e]	1 000[e]	1 000[e]	1 000[e]
Republic of Korea[1,3]	932	800[rv]	852	820	800
U.S.S.R.[e]	520	520	530	530	530
India[2,3]	383	396[r]	410	441	445
Brazil[1,3,5]	544	555	581	620	620
Finland[1]	318	284	319	379	380
France[1]	311	315[r]	330	330	340
Australia[1,3,4]	140	189[r]	212	205	200
North Korea[e]	170	170	170	170	170
Italy[1,2]	133	151	151	159	155
Canada[1,2,3]	127	123	136[r]	146[r]	145
Norway[1]	100[e]	100[e]	100[e]	50[rv]	100
Austria[2]	131	134	130	133	135
Other countries	433	422	396	380	382
Total	7 828	7 697	7 803	7 991	7 980

Sources: U.S. Bureau of Mines, Talc and Pyrophyllite 1989; Energy, Mines and Resources Canada.
[1] Talc. [2] Steatite. [3] Pyrophyllite. [4] Chromite. [5] Algomatolite.
[e] Estimated; [rv] Reported value; [r] Revised.

PRICES AND STOCKS

After tin trading was re-introduced on the London Metal Exchange (LME) in June 1989, speculative activities kept tin prices artificially high throughout that summer. However, high inventory levels and increased production from Brazil and China brought prices down to a low of US$3.11/lb by year-end. Stocks at the end of February 1990 were 43 200 t, up from 33 200 t a year earlier.

The inability of Brazil to curb the smuggling of tin concentrates from the Bom Futuro mine, continuing high metal exports from China, the resumption of sales of surplus tin from its stockpile by the United States Defense Logistics Agency, rising stock levels, and the continued weakening in demand resulted in a steadily declining price for tin. At year-end 1990, the tin price was US$2.53/lb on the LME and averaged $2.82 for the year. Tin stocks were estimated to be around 50 000 t at the end of 1990.

OUTLOOK

The price of tin is expected to rise modestly in 1991, to a range of US$3.00-$3.50/lb. For 1991, much will depend on consumption trends. Sustained low tin prices are likely to extend through the first half of 1991 as oversupply and low demand continue. Tin consumption will probably be affected by the economic downturn in several major Organization for Economic Co-operation and Development (OECD) countries, particularly the United States, which is expected to continue for much of the year.

Offsetting an expected fall in consumption, there was a significant reduction of high-cost capacity due to low tin prices in 1990, especially in southeast Asia. This trend is expected to continue in 1991. In addition, decreased production at Brazil's Bom Futuro mine due to low prices and uncertainty as to the legality of garimpeiro mining will likely take place. World demand for tin in 1991 is forecast at about 182 000 t while supply is expected to total 178 000 t. This small deficit of metal will exert some upward pressure on tin prices in the latter half of 1991.

Continuing pressure from the ATPC for Brazil and China to join the association has not been successful. These two countries account for 37% of world tin concentrate production and have an important influence on markets. Brazil has stated that it will not join the association until it can control the smuggling of tin concentrates from the Bom Futuro mine.

Longer-term prospects for tin consumption are not encouraging. Chemical uses for tin offer the best prospects for increased usage. On the other hand, consumption of tinplate is likely to continue to fall.

Note: Information contained in this review was current as of mid-January 1991.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EEC MFN	Japan[1] MFN
2609.00	Tin ores and concentrates	Free	Free	Free	Free	Free	Free
7204.30	Waste and scrap of tinned iron or steel	Free	Free	Free	Free	Free	Free
8001.10	Tin, not alloyed	Free	Free	Free	Free	Free	Free
8001.20	Tin alloys						
8001.20.10	Tin-antimony alloys	Free	Free	Free	Free	Free	3.2%
8001.20.20	Tin-lead antimony alloys	6.8%	Free	Free	Free	Free	3.2%
8001.20.90	Other	10.2%	6.5%	Free	Free	Free	3.2%
8002.00	Tin waste and scrap	Free	Free	Free	Free	Free	Free
8003.00	Tin bars, rods, profiles and wire						
8003.10	Bars and rods, not alloyed or of tin-antimony alloys	Free	Free	Free	2.5%	3.2%	3.7%
8003.00.10.10	Not alloyed	Free	Free	Free	2.5%	3.2%	3.7%
8003.00.30	Bars and rods, of phosphor-tin alloys	5.5%	3.5%	2.2%	2.5%	3.2%	3.7%
8003.00.50	Bars and rods, of other alloys; profiles; other wire	10.2%	6.5%	4%	2.5%	3.2%	3.7%
8004.00	Tin plates, sheets and strip, of thickness exceeding 0.2 mm						
8004.00.10	Of tin-lead-antimony alloys	6.8%	Free	2.7%	1.4%	2.5%	3.7%
8004.00.20	Of phosphor-tin alloys	5.5%	3.5%	2.2%	1.4%	2.5%	3.7%
8004.00.90	Other	10.2%	6.5%	4.0%	1.4%	2.5%	3.7%
8004.00.90.10	Not alloyed	10.2%	6.5%	4.0%	1.4%	2.5%	3.7%
8004.00.90.20	Of tin-antimony alloys	10.2%	6.5%	4.0%	1.4%	2.5%	3.7%
8004.00.90.90	Other	10.2%	6.5%	4.0%	1.4%	2.5%	3.7%
8005.20	Powders and flakes						
8005.20.10	Powders, not alloyed	4%	Free	1.6%	2.5%	2.9%	4.9%
8005.20.20	Alloyed powders, flakes	10.2%	6.5%	4.0%	2.5%	2.9%	4.9%
8006.00	Tin tubes, pipes and tube or pipe fittings (i.e. couplings, elbows, sleeves)	10.2%	6.5%	4.0%	1.4%	4.5%	4.9%
8007.00	Other articles of tin	10.2%	6.5%	7.1%	2.4%-3.3%	5.3%	5.8%
8007.00.00.10	Anodes for electroplating	10.2%	6.5%	7.1%	2.4%-3.3%	5.3%	5.8%

Sources: Customs Tariffs, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States effective January 1, 1990; Official Journal of the European Communities, Vol. 33, No. L247, 1990, "Conventional" column; Custom Tariff Schedules of Japan, 1990.

[1] GATT rate is shown, lower tariff rates may apply circumstantially.

Note: Where there is a tariff "range," a complete match of the HS code was not available; therefore, the high and low for the product in question is shown.

TABLE 1. CANADA, TIN PRODUCTION AND TRADE, 1989-90, AND CONSUMPTION 1988-89

Item No.		1989		1990p	
		(tonnes)	($000)	(tonnes)	($000)
Production					
	Tin content of tin concentrates and lead-tin alloys	x	x	x	x
Exports				(Jan.-Sept)	
2609.00	Tin ores and concentrates				
	Malaysia	1 602	6 906	1 673	8 552
	Mexico	434	3 814	270	1 274
	Singapore	684	2 129	72	320
	West Germany	–	–	9	61
	United Kingdom	70	815	–	–
	Total	2 790	13 666	2 023	10 207
7204.30	Waste and scrap of tinned iron or steel				
	United States	7 617	2 249	592	480
	Other countries	531	454	217	61
	Total	8 148	2 707	809	542
8001.10	Tin not alloyed unwrought				
	United States	41	459	33	223
	Other countries	2	23	...	4
	Total	42	483	33	227
8001.20	Tin alloys unwrought				
	United States	79	568	199	1 358
	Other countries	...	8	–	–
	Total	80	577	199	1 358
8002.00	Tin waste and scrap				
	United States	3 048	2 263	268	312
	Other countries	156	84	24	15
	Total	3 204	2 348	292	328
8003.00	Tin bars, rods, profiles and wire				
	United States	50	264	125	794
	Japan	3	2	–	–
	Total	53	267	125	794
8004.00	Tin plates, sheets and strip, of a thickness exceeding 0.2 mm				
	United States	360	594	21	34
	Taiwan	140	54	–	–
	Hong Kong	100	34	–	–
	Other countries	95	75	88	16
	Total	696	759	109	50
8005.20	Tin powders and flakes				
	South Korea	1	36	1	39
	Other countries	...	...	1	31
	Total	1	37	2	71
8007.00	Tin articles n.e.s.				
	United States	..	2 430	..	2 290
	Other countries	..	1 281	..	897
	Total	..	3 711	..	3 187
Imports					
2609.00	Tin ores and concentrates	49	49	...	3
7204.30	Waste and scrap of tinned iron or steel	62 553	5 574	20 403	1 828
8001.10	Tin, not alloyed unwrought	3 862	37 616	2 814	22 482
8001.20.10	Tin-antimony alloys	106	1 112	82	639
8001.20.20	Tin-lead antimony alloys	5	48	17	141
8001.20.90	Other tin alloys	6	60	21	182

TABLE 1 (cont'd)

Item No.		1989 (tonnes)	1989 ($000)	Jan.-Sept. 1990p (tonnes)	Jan.-Sept. 1990p ($000)
Imports (cont'd)					
8003.00.10.10	Bars and rods, not alloyed	173	1 782	28	227
8003.00.30	Bars and rods, of phosphor-tin alloys	...	2	–	–
8003.00.50	Bars and rods, of other alloys; profiles; other wire	47	601	17	186
8004.00	Tin plates, sheets and strip, of thickness exceeding 0.2 mm	21	303	30	202
8005.20	Powders and flakes	15	196	13	126
8005.20.10	Powders, not alloyed	13	178	12	114
8005.20.20	Alloyed powders, flakes	1	18	1	11
8006.00	Tin tubes, pipes and tube or pipe fittings	4	57	15	130
8007.00.00.10	Other articles of tin - anodes for electroplating	7	61	3	19

		1988r (tonnes)	1989 (tonnes)
Consumption[1]			
	Tinplate and tinning	1 797	1 704
	Solder	1 228	1 113
	Babbit	65	395
	Bronze	193	207
	Other uses (including collapsible containers, foil, etc.)	206	147
	Total	3 489	3 567

Source: Statistics Canada.
[1] Available data as reported by consumers.
p Preliminary; r Revised; x Confidential; n.e.s. Not elsewhere specified; – Nil; ... Amount too small to be expressed; . . Not available.
Note: Totals may not add due to rounding.

TABLE 2. CANADA, TIN PRODUCTION, TRADE[1] AND CONSUMPTION, 1970, 1975, 1980 AND 1983-90

	Production[2]	Exports[3]	Imports [4]	Consumption[5]
		(tonnes)		
1970	120	268	5 111	4 565
1975	319	1 052	4 487	4 315
1980	243	883	4 527	4 517
1983	140	371	3 769	3 371
1984	209	315	4 105	4 076
1985	119	358	3 696	3 511r
1986	x	3 727	3 925	3 270
1987	x	2 778	3 792	3 780
1988	x	3 591	4 269r	3 489
1989	x	2 790	4 199	3 567p
1990	x	2 023a	2 979a	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Beginning in 1988 exports and imports are based on the new Harmonized System and may not be in complete accordance with previous method of reporting. Exports include HS class 2609.00. Imports include HS classes 8001.10, 8001.20.10, 8001.20.20, 8001.20.90, 8003.00.10.10, 8003.00.30 and 8003.00.50. [2] Tin content of tin concentrates shipped plus tin content in lead-tin alloys produced. [3] Tin in ores and concentrates and tin scrap, and re-exported primary tin. [4] Tin metal. [5] Current coverage exceeds 90% whereas until 1972, coverage was in the order of 80%-85%; available data as reported by consumers.
a Exports and imports are Jan.-Sept. figures; p Preliminary; x Confidential; r Revised; . . Not available.

TABLE 3. WORLD TIN PRODUCTION, CONSUMPTION AND PRICES, 1984-89

	Production			Prices[1]	
	Tin in Concentrates	Primary Metal	Consumption	LME[2]	N.Y. Dealer
		(000 t)			(US$/lb)
1984	206	215	209	5.56	5.67
1985	199	205	209	5.57	5.25
1986	185	193	213	2.87	2.94
1987	189	194	221	3.10	3.15
1988	204	251	230	3.25	3.31
1989	222p	252p	232p	3.93	3.97
1990	. .	. .	. .	2.82	2.88

Source: International Tin Statistics.
1 "Metals Week." 2 London Metal Exchange. For 1987, 1988 and part of 1989, the "Europe Free Market" in-warehouse Rotterdam prices were used to calculate averages.
p Preliminary; . . Not available.

TABLE 4. WORLD CONSUMPTION OF PRIMARY[1] TIN METAL, 1986-89

	1986	1987	1988	1989p
	(tonnes)			
EEC Total	46 695	47 186	51 072	51 307
West Germany	16 884	16 947	19 142	18 333
France	7 461	7 389	7 800e	8 100
United Kingdom	6 200	6 200	6 400	6 300e
Italy	5 600	6 000	6 000	5 900
Netherlands	4 289	4 600e	4 660e	5 300e
Belgium/Luxembourge	1 161	1 900	2 900	3 300
Spaine	2 600	2 600	2 800	2 900
United States	32 514	35 620	37 500	36 500
Japan	31 521	32 608	32 164	33 838
U.S.S.R.e	31 500	30 000	27 000	28 000
People's Republic of Chinae	11 000	12 500	14 000	14 500
Brazil	6 059	7 900	9 047	9 000e
Republic of Koreae	4 335	4 500	5 000	5 500
Canada	3 070	3 600	3 489	3 567
Poland	3 624	2 700	3 500e	3 000
Australiae	2 380	2 200	2 380	2 160
Others	41 711	41 990	45 079	45 113
Total	213 409	220 804	230 231	232 485

Source: International Tin Statistics.
[1] May include secondary tin in some countries.
p Preliminary; e Estimated.

TABLE 5. WORLD PRODUCTION OF TIN-IN-CONCENTRATES, 1986-89

	1986	1987	1988	1989p
		(tonnes)		
Brazil	26 405	30 405	44 020	50 161
People's Republic of China[e]	25 000	28 000	30 000	33 000
Malaysia	29 134	30 388	28 866	32 006
Indonesia	24 634	26 226	29 588	31 262
Bolivia	10 479	8 128	10 541	15 838
Thailand	16 792	14 765	13 997	14 683
U.S.S.R.[e]	16 000	16 000	16 000	14 000
Australia	8 515	7 710	7 009	7 776
Peru	4 817	5 263	4 378	5 053
United Kingdom	4 345	4 084	3 453	4 012
Canada[1]	2 485	3 466	3 591	2 790
Zaire	1 889	2 226	1 943	1 642
Others	14 473	6 590	11 377	10 714
Total	184 968	183 251	204 763	212 234

Source: International Tin Statistics.
[1] Figures for Canada represent exports.
[p] Preliminary; [e] Estimated.

TABLE 6. WORLD PRODUCTION OF PRIMARY TIN METAL, 1986-89

	1986	1987	1988	1989p
		(tonnes)		
Malaysia	43 788	44 363	47 376	50 900e
Brazil	25 167	28 841	42 693	44 240
Indonesia	22 080	24 200	28 365	29 916
People's Republic of China[e]	26 000	25 000	24 000	28 300
U.S.S.R.[e]	17 000	18 000	18 000	16 500
Thailand	19 709	15 438	14 675	14 571
Bolivia	7 673	2 667	5 491	9 690
United Kingdom	9 200	12 135	9 014	7 282e
Netherlands	5 112	3 824	3 463	4 529e
Germany, Democratic Republic[e]	3 300	3 900	4 100	4 000
Mexico	483	1 723	1 514	3 000e
South Africa	1 796	1 608	2 330e	2 500e
South Korea	1 266	1 834e	2 500e	2 400e
Spain	1 700	1 431	656	1 727
United States	3 247	3 905	1 467	1 000e
Other	5 942	5 401	4 614a	4 509a
Total	193 463	194 270	210 258	225 064

Source: International Tin Statistics.
a Excludes tin in lead-tin alloys from Canadian lead smelters; p Preliminary; e Estimated.

TABLE 7. MONTHLY AVERAGE TIN PRICES,[1] 1989 AND 1990

	N.Y. Dealer		London Metal Exchange	
	1990	1989	1990	1989
	(US$/lb)			
January	3.07	3.46	3.02	3.44
February	2.87	3.63	2.84	3.60
March	2.97	4.08	2.91	4.03
April	3.04	4.71	2.96	4.67
May	2.99	4.73	2.92	4.68
June	2.88	4.67	2.80	4.61
July	2.81	4.48	2.73	4.43
August	2.80	4.01	2.72	3.99
September	2.75	3.63	2.65	3.78
October	2.88	3.72	2.82	3.67
November	2.83	3.19	2.78	3.16
December	2.64	3.16	2.59	3.11
Yearly average	2.88	3.97	2.82	3.93

Source: "Metals Week."
[1] From January 1989 to May 1989 the "Europe Free Market" prices were used.

Tungsten

1990

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Continued fierce competition among suppliers of tungsten concentrates and intermediate products, and a large inventory of tungsten materials as well as excess mine capacities shadowing the tungsten market, are the chief factors contributing to weak tungsten prices. In addition, the recessionary conditions prevalent in North America and the United Kingdom, coupled with the rise in oil prices which further contributed to the economic slowdown, and the staggering problems incurred by Eastern Europe, the China situation and the recent eruption of the Persian Gulf crisis, increased the downward pressure on the already depressed tungsten market.

According to the International Tungsten Industry Association, worldwide tungsten concentrate consumption was estimated at 50 300 tonnes (t) in 1989, and is expected to remain about the same in 1990. However, tungsten ore consumption in the western economy was forecast at 15 980 t, down from the 17 516 t recorded in 1989. This decline is mainly attributed to the rise in intermediate products exported from China and the growth in low-priced Chinese ferrotungsten exports, which resulted not only in curtailed concentrate consumption by ferro converters, but also made the direct addition of scheelite in steel and superalloy production uneconomic.

CANADIAN DEVELOPMENTS

With the continued decline of the tungsten market, the Canada Tungsten Mining Corporation Limited (Cantung) mine continues to remain on a maintenance basis. It suspended operations in August 1986 after incurring heavy losses in the first quarter of 1986, which were compounded by a strike. All further development work on Canadian tungsten properties development has been postponed indefinitely.

Canadian consumption of tungsten products in all end uses in 1990 was estimated to be 2730 t. The principal consumers of tungsten metal powder in Canada are: the two divisions of Kennametal Inc. in Port Coquitlam and Victoria, British Columbia, and Teledyne Canada Firth Sterling Ltd. and Seco Tools Canada Inc. (formerly Carboloy Canada Inc.), both located in Ontario. Tungsten wire is consumed by Canadian General Electric Ltd. and GTE Sylvania Canada Ltd.

WORLD DEVELOPMENTS

United States

Canada Tungsten stopped ammonium paratungstate (APT) production at its Fort Madison, Indiana plant in mid-March due to higher-than-acceptable inventory levels. The plant was operating near its capacity of about 200 000 short ton units per year. The company will supply customers from its inventory. Other products produced include blue oxide and ammonium metatungstate (AMT), which are still in production. Furthermore, Canada Tungsten, which normally tenders for its feed on a quarterly basis, has postponed indefinitely its first-quarter 1990 tender.

Production began at the Curtis Tungsten Inc. mine in Andrew, California, with the first 24-t shipment of scheelite delivered in February. The average grade of mined tungsten is less than 1%. This mine is expected to produce 3 million lb of contained tungsten when full production is expected to be reached in the second quarter of 1990.

The U.S. strategic stockpile contains tungsten, which is classified as a strategic mineral commodity in the United States. The stockpile contains 54 177 914 lb of stockpile-grade tungsten, and another 22 178 394 lb of non-stockpile-grade material. The current goal is 55 450 000 lb; the Defense Logistics Agency has the authority to boost this to 70 900 000 lb.

The U.S. Defense Department has favoured tungsten over uranium for use in penetrator shells. Tungsten is also needed for the planned construction of the Superconducting Super Collider (SSC), which is to be built in Texas.

At the end of 1990, Strategic Minerals Corp. (Stratcor) reportedly prepared an anti-dumping suit for filing with U.S. government trade agencies which alleged that China is exporting tungsten ores and concentrates to the United States at prices below market value. Other U.S. primary tungsten producers did not join in the suit. Stratcor's subsidiary, U.S. Tungsten Corp., operates the largest U.S. tungsten mine at Bishop, California, which produces tungsten concentrates for conversion into APT.

Australia

In July, North Broken Hill Peko put up for sale its Dolphin scheelite mine on King Island in the Bass Strait off the Tasmanian coast. The mine has been a marginal operation for some time due to depressed tungsten prices. On November 30, 1990, North Broken Hill Peko closed the King Island mine as current prices and increased energy costs made the operation unprofitable.

Proven and probable reserves are 1.2 t, grading 1.3% tungstic oxide. The concentrate produced was of high quality; its gravity scheelite concentrate averaged 74% WO_3, and its low-moly or artificial scheelite graded 79.4% WO_3. The latter product had kept the mine operating as it is considered a very pure product which some customers, notably the Japanese, will pay more for.

Brazil

A new Brazilian intermediate facility was under construction in 1990 alongside the Currais Novos scheelite mine near Natal. The Metasa plant, expected to be in operation at year-end, is reported to initially produce 20 tonnes per month (t/m) of ferrotungsten and approximately 10 t/m of tungsten carbide. The operation's owners include Mineração Tomas Salustino S.A., Mineração Ecocil and Polissinter; the Government of Rio Grande do Norte will have a 5% interest. Scheelite reserves at Currais Novos are sufficient for 20 years of operation at current production rates. Most of the output is expected to be exported.

Brazilian tungsten production will be reduced 40% by the closure in 1990 of the Boca de Lage mine at Currais Novos by Anglo American Corp. of South America SA's subsidiary, Tungstenio do Brasil Minerios e Metais. This decision was taken after the company failed to reach an agreement with the landowners for a new five-year lease. Therefore, Brazil's annual production will fall from 670 t to 422 t.

Brazil's consumption of tungsten, used in specialty steels, alloys and tools, is approximately 670 t/y, inferring that Brazil will probably import tungsten from China.

China

In April 1990, the European Communities (EC) imposed an anti-dumping duty on Chinese tungsten products. Two major tungsten carbide producers, Zigong Cemented Carbide Plant in Sichuan province and Zhuzhou Cemented Carbide Works in Hunan province, in addition to the officials of both the China Minerals and Metals Import and Export Corp. (Minmetals) and the China National Nonferrous Metals Import and Export Corporation (CNIEC), stated that the EC action was unfair and that China planned to appeal the duty. The duties, provisionally imposed on April 2, 1990 for four months, are 33% for tungsten carbide powder, 35% for tungstic acid/oxide products, 37% on tungsten ore supplied by CNIEC, and 42.4% on ore from other suppliers, including Minmetals.

The EC reached a final decision on September 24, 1990, on the question of permanent imposition of tariffs on certain tungsten imports from China, the world's largest exporter of tungsten. The duties applied to imports of tungsten detect from China, net, free-at-Community-frontier price of the product, will be: tungsten ore (42.4%), tungstic acid and oxide (35%), and tungsten carbide and fused tungsten carbide (33%). These tariffs will apply to all exporters to the EC, other than Minmetals and CNIEC. The latter will have to comply with closely monitored minimum price undertakings which will have the effect of increasing prices of the products concerned to remove the injury caused to the Communities' industry.

As a result of the EC penalties imposed and the minimum price restriction, Chinese tungsten ore and concentrate has virtually disappeared from the EC. The two Chinese government nonferrous sales agencies stated that they are no longer competitive. Hence, Chinese APT is selling in the EC for less than wolframite ore. However, Chinese tungsten ore prices in non-EC countries, such as Austria, were approximately $35/t.

Export policy uncertainties and poor markets resulted in financial difficulties for Chinese producers. A producer of APT in Fujian province closed temporarily in 1990; its production capacity is 3000 t/y, of which 2000 t were exported in 1989. In Jiangxi province, a number of APT plants are operating on a part-time basis.

In addition to the western import restrictions, the transforming face of Eastern Europe and the U.S.S.R. will also have an impact on the nonferrous trade from China. It is reported that China's tungsten exports to the U.S.S.R. in 1991 will be halved as the U.S.S.R. disarmament program reduces its demand for tungsten.

Hungary

The international lighting industry, which uses tungsten wire in light bulb filaments, is being restructured in Hungary and worldwide to improve efficiency. General Electric Company (GEC) acquired a majority interest in Tungsram, the Hungarian state-owned lighting company, for US$150 million. As a consequence of this purchase, Tungsram streamlined its workforce, updated its plant technology and adopted a western style management to improve efficiency and productivity levels. Tungsram's competitiveness has increased with the addition of U.S. technology and Hungarian know-how.

India

In the third quarter of 1990, the Indian government outlined a new mining policy which stressed that the government reserved the exclusive right to explore for the 13 strategic minerals: copper, lead, zinc, nickel, molybdenum, tungsten, platinum group metals, gold, chrome, manganese, iron, diamonds and sulphur. While the guiding principle in the government's development strategy is economic viability, the state may undertake to develop any deposit deemed in the public interest to ensure the availability of raw materials for the realization of national goals.

A new Madras-based company, in technical collaboration with Lucky Goldstar International of South Korea, is to set up a 400-million-rupee (Rs) tungsten metal powder production plant in Madras. The state-owned organization, Tamil Nadu Industrial Development Corporation, will take a 26% stake in the project. Sterling Computers, the parent company of Sterling Tungsten, was to hold a 25% interest, and the balance was to be offered to the public in the first quarter of 1990. India currently does not have the capability to produce tungsten metal powders, which are used in a number of domestic applications including the electronics industry.

The Indian Midhani superalloys plant in Hyderabad, run by the Ministry of Defense, plans to produce 3000 t/y of superalloys and specialty metals by 1994/95. Production in 1990/91 will reach 1800 t, valued at Rs480 million. Midhani, whose products include titanium, tungsten and molybdenum alloys, recently won a Rs725 million order to supply sophisticated gun barrels and other ordnance forgings to Soviet T-72 battle tanks, as well as a Rs50 million order to supply specialty steel products for ammunition for these tanks.

Peru

Despite low tungsten prices, the Peruvian tungsten producer, Minera Regina S.A., which accounts for approximately 70% of Peru's output, boosted production to achieve greater efficiency and improve the quality of its product. Total Peruvian production in 1990 was forecast at 1200 t tungsten content. This consists of 150 t of tungsten contained in high-grade (74%-76% WO_3) scheelite, 550 t in ferberite, 300 t in hubnerite, 100 t in low-grade concentrate and 100 t in hand-picked ores grading 68% WO_3. Peru's exports, almost exclusively to the United States, totalled 1432 t in 1989, up from 1006 t in 1988.

Portugal

At the end of March, Charter Consolidated PLC put its majority stake in the Portuguese tungsten mine, Beralt Tin & Wolfram, up for sale. Charter withdrew from mining to establish itself as an industrial holding company. It effectively owns 60% of Beralt's mining operation at Panasqueira, near Fundao in Portugal, with the remainder being held by Union Carbide Corporation (20%) and the Portuguese government (20%). The mine produces some 1500 t/y of wolfram concentrates; Charter began development work at the mine aimed at extending its life beyond the current five years. The property has estimated proven and probable reserves of 14.5 Mt, and an in-situ grade of 0.38% wolframite. Beralt, which produces a high-grade product and is within the EC, has the potential to be a more valuable property should tungsten prices recover.

In the fourth quarter, Minerals and Resources Corporation Limited (MINORCO), which holds a 35.8% stake in Charter, announced it was buying a major interest in Beralt from Charter, as well as its distribution group, Anmercosa Sales.

USES

The recent slowdown in the world economy has weakened demand for tungsten. Many of the industrial activities which sustained the increased consumption of tungsten in 1987/88 have recently declined or levelled off. The impacts of substitution, as well as structural and technological changes, which are expected to be more favourable to tungsten, remain to be seen.

The U.S. Bureau of Mines estimates that the end uses of tungsten during 1990 were: metalworking, mining, and construction machinery and equipment (67%); lamps and lighting (12%); electrical and electronic machinery and equipment and transportation (10%); chemicals (6%); and other (5%).

PRICES

Over the past year, the tungsten market lost virtually all gains made since the 1985/86 price collapse. With inventories increasing and consumption slowing, prices are expected to remain weak and/or deteriorate even further in the immediate future. Since December 1989, the price of wolframite has fallen by 18%, and the price of scheelite by 4%. By the second quarter, oversupply of Chinese material drove the International Tungsten Indicator down to US$41.44/t, which stands in sharp contrast to the early 1970s when it reached almost $200. In December, wolframite was trading on the free market in the $36-$49/t range whereas scheelite was trading in the $52-$71/t range.

Ferrotungsten prices, initially at $5.10-$5.15/kg, hovered around the $5.60-$5.90/kg range. By August, the price rose firmly above the $6.00/kg mark. At year-end, ferrotungsten prices softened to $5.70-$5.80/kg.

OUTLOOK

Roskill Information Services states that the difficulties experienced by the tungsten industry over the last ten years are likely to continue. Currently, the fundamentals of supply and demand remain out of balance. Demand is low in the market economy countries and large volumes of supply are coming from China. This continues to depress prices for tungsten concentrates, ammonium paratungstate, ferrotungsten and other tungsten products. In the 1990s, Roskill suggests that recycling of tungsten will reach its optimum level, after which prospects are expected to improve for the primary tungsten producers. This improvement may be short-lived as, with increasing prices, mines currently held in maintenance may be encouraged to reopen. The competition for sales volumes and increased market share could again depress prices.

Note: Information contained in this review was current as of mid-January 1991.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2611.00	Tungsten ores and concentrates	Free	Free	Free	Free
2841.80	Tungstates (wolframates)	9.2%	6%	3.6%	6%
2849.90	Tungsten carbide	Free	Free	Free	6.3%
7202.80	Ferrotungsten and ferro-silico-tungsten	10.2%	6.5%	4%	3.3%
8101.10.10	Tungsten powders, not alloyed	4%	Free	1.6%	6.3%
8101.10.20	Tungsten powders, alloyed	10.2%	6.5%	4%	6.3%
8101.91.10	Sintered bars and rods, not alloyed	Free	Free	Free	3.9%
8101.91.91	Unwrought tungsten, not alloyed	4%	Free	1.6%	3.9%
8101.91.92	Unwrought tungsten, alloyed; waste and scrap	10.2%	6.5%	4%	2.5% to 3.9%
8101.92.10	Tungsten bars and rods, not alloyed, other than those obtained simply by sintering	Free	Free	Free	3.9%
8101.92.20	Tungsten bars and rods, alloyed; profiles, plates, sheet, strip and foil	10.2%	6.5%	4%	3.9%
8101.93.10	Tungsten wire, not alloyed	Free	Free	Free	3.9%
8101.93.21	Tungsten wire, alloyed, not coated or covered	8%	5%	3.2%	3.9%
8101.93.22	Tungsten wire, alloyed, coated or covered	10.2%	6.5%	4%	3.9%
8101.99	Tungsten (wolfram) and articles thereof n.e.s.	10.2%	6.5%	4%	3.3%

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States effective January 1, 1990.
n.e.s. Not elsewhere specified.

Tungsten

TABLE 1. CANADA, TUNGSTEN PRODUCTION AND TRADE, 1989-90

Item No.		1989		1990p	
		(kilograms)	($000)	(kilograms)	($000)
Production1 (WO3)		–	–	–	–
Imports				(Jan.-Sept.)	
2611.00	Tungsten ores and concentrates				
	United States	194	3	–	–
	Total	194	3	–	–
2841.80.00.90	Tungstates (wolframates)				
	United States	6 287	47	1 416	7
	Total	6 287	47	1 416	7
2849.90.00.10	Tungsten carbide				
	United States	282 435	5 807	165 053	3 491
	People's Republic of China	18 406	358	30 850	622
	France	30 654	1 297	13 506	531
	Other countries	25 223	485	7 982	274
	Total	356 718	7 947	217 391	4 918
7202.80	Ferrotungsten and ferro-silico-tungsten				
	People's Republic of China	17 633	147	5 272	46
	United States	13 469	125	467	8
	Total	31 103	272	5 739	55
8101.10.10	Tungsten powders, not alloyed				
	United States	5 377	134	5 194	150
	West Germany	–	–	1 000	22
	South Africa	–	–	104	2
	Total	5 377	134	6 298	175
8101.10.20	Tungsten powders, alloyed				
	United States	40 376	1 427	21 943	798
	Total	40 376	1 427	21 943	798
8101.91.10	Unwrought tungsten, sintered bars and rods, not alloyed				
	United States	1 480	63	748	42
	Other countries	186	32	121	8
	Total	1 666	95	869	50
8101.91.91	Unwrought tungsten, not alloyed				
	United States	212	4	866	19
	West Germany	–	–	2	...
	Total	212	4	868	19
8101.91.92.10	Unwrought tungsten, alloyed				
	United States	76 630	496	2 362	56
	Total	76 630	496	2 362	56
8101.91.92.20	Unwrought tungsten, waste and scrap				
	United States	12 570	140	3 175	59
	United Kingdom	4 854	30	–	–
	Total	17 425	171	3 175	59
8101.92.10	Tungsten bars and rods, not alloyed, other than those obtained simply by sintering				
	United States	3 224	128	3 100	93
	United Kingdom	1 378	109	1 351	59
	West Germany	255	21	–	–
	Total	4 858	258	4 451	152
8101.92.20.10	Tungsten bars and rods, not alloyed; profiles, plates, sheets, strip and foil				
	United States	414	15	35	1
	Total	414	15	35	1
8101.92.20.20	Tungsten bars and rods, alloyed; profiles, plates, sheets, strip and foil				
	United States	7 753	531	7 688	499
	Denmark	5 259	381	1 278	89
	Other countries	753	29	435	21
	Total	13 765	941	9 401	609
8101.93.10	Tungsten wire, not alloyed				
	United States	12 362	930	13 886	953
	Other countries	955	56	979	74
	Total	13 317	986	14 865	1 027

TABLE 1. (cont'd)

Item No.		1989		1990p	
		(tonnes)	($000)	(tonnes)	($000)
Imports (cont'd)					
8101.93.21	Tungsten wire, alloyed, not coated or covered				
	United States	12 380	502	7 452	276
	Japan	40	2	–	–
	Total	12 420	504	7 452	276
8101.93.22	Tungsten wire, alloyed, coated or covered				
	United States	7 836	698	6 822	443
	Japan	5 340	330	3 269	257
	Total	13 176	1 029	10 091	701
8101.99	Tungsten (wolfram) and articles thereof, n.e.s.				
	United States	6 866	449	6 228	385
	West Germany	1 330	108	327	26
	Other countries	317	14	570	12
	Total	8 513	571	7 125	423
Exports					
2611.00	Tungsten ores and concentrates				
	Sweden	–	–	5 386	136
	Other countries	365	14	–	–
	Total	365	14	5 386	136
8101.10	Tungsten (wolfram) powders				
	United States	3 136	72	11 626	289
	West Germany	375	18	4 760	110
	Turkey	–	–	700	33
	Other countries	2 314	111	1 854	92
	Total	5 825	201	18 940	524
8101.91	Unwrought tungsten; including bars and rods obtained simply by sintering; waste and scrap				
	United States	1 532	38	29 523	264
	Total	1 532	38	29 523	264
8101.92	Tungsten bars and rods, other than those obtained simply by sintering; profiles, plates, sheets, strip and foil				
	South Korea	–	–	100	2
	Australia	248	28	–	–
	Other countries	97	6	–	–
	Total	345	34	100	2
8101.93	Tungsten (wolfram) wire				
	Japan	5	34	1	11
	United States	–	–	10	5
	France	10	4	–	–
	Total	15	39	11	16
8101.99	Tungsten (wolfram) and articles thereof, n.e.s.				
	United States	6 805	111	11 370	82
	Netherlands	–	–	25	4
	Australia	505	42	–	–
	Other countries	358	26	15	2
	Total	7 668	179	11 410	88

Sources: Energy, Mines and Resources Canada; Statistics Canada.
1 Producers' shipments.
p Preliminary; – Nil; n.e.s. Not elsewhere specified.
Note: Totals may not add due to rounding.

TABLE 2. CANADA, TUNGSTEN PRODUCTION, TRADE AND CONSUMPTION, 1975 AND 1980-90

		Imports		
	Production[1]	Tungsten Ore[2]	Ferro-tungsten[3]	Consumption[4]
	(kilograms)			
1975	1 477 731	1 000	45 359	451 336
1980	4 007 000	6 000	7 000	290 479
1981	2 515 000	14 000	6 000	401 447
1982	3 029 730	7 620	4 536	485 606
1983	1 537 880	12 000	3 000	503 651
1984	4 195 785	6 000	5 000	659 665
1985	4 030 547	12 000	2 000	707 271
1986	2 649 990	11 000	6 000	655 982[r]
1987	–	1 000	11 000	729 776[r]
1988	–	205	53 052	385 917
1989	–	194	31 103	347 442
1990[p]	–	5[a]	5 739[a]	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Producers' shipments of scheelite (WO_3 content). [2] W content. [3] Gross weight.
[4] Available data as reported by consumers.
[a] Jan.-Sept. 1990 only; [p] Preliminary; [r] Revised; – Nil; . . Not available.

TABLE 3. TUNGSTEN ORES AND CONCENTRATES, WORLD MINE PRODUCTION AND CONSUMPTION

Year	Production	Consumption	Imports	Exports
	(tonnes of contained tungsten)			
1979	48 872	51 217	25 689	28 470
1980	50 662	49 149	28 225	30 491
1981	49 222	47 165	27 432	26 389
1982	43 767	40 052	22 844	24 367
1983	41 512	40 020	20 966	25 536
1984	49 313	47 669	26 931	25 813
1985	48 254	45 162	24 924	26 468
1986	43 946	41 949	21 368	23 201
1987	40 980	45 107	20 986	22 803
1988	46 003	46 722	24 981	23 304
1989	49 094	48 634	20 391	22 273

Source: Committee on Tungsten, United Nations Conference on Trade and Development (UNCTAD).

Uranium

1990

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OVERVIEW

In 1990, Canada's uranium industry continued to face an uncertain market, plagued by oversupply and low and volatile prices. The Nuexco Exchange Value (EV)[1] spot-price indicator fell to an all-time low of US$8.35/lb U_3O_8 in October, recovering by year-end to US$9.70. As a result of excess supply, Western World uranium output fell as production centres closed or curtailed their operations. Global inventories and new sources of low-priced uranium (see Markets and Prices) suggest adequacy of supply well into the 1990s. Prospects for a market turnaround in the near term seem doubtful, and new production capacity could be deferred beyond the mid-1990s.

As the uranium market weakened in 1990, some Canadian uranium producers trimmed output levels, others purchased uranium on the spot market, and one was forced to close two of its production facilities. Nonetheless, some sales were forthcoming, and Canada's uranium marketers signed new export contracts for the delivery of about 7900 tonnes of uranium (tU) during the 1990s. Most of these contracts contained quantity-flexibility provisions, which have become more prevalent in uranium contracts in recent years. The average price of all export deliveries in 1990 was slightly below that of 1989; less than 1% of export deliveries in both years were spot sales.

The growing public interest in protecting the environment will mean that new uranium projects must undergo intensive scrutiny. This will inevitably increase the lead time needed for new uranium developments, perhaps contributing to tightened supply and a strengthening of uranium prices during the decade. In the longer term, increasing awareness that nuclear power plants do not contribute to acid rain or global warming, fears about another oil crisis brought on by events such as the Persian Gulf War, and concern about the concentration of oil resources in the Middle East, could renew interest in nuclear power and place upward pressure on uranium prices, in turn drawing new production capacity on stream.

PRODUCTION AND DEVELOPMENTS

During 1990, the persistent oversupply situation and declining prices had a dramatic impact on the Canadian uranium industry. Primary uranium production for the year is estimated at 8750 tU, down considerably from the level of 1989; output could remain well below production capability in 1991. The decline reflects two mine closures in Ontario and operating cutbacks in Saskatchewan, the latter taken in line with efforts to match output to commitments. Table 1 shows that direct employment at Canada's uranium production centres fell almost 10% in 1989; it dropped a further 40% in 1990 to fewer than 2500 workers, due mainly to the Rio Algom Limited mine closures and Denison Mines Limited workforce reductions at Elliot Lake, Ontario. Figure 1 locates Canada's major uranium deposits and existing production centres, while Figure 2 illustrates the output and ownership share of Canada's uranium production centres in 1989.

Uranium ranks sixth in terms of output value among Canada's metal commodities. As shown in Table 2, estimated total shipments for 1990 under all active domestic and export contracts reached 9460 tU, valued at C$868 million, down sharply from 1989. The difference between the annual production and shipment figures reflects inventory adjustments by the producers. As domestic requirements represent only about 15% of current Canadian output, most of Canada's uranium production is available for export.

To illustrate the differences between the Ontario and Saskatchewan uranium industries, Table 3 lists the operational characteristics of Canada's existing uranium production centres in 1989.

Uranium

Elliot Lake, Ontario

In January 1990, Rio Algom announced that provisions had been made to cover the cost of closing its Quirke and Panel mines, then expected to take place by early 1991. Employees were notified in May that the closures could occur in August 1990, depending on the outcome of contract discussions with export customers. In July, the company announced that remaining export quantities had been reduced, that sufficient output to satisfy the 1990-92 delivery requirements would be produced by late August, at which time Quirke and Panel would close, and that applications for decommissioning licences would be made to the Atomic Energy Control Board (AECB). In March 1990, Denison announced a reduction of 450 workers at its Elliot Lake operation by August. The aims were to accommodate an expected 37% cut in output by 1991 and protect the livelihood of the remaining workforce.

Both Rio Algom and Denison will maintain an important presence in Elliot Lake. About 600 workers continue to produce uranium at Rio's Stanleigh operation under an Ontario Hydro contract extending until 2020; the workforce will also complete asset disposal and environmental decommissioning activities associated with the Quirke and Panel closures. Denison's complement of 1200 workers continues to produce uranium under contracts with Tokyo Electric Power Company and Ontario Hydro, scheduled to expire in 1997 and 2012, respectively.

The Rio Algom closures and Denison cutback meant the loss of 2200 jobs, a devastating blow to the Elliot Lake community (population 15 000). The Ontario government, in close cooperation with relevant federal government departments and agencies, has undertaken several initiatives in an effort to lessen the impact of this employment loss. In December, Ontario announced that the Elliot Lake area would receive $15 million to help diversify and revitalize its economy.

In early December, Denison announced the formation of a 50-50 joint venture with Freeport Uranium Recovery Company of the United States, effective January 1, 1991. Freeport will produce uranium concentrates from its two existing phosphate processing plants in Louisiana, having a combined annual capacity in excess of 450 tU, and Denison will market them. The partnership is seen as enhancing Denison's position as one of the world's leading suppliers of uranium. In late December, Bill James was appointed as Denison's new president and chief executive officer, and challenged with guiding the company through this very difficult period in its history.

Athabasca Basin, Saskatchewan

Early in the year, Cameco Corporation[2] announced that its public share offering would be delayed due to the depressed uranium market. Under the merger agreement terms of 1988, when Cameco was formed, its shareholdings were to have been reduced through privatization by 30% within two years, 60% within four years, and 100% within seven years.

In July, Cameco sold Uranerz Exploration and Mining Limited (UEM) a one-third interest in its Rabbit Lake operation and associated properties (including the Collins Bay deposits and Eagle Point South). Cameco and UEM now have identical equity splits (2/3 and 1/3, respectively) in both the Key Lake and Rabbit Lake operations, although Cameco operates both. Since UEM already owned one third of Eagle Point North, the entire Eagle Point orebody can now be developed as a single underground mine.

In 1987, an Environmental Impact Statement (EIS) was filed with the regulatory authorities for approval to proceed with the development of the Collins Bay A and D deposits and the Eagle Point orebody; provincial and federal approvals were granted in early 1988 to proceed with the test mining phase. At Eagle Point, site preparation was well under way in late 1990, with work focussing on construction of a decline in preparation for scheduled production in the mid-1990s.

All activity at Rabbit Lake and Key Lake ceased for a six-week summer shutdown. Milling has been suspended at Rabbit Lake since July 1989 due to market conditions, but at Key Lake, nominal mill capacity was exceeded to compensate for the summer closure. Mining at Key Lake has been accelerated so that the Deilmann pit can be depleted by 1995 and turned into a tailings impoundment facility. During 1990, ore was mined at the Collins Bay B zone and stockpiled at Rabbit Lake; milling could resume as early as August 1991, with annual output gradually increasing to the expanded (nominal) capacity of 4600 tU by 1996, but all production decisions will be dependent on market conditions. In October, the Rabbit Lake operating licence was renewed by the AECB, and approval was given for output levels to a maximum of 5400 tU annually.

In January, Cluff Mining resumed ore processing after an extended shutdown of operations that started in August 1989. The mill operates every other week due to the depressed market conditions. With the completion of mining at the Claude pit in mid-1989, output from the new Dominique-Janine North pit supplemented ore from the Dominique-Peter underground mine, which resumed production in mid-April. In 1990, roughly half of Cluff's production came from open-pit and half from underground operations. Anticipating ore depletion at Dominique-Janine North during 1991, Cluff Mining has studied the feasibility of extending the pit to the south, and began the preparation of an EIS.

Additional Production Possibilities

At the Cigar Lake project in northern Saskatchewan, sinking of the 500-m-deep shaft was completed in May, while shaft furnishing continues. Lateral development from the 420-m and 480-m levels is proceeding. On the thicker ore sections, vertical mining is foreseen, either by blind-hole boring (down) or box-hole boring (up); undercut and fill methods are a possibility on the thinner ore sections. Test mining and bulk sampling activities could be completed in 1991 to permit the preparation of an EIS and mining feasibility report during 1992. Project operator Cigar Lake Mining Corporation drilled four more surface holes into the deposit in the spring, and planned eight underground holes by year-end. The project owners include Cameco (48.74%), Cogema Canada Limited (32.625%), and Idemitsu Uranium Exploration Canada Ltd. (12.875%).

At the Midwest project, near South McMahon Lake in northern Saskatchewan, the results of a year-long test mining program, completed in October 1989, have been evaluated, and an Environmental Impact Assessment has been prepared. (The test consisted of drilling two 120-cm diameter blind bore holes and recovering the cuttings; the test mine was then allowed to flood.) The high-grade section of the deposit reportedly contains 12 500 tU grading over 5% U, whereas total drill-indicated resources are estimated to exceed 21 500 tU at an average grade of 1% U. Denison is operator of the joint venture project and holds a 45% interest; the other major partners include Uranerz (20%), Bow Valley Industries Ltd. (20%), and PNC Exploration (Canada) Co. Ltd. (15%). In August, PNC indicated its intention to transfer its equity interest in the project to the Overseas Uranium Resources Development Corporation (OURD) of Japan.

In July, Urangesellschaft Canada Limited, operator of the Kiggavik uranium project in the Northwest Territories, requested the federal Environmental Assessment and Review Process (EARP) panel to delay indefinitely its planned environmental assessment hearing for the project. The company indicated that more time was needed "to respond thoroughly to the request for considerable additional information," resulting from the panel's earlier identification of deficiencies in its Environmental Assessment Report. The project is held by Urangesellschaft (79%), CEGB Exploration (Canada) Ltd. (20%), and Daewoo Corporation (1%) of Korea.

In November, Minatco Ltd., an affiliate of Total Petroleum of France, announced that it had acquired 100% of the Wolly uranium project in Saskatchewan from joint venture partners Canadian Occidental Petroleum Ltd. and Canadian Nickel Company Limited. The Wolly project is located adjacent to the Rabbit Lake property and hosts significant uranium mineralization, including the McClean, Jeb, and Sue deposits. The McClean deposits could be mined by underground methods, while the Jeb and Sue deposits are accessible by open-pit methods. Minatco is continuing exploration and development work at Wolly, and was completing an EIS at year-end in preparation for a production decision by the mid-1990s.

Uranium

The start-up date of any of these four projects is contingent on the receipt of the necessary regulatory/environmental approvals and on developments in the international uranium market.

EXPLORATION

In 1990, the Uranium Resource Appraisal Group (URAG) of Energy, Mines and Resources (EMR) Canada, completed its sixteenth annual assessment of Canada's uranium supply capabilities and an associated survey of exploration activity. The results were reported[3] late in the year.

As in previous years, uranium exploration activity in 1989 was again concentrated in areas favourable for the occurrence of deposits associated with Proterozoic unconformities, most notably in the southeastern part of the Athabasca Basin of northern Saskatchewan, where the objective is to discover more deposits like Key Lake or Cigar Lake. Exploration expenditures of $58 million matched those of 1988, due partly to the underground test mining (advanced pre-development exploration) programs at the Cigar Lake and Midwest projects. Actual uranium expenditures for surface exploration in Saskatchewan were down 30% in 1989.

In 1989, about 30 companies participated in 57 active exploration projects, managed by just 13 operators.[4] The 10 most active of these, spending 99% of the $58 million, were, in alphabetical order, Amok Ltd., Cameco Corporation, Cigar Lake Mining Corporation, Cogema Canada Limited, Denison Mines Limited, Interuranium Canada Limited, Minatco Ltd., PNC Exploration (Canada) Co. Ltd., Uranerz Exploration and Mining Limited, and Urangesellschaft Canada Limited. As shown in Table 4, which summarizes uranium exploration activity from 1976 to 1989, the number of "million-dollar" projects has remained relatively constant since 1982.

Of particular interest in the 1989/90 field season was the grass-roots exploration activity conducted near Great Bear Lake, Northwest Territories, which was sparked as a result of deposit-origin investigations by the Geological Survey of Canada. This work established a conceptual model indicating that deposits comparable to the Olympic Dam copper-gold-uranium orebody in Australia may be discovered in the area.

In May, Cameco announced the discovery of a high-grade uranium deposit in northern Saskatchewan (Figure 1) at a depth of 500-550 m. The P2 North deposit at McArthur River, 70 km northeast of Key Lake, has been drilled along strike for over 2 km. The best intersection returned 47% U across 9 m, but grades up to 65% U have been reported. Resources are estimated to contain over 77 000 tU grading in excess of 3% U on average. The major joint venture partners are Cameco (44%), UEM (29%), AGIP Resources Ltd. (10%) and Cogema (6.5%). Follow-up evaluation of the deposit continues, with development timing scheduled to coincide with depletion of stockpiled ore at Key Lake.

RESOURCES

Uranium supply from Canada in the next decade will come from "known" resources, estimates of which are divided into three major categories, measured, indicated and inferred, that reflect different levels of confidence in the reported quantities. Most of these resources are associated with deposits identified in Figure 1.

In its latest annual assessment of domestic uranium supply capabilities, EMR reported[3] that estimates of known uranium resources as of January 1, 1990, had increased by 7% to over 580 000 tU, as shown in Table 5. Additions to these discovered resources more than offset losses resulting from 1989 production. Moreover, these new discoveries will compensate in large part for the expected losses in resources, not included in the EMR estimates, that will result from the closure of Rio Algom's Quirke and Panel mines at Elliot Lake, Ontario.

SUPPLY CAPABILITY

With the premature closure of Rio Algom's Quirke and Panel mines, production capability from Canada's existing operations fell more than 15% in 1990. Although the expansion of capacity at Cameco's Rabbit Lake operation has more than offset the Elliot Lake loss, it is unclear when, and at what rate, Cameco will resume operating its enlarged facility. Canadian output in 1991 may well be below capability as producers continue to avoid the spot market and gear output to their existing contract commitments. At some operations, significantly higher uranium prices would be required to bring production up to full capacity.

To illustrate Canadian uranium availability in the short term, Figure 3 provides two projections of production capability. The upper curve assumes a level of production that could be realistically expected, supported by known resources recoverable at prices of $150/kgU or less. The lower curve is based only on resources in the so-called low-cost category, i.e., $100/kgU or less. No firm commitments have been made for the start-up of any production centres beyond those currently in operation. Table 6 places Canada in the world context with respect to actual uranium production from 1983 to 1989 inclusive.

Developments in the international uranium market and uncertainty regarding the costs associated with certain of the planned projects noted above make it difficult to project production capability levels in the future.

GOVERNMENT INITIATIVES

After an intensive review, the federal government made a decision in March to sustain the nuclear option for Canada, as one component of Canada's future energy mix. It undertook to revitalize Atomic Energy of Canada Limited (AECL), the lead agency for nuclear energy, and committed stable funding for AECL's nuclear research and development (R&D) program for seven years, in partnership with the nuclear provinces, notably Ontario. Having invested $80 million in the design of the new, smaller 450 MWe Candu 3 reactor, the federal government also authorized negotiations on the sale of a prototype Candu 3 to The New Brunswick Electric Power Commission. The new Candu 3 would compete directly with coal-fired plants in the size range most desired by world utilities. These initiatives represent a strong vote of confidence by the Government of Canada in nuclear power, in the Candu system, and in AECL. The federal government also decided to increase the resources of the AECB by about 30% over the next few years to allow increased effort in the areas of nuclear safety, radioactive wastes and public information.

Following the implementation of the Canada - U.S. Free Trade Agreement (FTA) on January 1, 1989, the Canadian government initiated an overall review of the commercial aspects of Canada's uranium export policy. This review was prompted by a desire to ensure that the policy would facilitate the industry's search for new business opportunities, while maintaining Canada's nuclear non-proliferation and security objectives, and maintaining consistency with Canada's commitments under the General Agreement on Tariffs and Trade and the Canada - U.S. FTA. A companion objective was to simplify the administration of the policy and make it easier for Canada's uranium customers to understand. The review led to some minor adjustments, announced in a letter dated May 18, 1990, from the Minister of Energy, Mines and Resources to the Canadian uranium industry. None of the adjustments are expected to lead to any significant change to Canada's uranium export business, but should assist and simplify the marketing efforts of the Canadian uranium industry.

On June 18, Canada's Minister of the Environment announced a major package of reforms to the federal government's environmental assessment and review process. A key feature of the package will be the proposed Canadian Environmental Assessment Act, which will formalize the federal government's obligation to integrate environmental considerations into the project planning and implementation process, and create a new agency to be known as the Canadian Environmental Assessment Agency.

The new Act will cover all projects for which the federal government holds decision-making authority–as a proponent, land manager, provider of funding or a regulatory authority. Since uranium mining projects are licensed by the federal AECB, all major new uranium projects will be subject to the new process. The process will inevitably have an impact on the lead times and related costs of new uranium projects.

Uranium

On June 22, the Saskatchewan Department of Energy and Mines announced a new uranium royalty system, retroactive to July 1, 1989. The new system, an improvement over the old system introduced in 1976 and revised in 1980, allocates royalties more fairly among producers and provides a more equitable and straight-forward method to calculate profits on which royalties are based. The key changes in the new system include: i) measuring profitability per kilogram of product sold rather than using a rate of return on a prescribed capital base; ii) reducing the royalty exemption bracket; iii) allowing for reclamation expenditures in calculating profit-related royalties; iv) allocating expenditures among project partners to reflect commercial realities; and v) crediting the basic royalty against the profit-related royalty rather than deducting it in the calculation of profits.

The AECB will open a regional office in Saskatoon in mid-1991 to handle the increased workload related to uranium mining operations in Saskatchewan. The office, comprised of a manager and six staff of the AECB's Uranium Facilities Division, will also help to improve communications with provincial officials, lead to closer working relationships, and reduce duplication of effort. It is expected that: i) the Saskatchewan government will amend its occupational health and safety regulations to remove references to radiation limits for uranium miners; ii) the AECB will seek to incorporate Saskatchewan's non-radiological health and safety regulations for uranium miners into its own regulations; and iii) the AECB will seek funding to pay Saskatchewan for non-radiological occupational inspections of uranium mines.

In 1990, progress was made on a range of radioactive waste management issues. In the fall, a public review was initiated of the generic concept of deep geological disposal of nuclear fuel wastes in the stable rock formations of the Canadian Shield. There will be no site selection until such time as the concept has been accepted as safe by the governments concerned. Meanwhile, storage at reactor sites is safe, cheap and reliable and can be continued for many decades.

For low-level radioactive wastes, an innovative approach has been adopted, using an independent panel that looks for communities willing to accept a facility on a voluntary and participatory basis, with full compensation for unmitigatable local impacts. It has been well received, and six communities have expressed a desire to continue in this process. If successful, this approach may be a useful model for eventually siting other facilities, including a high-level waste repository. With regard to uranium tailings, a number of sites will be decommissioned in the next few years. The AECB has a set of requirements for decommissioning, and works closely with the mining companies and the provincial governments to ensure that these standards are met.

OTHER DEVELOPMENTS

In April, two Canadian companies, Cameco and Agra Industries Limited, and a U.S. company, Isotope Technologies, announced a joint venture to pursue the commercial development of a new laser isotope separation technology known as CRISLA (Chemical Reaction by Isotope Selective Laser Activation). Applications include the production of: enriched uranium, ultra-pure metals, pure isotopes for environmental monitoring, and high-purity pharmaceuticals. Headquartered in Saskatoon, CRISLA Technologies will focus its initial R&D efforts on the separation of uranium isotopes.

In July, Rio Algom Mining Corp., the wholly-owned U.S. subsidiary of Rio Algom Limited, acquired about 8% of the shares of Uranium Resources, Inc. (URI). Texas-based URI owns *in situ* leach uranium operations in Texas, and undeveloped properties there and in New Mexico. Annual output of about 325 tU is expected from URI's Rosita solution mining operation in Texas, which began production in September.

In November, as a result of an incident a year earlier at its Rabbit Lake property in Saskatchewan, Cameco was fined $50 000 for discharging slightly radioactive minewater without a permit, where there was a "reasonable possibility" that the discharge could result in a change in water quality. In imposing the fine, the judge noted that the spill had caused only minimal environmental impact, and that surface water near the spill never exceeded the range of natural background levels of uranium. Cameco was charged under Section 17(a) of the Environmental Management and Protection Act of Saskatchewan, which carries a $1 million maximum fine. The company had also been fined $10 000 in December 1989, under the federal Atomic Energy Control Act, after pleading guilty to two charges resulting from the same incident.

MARKETS AND PRICES

The uranium market has suffered from oversupply since the late 1970s when surplus inventories began to accumulate due to delays and cutbacks in reactor construction, and declines in new reactor orders. Although reactor-related requirements have exceeded production since 1985, the drawdown of excess utility inventories has been slower than expected and a significant surplus still overhangs the market. The oversupply situation has been exacerbated recently by the availability of low-priced uranium from the West German uranium stockpile and from non-traditional suppliers, especially the U.S.S.R., certain Eastern European countries and China.

In addition, broker/traders became increasingly active during 1990, moving excess supplies into the market and thus contributing to increased spot-market price volatility. The Nuexco EV slid to US$8.70/lb U_3O_8 by February, jumped to $11.70 in July, fell to a record low of $8.35/lb U_3O_8 in October and recovered to $9.70/lb U_3O_8 at year-end. In Canada, the average price of all export deliveries in 1990 was C$71/kgU (US$24/lb U_3O_8), slightly below the 1989 average. Less than 1% of Canada's export deliveries in 1990 were spot sales, compared with 1% in 1989, 35% in 1987, 21% in 1986, and 1.5% in 1982. The average price of Canadian export deliveries for 1974 to 1990 is shown in Table 7.

The latest edition of "Uranium: Resources, Production and Demand" (the "Red Book"), published jointly by the Nuclear Energy Agency (NEA) of the Organization for Economic Co-operation and Development and the International Atomic Energy Agency (IAEA), indicates that world uranium requirements will increase from about 42 000 tU in 1990 to 53 000 tU in 2005. Clearly, these requirements cannot be met by output from existing and committed production centres relying on lower-cost resources. As a result, most market analysts estimate that new production facilities will be required by the mid-1990s. However, while output from planned and prospective production centres can be made available, the emergence of non-traditional suppliers and the availability of surplus inventory suggest that the need for new sources of uranium production could be delayed significantly. The timing of many of these new projects could well depend on the supply-diversification strategies of the world's nuclear utilities.

Table 8 shows by country of buyer the nominal amount of uranium under Canadian export contracts reviewed and accepted since 1974, and illustrates Canada's diverse export base. As of January 1, 1991, forward commitments under all export contracts and domestic contracts are approximately 60 000 tU and 70 000 tU, respectively. Table 9 shows actual exports of Canadian origin natural uranium from 1984 to 1989 for Canada's principal export customers; actual exports in 1990 are expected to match those of 1989. Figure 4 illustrates the future importance of Canada's export markets in terms of forward scheduled deliveries of uranium in concentrates.

REFINING

Cameco operates Canada's only uranium refining and conversion facilities, located at Blind River and Port Hope, Ontario, respectively. At Blind River, uranium concentrates are refined to uranium trioxide (UO_3), an intermediate product, and then transported by truck to Port Hope. There, the UO_3 is converted to either uranium hexafluoride (UF_6), for use in foreign light-water reactors following enrichment outside of Canada, or uranium dioxide (UO_2), for use in CANDU reactors. Due to the soft conversion market, Cameco reduced production at both facilities in 1989 and 1990. Following an extended four-month shutdown in mid-1990, operations resumed in October. The cutback allowed Cameco to reduce its inventories of conversion products and lower its operating costs.

The Blind River refinery processes uranium concentrates from around the world. With an annual capacity of 18 000 tU as UO_3, it is the largest refinery of its kind in the world. Due to the depressed conversion market, and Cameco's decision to reduce production, output in 1989 was about 8600 tU as UO_3, some 25% below the 1988 level. At Port Hope, combined production at the two conversion facilities, which have a capacity of 10 500 tU as UF_6 and 2500 tU as UO_2, respectively, was about 9200 tU in 1989, some 18% below the 1988 level.

NUCLEAR POWER DEVELOPMENTS

At the end of 1990, 19 CANDU reactors with a combined generating capacity of about 13 000 megawatts electric (MWe) were in service in Canada, as shown in Table 10. During the year, almost 15% of Canada's electric power was nuclear-generated, while in Ontario it was almost a half, and in New Brunswick nearly a third.

In October, Unit 2 of Ontario Hydro's four-unit Darlington nuclear generating station, east of Toronto, went into commercial service at full power. Unit 1 received an operating licence on October 4, and was expected to reach full power by mid-February 1991. Construction delays at Units 3 and 4 will likely cause a re-scheduling of the in-service dates into 1992 and 1993, respectively. Ontario Hydro's four-unit Pickering A and Bruce A stations are undergoing extensive work to improve performance, replace pressure tubes and make system modifications to meet new licence requirements. This work is lowering the average Canadian reactor performance for a few years but overall system lifetime capacity factors are still expected to meet the 80% planning target.

The CANDU nuclear reactor at Point Lepreau, New Brunswick, continues to perform very well, achieving a 95% operating capacity factor in 1990; since start-up in 1983, its capacity factor has averaged 93%, making it the top-performing CANDU in the world.

On September 6, Ontario elected a New Democratic Party government for the first time in the province's history. The party has long believed that nuclear power should be phased out in favour of conservation and more efficient electricity generation, and to that end placed a moratorium on the construction of new nuclear facilities. Premier Bob Rae announced that construction at the four-unit Darlington station would be completed and the facility brought into full operation to provide Ontario with the security of electricity supply it needs for the immediate future. Ontario Hydro was asked to "divert planned expenditures for new nuclear developments towards the most comprehensive energy conservation and efficiency program ever undertaken by a utility in North America." However, the assessment of Ontario Hydro's 25-year energy demand/supply plan will continue, with nuclear R&D maintained at agreed levels.

OUTLOOK

In September 1990, the IAEA reported that global consumption of electricity is now projected to grow at an annual rate in excess of 3%, with nuclear-electric generation increasing at just less than 3% per annum. Since 1986, 71 new nuclear plants have been brought on line worldwide, 12 of those in 1989; an additional 96 nuclear reactors were under construction as of January 1, 1990. In just 30 years, nuclear power's share of total world electricity generation has risen from less than 1% to about 17%.

Beyond 2000, the future of nuclear power may be affected by decisions taken in the next few years with regard to the environment. The growing awareness that nuclear power plants contribute little to global warming, and rising concern about the emission of CO_2 and other "greenhouse" gases may result in increased orders for nuclear power plants. In France, for example, where nuclear plants now generate 75% of all electricity, emissions of CO_2 have fallen steadily over the past decade as nuclear's share of total electricity generation has risen. In Sweden there has been a clear change in attitude, whereby the major political parties have backed away from the 1988 decision to close two of the country's twelve nuclear power reactors by 1996.

Canada's uranium producers are adjusting to the volatile market conditions of recent years, and are prepared for the challenge of the 1990s. Producers have trimmed output levels, some have purchased uranium on the spot market, and one has been forced to close two production facilities. On the other hand, development work is proceeding on several new uranium projects. Canada has the uranium resources, infrastructure, political will and determination to remain a reliable and competitive supplier of uranium for many years to come.

REFERENCES

1 The price at which transactions for significant quantities of natural concentrates could be concluded as of the last day of the month according to the Nuclear Exchange Corporation (Nuexco), a Colorado-based uranium brokerage firm.

2 On November 1, 1990, the official name of Cameco - A Canadian Mining & Energy Corporation was shortened to Cameco Corporation.

3 "Canadian Uranium Resource Estimates Increase" - News Release 90/120, EMR Canada, September 17, 1990.

4 In certain cases, the identified operator has reported the total expenditures of a joint-venture effort. Therefore, contributions by other parties not responding to the URAG survey are accounted for in the $58 million total.

Note: Information contained in this review was current as of mid-January 1991.

TABLE 1. URANIUM PRODUCTION IN CANADA AND WORK FORCE SUMMARY, 1988 AND 1989

Province and Producer	Total Work Force[1] (Dec. 31)		Annual Output (tU)	
	1988	1989	1988	1989
Athabasca Basin, Saskatchewan				
Cluff Mining	180	120	860	727
Cameco Corporation				
Key Lake	440	350	4 629	4 893
Rabbit Lake	350	220	2 679	1 796
Subtotal	970	690	7 168	7 416
Elliot Lake, Ontario				
Denison Mines Limited	1 670	1 580	1 876	1 697
Rio Algom Limited				
Quirke	1 050	990	1 112	1 074
Panel	570	590	769	665
Stanleigh	470	430	468	471
Subtotal	3 760	3 590	4 225	3 907
Total	4 730	4 280	12 393[a]	11 323[a]

Sources: Company annual reports and Atomic Energy Control Board open files.
[1] Figures have been rounded. [a] Primary output. In 1988, an additional 73 tU was recovered by the Elliot Lake producers from Cameco's refinery/conversion facility by-products; in 1989, about 31 tU was recovered.

TABLE 2. VALUE OF URANIUM SHIPMENTS[1] BY PROVINCE, 1986-90

	Unit	1986	1987	1988	1989	1990p
Ontario producer shipments	tU	4 752	4 901	3 872	4 099	4 894
Value of shipments	$ million	566	581	446	501	635
Saskatchewan producer shipments	tU	6 750	8 711	8 194	6 896	4 564
Value of shipments	$ million	476	601	572	412	233
Total producer shipments	tU	11 502	13 612	12 066	10 995	9 458
Total value of shipments	$ million	1 042	1 182	1 018	913	868

Source: Energy, Mines and Resources Canada.
[1] Shipments in tonnes of uranium (tU), contained in concentrate, from ore processing plants.
p Preliminary.

TABLE 3. OPERATIONAL CHARACTERISTICS OF EXISTING CANADIAN URANIUM PRODUCTION CENTRES, 1989

Company/ Facility Name	Ore-Processing Plant[1]			
	Capacity	Recovery	Annual Throughput	
	Nameplate/ Actual	Overall	Ore Total	Ore Grade
	(t/d)	(%)	(t)	(% U)
Cluff Mining/ Cluff Lake	+ 900/ 850	97	130 000	0.58
Denison Mines Limited/ Elliot Lake	7 700/ 7 400	94	2 469 000	0.07
Cameco Corporation/ Rabbit Lake	1 800/ 1 400	96	245 000	0.71
Cameco Corporation/ Key Lake	+ 700/ + 720	99	243 000	2.04
Rio Algom Limited/ Elliot Lake				
Quirke	5 000/4 700	93	1 580 000	0.07
Panel	3 000/2 900	94	941 000	0.07
Stanleigh	+ 4 500/2 800	95	633 000	0.08

Sources: Corporate annual reports and Atomic Energy Control Board open files.
[1] Figures have been rounded.

TABLE 4. URANIUM EXPLORATION ACTIVITY IN CANADA, 1976-89

Year	Expenditures[1]	Drilling[2]	Million-Dollar Projects[3]
	($ million)	(km)	(number)
1976	44	155	4
1978	90	334	7
1980	128	503	24
1982	71	247	13
1984	35	197	12
1986	33	162	11
1987	37	164	12
1988	59	201	11
1989	58	158	11

[1] Direct exploration and drilling expenditures in current dollars. [2] Exploration and surface development drilling; excludes development drilling on producing properties. [3] Number of projects where direct exploration and drilling expenditures exceeded $1 million in current dollars.

TABLE 5. ESTIMATES OF CANADA'S URANIUM RESOURCES RECOVERABLE FROM MINEABLE ORE,[1] 1/1/89 AND 1/1/90

Price Ranges Within Which Mineable Ore is Assessed[2]	Measured		Indicated		Inferred	
	1/1/89	1/1/90	1/1/89	1/1/90	1/1/89	1/1/90
			(000 tU)			
Up to $100/kg U	41	45	98	87	109	117
$100 to $150/kg U	2	2	94	93	95	93
Subtotal	43	47	192	180	204	210
$150 to $300/kg U	22	22	32	33	51	91
Total	65	69	224	213	255	301

[1] Actual or expected losses in mining recovery and ore processing have been accounted for; these factors were individually applied to resources tributary to existing or prospective production centres. In underground operations, mineable ore is generally 75% to 85% of the ore-in-place; higher mining recoveries are achievable in open-pit operations. Ore-processing recoveries in Canada normally range from 90% to 97%; Canada's weighted average mill recovery for existing conventional uranium operations was 96% in 1989. [2] The Canadian dollar figures reflect the price of a quantity of uranium concentrate containing 1 kg of elemental uranium. The prices were used in determining the cut-off grade at each deposit assessed, taking into account the mining method used and the processing losses expected. The price of $100/kgU was used by URAG to illustrate those resources that were of economic interest to Canada in 1988 and 1989.
Note: $1/lb U_3O_8 = $2.6/kgU.

TABLE 6. PRODUCTION OF URANIUM IN CONCENTRATES BY MAJOR PRODUCING COUNTRIES, 1983-89

	1983	1984	1985	1986	1987	1988	1989
				(tonnes U)			
Canada	7 140	11 170	10 880	11 720	12 440	12 470	11 350
United States	8 140	5 720	4 350	5 200	5 000	5 190	5 320
South Africa	6 060	5 740	4 880	4 610	3 960	3 850	2 950
Namibia	3 720	3 690	3 600	3 300	3 540	3 600	3 100
Australia	3 210	4 390	3 250	4 150	3 780	3 530	3 660
Niger	3 470	3 400	3 180	3 110	3 000	2 970	2 990
France	3 270	3 170	3 200	3 250	3 380	3 390	3 240
Gabon	1 040	1 000	940	900	800	930	850
Other[1]	900	950	900	870	890	910	940
Total[2]	36 950	39 230	35 180	37 110	36 790	36 840	34 400

Sources: "Uranium: Resources, Production and Demand," a report jointly produced by the Nuclear Energy Agency of the OECD and the International Atomic Energy Agency, and miscellaneous national and international reports. Country figures are rounded to the nearest 10 tU.
[1] Includes Argentina, Belgium, Brazil, the Federal Republic of Germany, India, Israel, Japan, Portugal, Spain and Yugoslavia.
[2] Totals are of the listed figures only.

TABLE 7. CANADIAN URANIUM EXPORT PRICE,[1] 1974-90

Year	Average Export Prices: Current Dollars	Average Export Prices: Constant 1990 Dollars[2]	Spot Sale Portion of Deliveries
	($kg/U[3])		(%)
1974	39	104	n.r.
1975	52	126	n.r.
1976	104	232	n.r.
1977	110	231	n.r.
1978	125	248	n.r.
1979	130	234	n.r.
1980	135	220	n.r.
1981	110	162	1
1982	113	153	1.5
1983	98	126	10
1984	90	113	26
1985	91	111	20
1986	89	106	21
1987	79	90	35
1988	79	86	13
1989	74	76	<1
1990	71	71	<1

[1] EMR's Uranium Resource Appraisal Group (URAG) derives the Export Price figure annually. It is based on the average price under all export contracts made by Canadian producers for deliveries in the given year; prices are rounded. [2] The constant dollar values are derived using the Implicit Price Index for Gross Domestic Product. [3] \$/kgU x 0.38465 = \$/lb U_3O_8.
n.r. Not reported.

TABLE 8. CANADIAN URANIUM UNDER EXPORT CONTRACTS[1]

Country of Buyer[2]	Tonnes U
Belgium	3 110
Finland	3 512
France	9 715
Italy	1 115
Japan	27 181
South Korea	6 830
Spain	3 559
Sweden	9 475
Switzerland	154
United Kingdom	7 639
United States	72 924
West Germany	14 994
Total	160 208

[1] The nominal quantity of uranium in all contracts reviewed and accepted under Canadian uranium export policy since September 5, 1974. Country totals are adjusted to reflect new and amended contracts, and the exercising of quantity-flexibility options, as of December 31, 1990. [2] In most cases, indicates country of end-user.

Uranium

TABLE 9. EXPORTS OF URANIUM OF CANADIAN ORIGIN, 1984-89

Country of Final Destination	1984	1985	1986	1987	1988	1989
	(tonnes of contained uranium[1])					
Belgium	121	157	63	–	153	190
Finland	137	81	116	142	151	71
France	525	612	1 013	1 438	964	696
Indonesia	–	–	–	–	–	1
Italy	50	53	301	293	–	46
Japan	2 436	1 799	816	1 317	717	1 729
Netherlands	–	–	85	40	–	–
South Korea	30	194	402	828	874	635
Spain	–	–	150	150	100	97
Sweden	254	514	449	377	783	497
Turkey	–	–	2	–	–	–
United Kingdom	692	685	700	824	1 204	871
United States	2 397	3 524	3 692	6 063	4 682	3 950
West Germany	295	269	654	1 317	806	615
Total	6 937	7 888	8 443	12 789	10 434	9 398

Source: Atomic Energy Control Board.
[1] Some of this uranium was first exported to an intermediate country, for conversion and/or enrichment, prior to transfer to the country of final destination.
– Nil.

TABLE 10. NUCLEAR POWER PLANTS IN CANADA[1]

Reactors	Owners	Net Capacity	In-Service Dates
		(MWe)	
Pickering 1 to 4	Ontario Hydro	2 060	1971-73
Bruce 1 to 4	Ontario Hydro	3 076	1977-79
Point Lepreau	NBEPC[2]	635	1983
Gentilly 2	Hydro-Québec	638	1983
Pickering 5 to 8	Ontario Hydro	2 064	1983-86
Bruce 5 to 8	Ontario Hydro	3 394	1984-87
Darlington 1 to 4	Ontario Hydro	3 524	1990-93[e]
Total net capacity (MWe) expected by 1993		15 391	

[1] As of December 1990. [2] The New Brunswick Electric Power Commission.
[e] Expected.

Figure 1

URANIUM DEPOSITS IN CANADA

● **PRODUCING**

1 ELLIOT LAKE
2 RABBIT LAKE (Incl. EAGLE POINT)
3 KEY LAKE
4 CLUFF LAKE

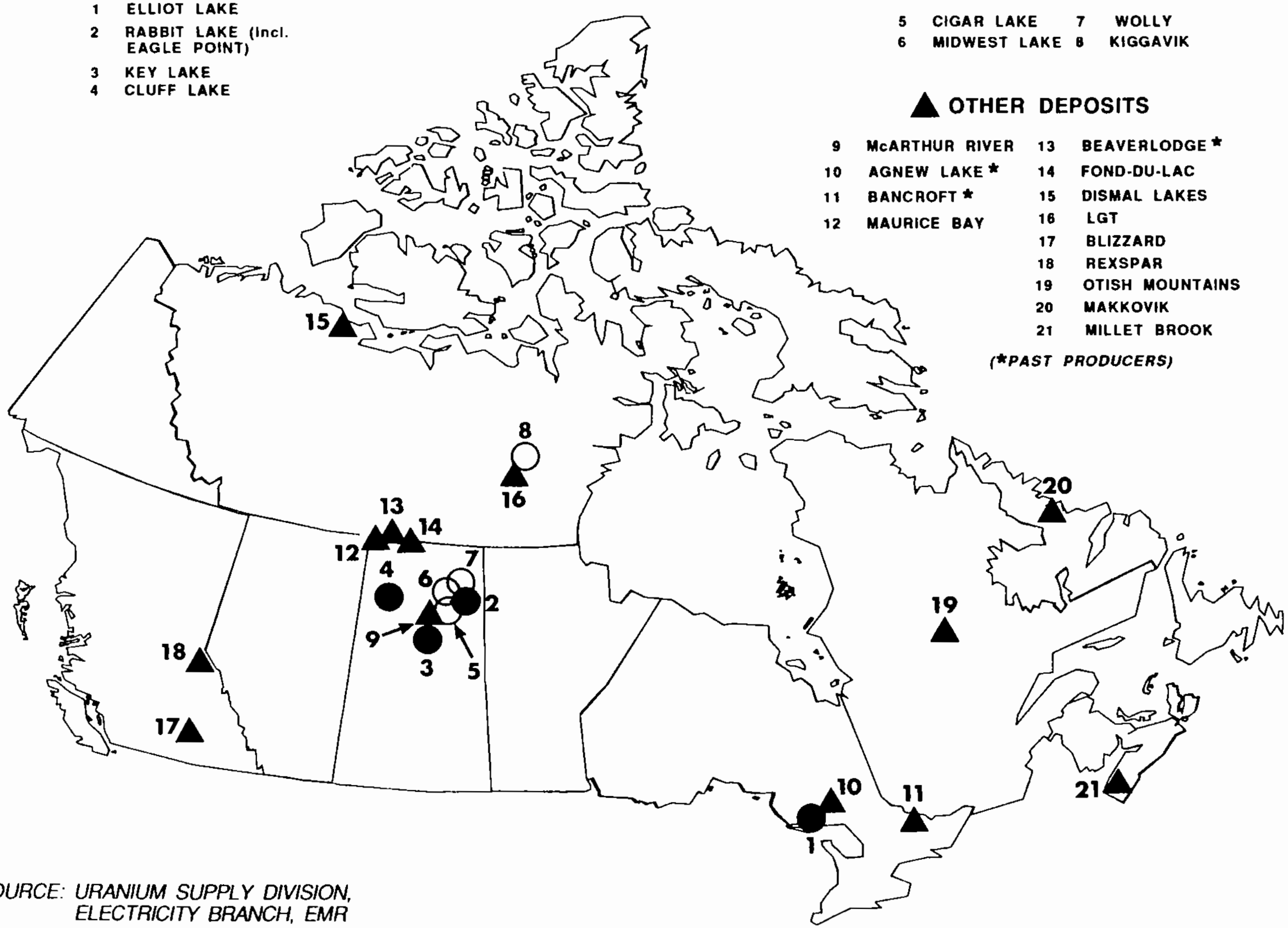
○ **UNDER DEVELOPMENT**

5 CIGAR LAKE
6 MIDWEST LAKE
7 WOLLY
8 KIGGAVIK

▲ **OTHER DEPOSITS**

9 McARTHUR RIVER
10 AGNEW LAKE*
11 BANCROFT*
12 MAURICE BAY
13 BEAVERLODGE*
14 FOND-DU-LAC
15 DISMAL LAKES
16 LGT
17 BLIZZARD
18 REXSPAR
19 OTISH MOUNTAINS
20 MAKKOVIK
21 MILLET BROOK

(*PAST PRODUCERS)

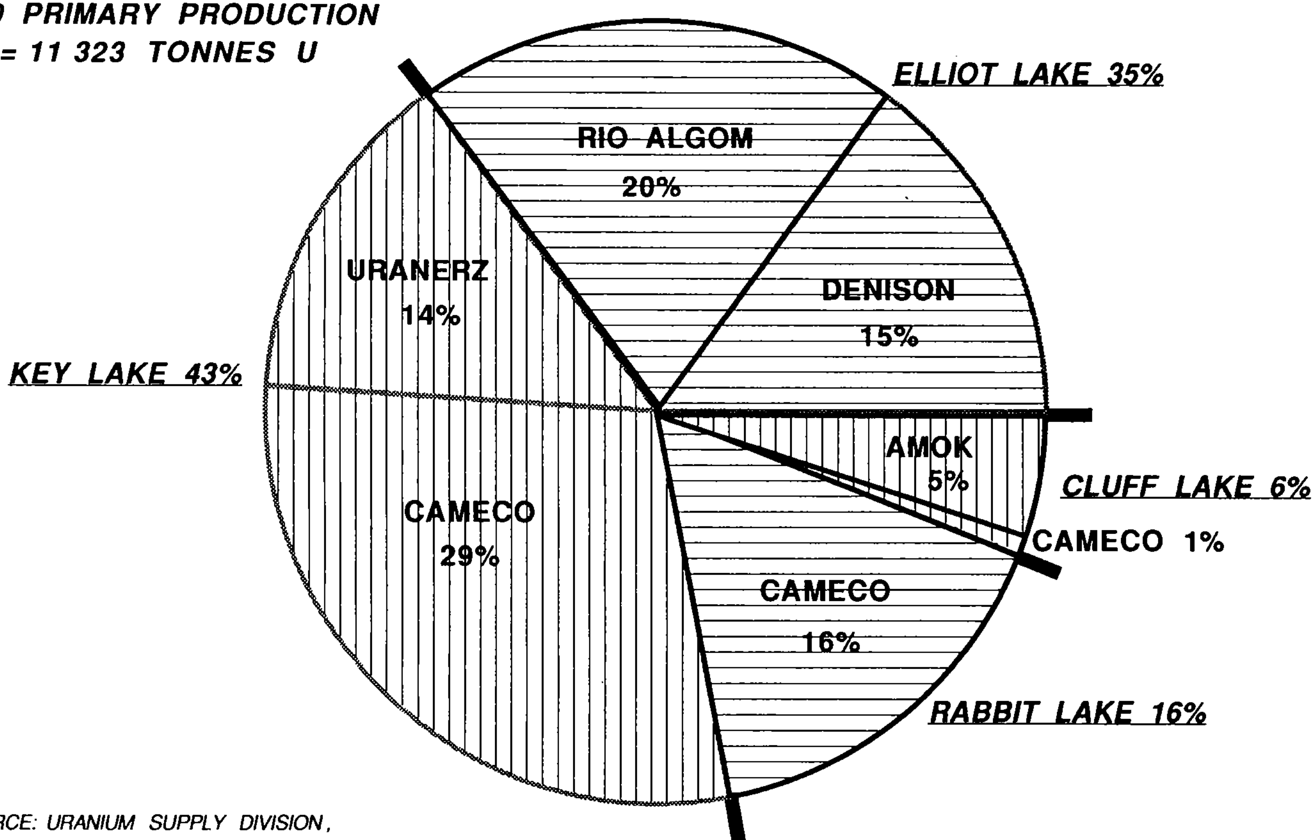


SOURCE: URANIUM SUPPLY DIVISION, ELECTRICITY BRANCH, EMR

Figure 2

CANADIAN URANIUM PRODUCTION AND OWNERSHIP IN 1989

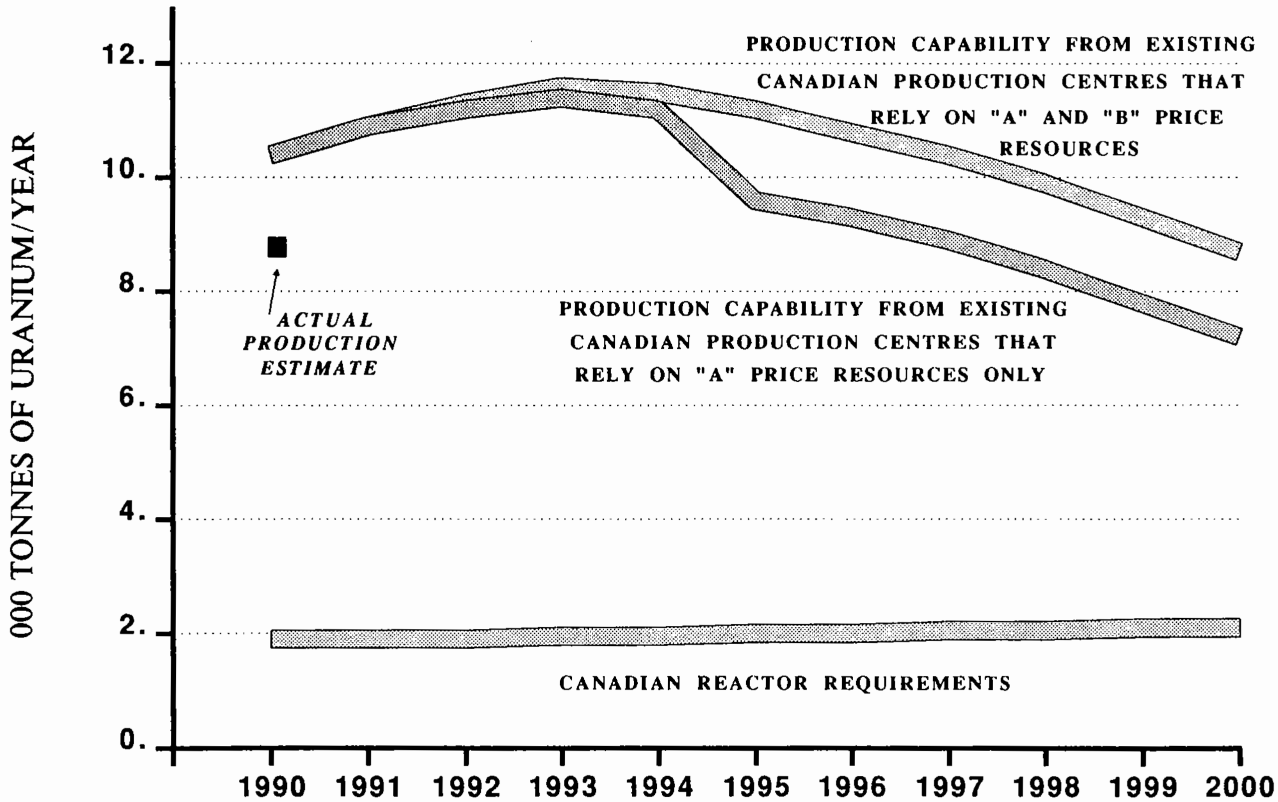
1989 PRIMARY PRODUCTION = 11 323 TONNES U



SOURCE: URANIUM SUPPLY DIVISION, ELECTRICITY BRANCH, EMR

Figure 3

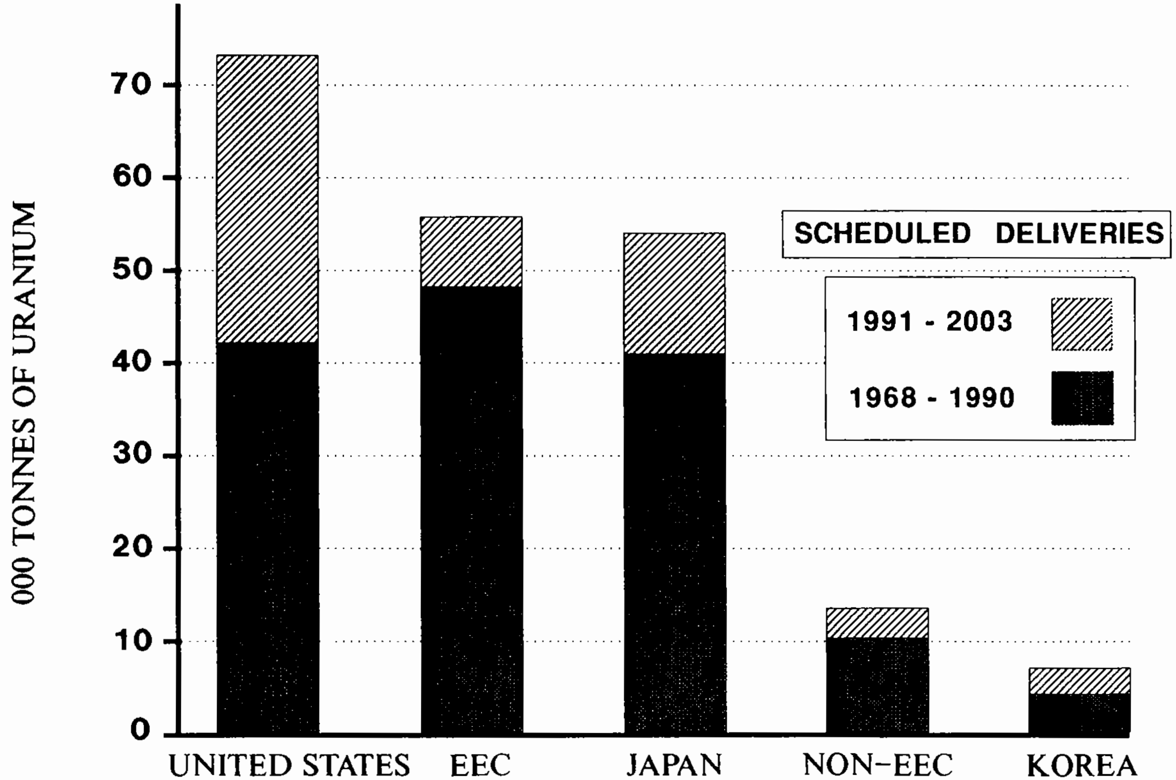
URANIUM PRODUCTION CAPABILITY COMPARED WITH REACTOR REQUIREMENTS



SOURCE: URANIUM SUPPLY DIVISION, ELECTRICITY BRANCH, EMR

Figure 4

SCHEDULED DELIVERIES OF CANADIAN URANIUM FOR THE EXPORT MARKET



SOURCE: URANIUM SUPPLY DIVISION, ELECTRICITY BRANCH, EMR

Vanadium

1990

Elaine Koren

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The arrival of Union Steel Corporation of South Africa Ltd. (Usco) and new production from Canada's Carbovan Inc. (Carbovan), two new sources of vanadium on the market, upset the supply/demand equation in 1990. The recessionary conditions prevalent in North America and in the United Kingdom, coupled with unstable oil prices, contributed further to the economic slowdown. In addition, the staggering problems resulting from the Eastern Europe and Persian Gulf crises have contributed to the dramatic decline of vanadium markets.

The bearish worldwide market for vanadium was evident throughout 1990, as prices (in US$) continued to slide to the previous low levels of 1983/84 when sub-$2.00 levels were seen. This resulted in the closure of South Africa's Vansa Vanadium S.A. Ltd. (Vansa), which had only been producing for two years.

With recessionary conditions present in the United States and declining defense spending, demand for vanadium-bearing steel alloys and vanadium-bearing materials decreased. Substitution has also affected vanadium consumption.

South Africa's Highveld Steel and Vanadium Corporation Limited's (Highveld) list price is one of the few producer prices to have survived into the 1990s. Until recently, Highveld's price was used as a benchmark and contributed to market price stability. Currently, less emphasis is placed on the Highveld list price for vanadium pentoxide given the increasingly changing market conditions.

World consumption of vanadium, projected at 92 million pounds (lb), is down this year, leading to a surplus in both slag and pentoxide inventory levels. At year-end, U.S. and European consumption was quoted as being down 8%-9% from 1989. In Japan, the demand for vanadium continued to remain firm.

CANADIAN DEVELOPMENTS

Carbovan, Canada's sole producer of vanadium, began its operations in the third quarter of 1990. Production was on a limited basis from its 1045 tonnes per year (t/y) (2.3 million lb/y) plant located in Fort McMurray, Alberta. Initial shipments consisted of redcake, HVO_3, an intermediate higher grade vanadium product. Vanadium pentoxide (V_2O_5) production is scheduled to start later in January 1991. At the time of writing, Carbovan was not producing V_2O_5 in commercial quantities as they would like "to come on stream as a reliable quality producer." It was reported that the Fort McMurray facility was producing more than 1360 kg (1500 lb) HVO_3 per week in the final quarter of 1990. Much of its vanadium will be sold for vanadium alloying to steel mills and the aerospace industry.

Canada's only ferrovanadium converter, Masterloy Products Limited (Masterloy), imports all of its vanadium pentoxide. Masterloy's Ottawa plant has a capacity of approximately 1000 t/y of ferrovanadium. Imported feedstock originates from South Africa, the United States or China. Masterloy supplies most of the ferrovanadium consumed in Canada, the offset being imported mainly from the United States. As well, up to a third of Masterloy's production is exported to the United States.

Principal consumers of ferrovanadium in Canada include Dofasco Inc., Stelco Inc., IPSCO Inc., Atlas Specialty Steel Division of Sammi Atlas Inc., The Algoma Steel Corporation, Limited and Sydney Steel Corporation (Sysco).

WORLD DEVELOPMENTS

United States

Vanadium is classified as a strategic mineral by the United States due to the country's significant import dependence and essential usage of vanadium in defense, energy and transportation equipment. The Defense Logistics Agency (DLA) awarded the contract to upgrade 1 934 826 lb of vanadium pentoxide (grade B) from the national defense stockpile to United States Vanadium Corp. for US$3 076 373. United States Vanadium Corp.'s bid was $1.59/lb.

UNC Reclamation of Mulberry, Florida, has been evaluating the commercial and technical feasibility of recovering V_2O_5 from a variety of materials, particularly sulphuric acid catalyst, boiler slag and fly ash. It was estimated that the UNC plant could recover up to 4 million lb/y of V_2O_5.

To further develop its vanadium products and applications, Strategic Minerals Corp. (Stratcor), developer of the vanadium-nitride alloy Nitrovan, is opening an $850 000 technology research centre adjacent to its Hot Springs, Arkansas, plant. This centre will focus on improving product quality, developing new feed sources, generating new product lines and researching ways to recycle existing waste stream materials and obtain by-products from them.

South Africa

South Africa's Usco, a new source of vanadium material, started to produce fused pentoxide flake in June 1990, using raw material from the Rhombus Vanadium property at Brits, 100 km north of Johannesburg. The Usco recovery plant at Vereeniging is a specially converted steel plant. Its rated V_2O_5 capacity is 9000 short tons per year. Market sources estimated 1990 output will be up to one third of its projected full capacity. Usco material was on the market in November.

In November, Vansa announced that it was to withdraw from vanadium production. Vansa came on stream in mid-1988, redeveloping the Steelport site in eastern Transvaal which had been worked previously by Highveld. The company produced approximately 4 million lb of V_2O_5 in 1989 and was forecast to produce up to 6 million lb in 1990. As of mid-1990, production totalled 2 million lb.

Australia

Precious Metals Australia (PMA), 100% owner of the Windmurra vanadium project in Western Australia, is examining the potential for construction of a 3700 t/y vanadium pentoxide mine and plant complex. The project is currently at the prefeasibility stage and recently received an Australian federal government grant of A$300 000 to cover approximately one half of the costs of the research and development work to be carried out over the next 24 months. Production levels would be based on the throughput of 900 000 t/y of ore yielding 450 000 t/y of upgraded magnetite. This deposit has an inferred resource quoted at 14.98 Mt and grades averaging 1.7% V_2O_5, exceeding most of the other vanadium orebodies except South Africa's Highveld.

PMA will probably use sodium oxalate, a by-product from alumina production, in its salt roast process for the pentoxide operation. Since sodium oxalate is a strong reagent, less energy will be required in the process. Pilot plant test work on ore beneficiation will be conducted in South Africa. If results prove positive, construction is planned to start in September 1991.

USES

Vanadium's main industrial use is in the production of high-strength, low-alloy steel and tool and die steels, which account for approximately 85% of its total consumption. Consequently, the demand for vanadium follows the business cycle of the steel industry, which mirrors the ebb and flow of the major industrialized economies. Another 10% is used in the manufacture of titanium-aluminum alloys for the aerospace industry. The remaining 5% is primarily used in chemicals.

PRICES

Signs of the 1990 bearish, roller coaster vanadium market were clearly evident in the first quarter as U.S. producers posted price decreases for their vanadium products in January, followed by increases in March. In the second quarter, South Africa's Highveld posted the V_2O_5 price up to $4.20/lb, an increase from

$2.50 in the first quarter. A downturn in the market began in May when spot prices softened. By the end of the second quarter, producers were cutting their prices. Highveld lowered its third-quarter V_2O_5 price at $3.35/lb. By the end of the third quarter, producers cited a second price decrease as the spot price continued to slide. Highveld followed suit, lowering its price to $2.95/lb. By year-end, spot prices bottomed out ranging from $2.25-$2.35/lb and rallying to $2.35-$2.50/lb.

Ferrovanadium prices started 1990 at $12.75/kg and continued to rise throughout the first quarter to just under the $22 mark. In the second quarter, ferrovanadium prices began a downward slide. By the end of June, prices fell to $14.50-$15.00/kg. At year-end, ferrovanadium prices were quoted at $13.60-$13.85/kg.

OUTLOOK

The price erosion evident in 1990 stems from a substantially lower international demand for vanadium-bearing steels, particularly in Eastern Europe, whereas new vanadium capacity has come on stream in South Africa (Usco) and Canada (Carbovan). The future for the vanadium market, in the short term at least, will depend on the length of time and commitment required to resolve the Persian Gulf crisis. This will depend on the decisions taken on whether or not to replace used materials, which will deplete surpluses and additional Eastern Europe materials on the market, and on the effect of new materials on the market. The long-term prospects will depend on the effect of new players entering the market who are relying on their strategic geographical locations, ready markets and/or their particularly lower energy costs to stake their positions. However, with Vansa closing its operations, Highveld operating at one sixth of its capacity, and two new operations moving into the already depressed market, it will be the high-cost producers who will be under the greatest pressure at the current price levels.

Note: Information contained in this review was current as of mid-January 1991.

TARIFFS

		Canada			United States	EEC	Japan[1]
Item No.	Description	MFN	GPT	USA	Canada	MFN	MFN
2825.30	Vanadium oxides and hydroxides	Free	Free	Free	9.6%	5.5%	Free
7202.92	Ferrovanadium	10.2%	6.5%	4%	2.5%	4.9%	3.7%

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States effective January 1, 1990; Official Journal of the European Communities, Vol. 33, No. L247, 1990, "Conventional" column; Custom Tariff Schedules of Japan, 1990.
[1] GATT rate is shown; lower tariff rates may apply circumstantially.

Vanadium

TABLE 1. CANADA, VANADIUM IMPORTS AND EXPORTS, 1989 AND 1990

Item No.		1989		Jan.-Sept. 1990p	
		(tonnes)	($000)	(tonnes)	($000)
Exports					
2825.30	Vanadium oxides and hydroxides	–	–	–	–
7202.92	Ferrovanadium				
	United States	187	6 676	–	–
	Sweden	35	925	–	–
	United Kingdom	18	513	–	–
	Finland	10	388	–	–
	Other countries	21	509	–	–
	Total	271	9 011	–	–
Imports					
2825.30	Vanadium oxides and hydroxides				
	South Africa	945	15 618	400	2 996
	United States	277	4 779	231	1 551
	People's Republic of China	23	386	32	266
	West Germany	18	329	–	–
	Total	1 263	21 114	663	4 814
7202.92	Ferrovanadium				
	United States	372	6 667	150	2 672
	West Germany	–	–	74	1 305
	Belgium	–	–	17	302
	Total	372	6 667	241	4 281

Source: Statistics Canada.
p Preliminary; – Nil.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, VANADIUM CONSUMPTION, 1986–89

	1986	1987	1988	1989p
		(tonnes)		
Ferrovanadium				
Gross weight	586	754	823	807
Vanadium content	433	591	627	647

Source: Energy, Mines and Resources Canada.
p Preliminary.

Zinc

1990

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Zinc performed strongly in 1990 due to tightness in the concentrate market, technical problems at several mines and smelters, labour disputes and speculation over the renewal of labour contracts. The average price for Special High Grade zinc on the London Metal Exchange (LME) was US69¢/lb, down from the average of US78¢/lb in 1989 but still above average prices for the rest of the 1980s.

Western World zinc consumption was about 5 208 000 t, down slightly from 1989, as economic decline in North America, Brazil and the United Kingdom was largely offset by strong growth in parts of Europe and Asia. Mine production rose to near-record output of about 5 322 000 t. Production losses in Canada were more than offset by new capacity brought on stream in Australia and the United States. Smelters remained at high capacity utilization but refined metal production fell to about 5 169 000 t due to labour disputes, technical problems and, in Peru, terrorist activity.

Zinc stocks were reduced throughout most of 1990 but rebounded slightly late in the year to represent just over five weeks of Western World consumption. In 1991, a forecast surplus of metal, weak demand and a return to normal stock levels are expected to cause prices to fall after the first quarter, once the tightness in the concentrate market eases. The zinc price is expected to average about US51¢/lb in 1991.

CANADIAN DEVELOPMENTS

Canadian mine production in 1990 fell to 1 183 000 t, a decrease of 32 000 t from 1989, the third consecutive year of decline. The total was 321 000 t lower than the record production of 1 504 000 t in 1987 as mine closures, labour disputes and some technical difficulties continued to plague the industry. Despite the problems, Canada remained the world's largest producer of zinc concentrates with about 22% of Western World supply.

In 1990, five mines opened, three mines closed, including one that opened earlier in 1990, and one mine was idle for much of the year. With the settlement of most labour contracts by year-end and with new capacity in the Yukon coming on stream next year, Canadian mine production for 1991 is expected to increase substantially.

Canadian metal production fell in 1990 for the second consecutive year to 579 000 t, down 14% from 1989. Major design modifications to an existing zinc plant in British Columbia along with labour and technical problems were responsible for the decreased production.

British Columbia

Cominco Ltd. closed its Sullivan mine in Kimberley in January due to falling metal prices and rising production costs and laid off 700 workers. The mine re-opened in November after an $11 million development program was initiated.

The closure of Sullivan and delays in concentrate shipments from the Red Dog mine in Alaska due to operating problems in the concentrator, led to feed shortages which had to be made up from foreign concentrate purchases. Cominco's problems were compounded by a 14-day strike in July at Trail, and a hydrogen explosion in a zinc purification plant. The closure in March of the new QSL lead smelter, due to technical reasons, and the subsequent operation of the old smelter at reduced capacity, also affected the processing of zinc leach residues at Trail.

The Samatosum mine in southern British Columbia, operated by Minnova Inc., ran smoothly during the year despite stability problems in the pit walls. Lower-than-expected zinc grades were encountered.

Zinc

A three-day strike took place in August at Westmin Resources Limited's Myra Falls operations near Campbell River. Ground instability in the H-W mine and other problems were also encountered during the year.

In northern British Columbia, Curragh Resources Inc. continues to develop its large Cirque deposit, and an airstrip and 87 km all-weather road were completed. The deposit has a geological reserve of 13 Mt grading 14% combined lead and zinc and 70 g/t silver, with an additional reserve of 20 Mt at lower grade. Capital costs to bring the deposit into production in 1992 are estimated at $130 million. Cirque will produce 100 000 t/y of zinc in concentrate when in full production. The Spanish zinc smelting company, Asturiana de Zinc S.A., of which Curragh has 20% equity, holds a 15% interest in the Cirque project.

At the Eskay Creek deposit north of Stewart, underground sampling of the 21B zone by Prime Resources Group Inc. is confirming the high-grade nature of the deposit. Although primarily a precious metals deposit, Eskay Creek contains significant base-metal values.

Other projects under active exploration include Cominco Ltd./Redfern Resources Ltd.'s Tulsequah Chief project in northwestern British Columbia, American Reserve Mining Corporation/Homestake Mining Company's Kutcho Creek project southeast of Dease Lake, Greenstone Resources Ltd./Dragoon Resources Ltd.'s McNeil property south of Cranbrook, and Regional Resources Ltd.'s Midway project in northeastern British Columbia.

Yukon

The Faro mine of Curragh Resources Inc. experienced further technical difficulties in 1990, including a power outage in June. In November, the company announced that it had fallen behind in zinc concentrate production by 95 000 t due to problems over the past two years. The nearby Vangorda and Grum deposits continue to be developed for production in 1991. Output from these orebodies will sustain current production at Faro of 120 000 t/y lead and 200 000 t/y zinc in concentrates.

At the Mt. Hundere project near Watson Lake, owned by Curragh and 20% partner Hillsborough Resources Limited, construction work on the mill and tailings dam began in September. The open-pit/underground mine, with a projected 8.5 year life span, is expected to cost $70 million and to begin producing concentrates in the second half of 1991. At full capacity in 1992, it will produce 30 000 t/y lead and 52 000 t/y zinc in concentrates. Zinc concentrates will be shipped to Asturiana de Zinc's smelter in Spain as well as to other destinations in Europe and Asia. Proven, probable and possible reserves at Mt. Hundere currently stand at 5.1 Mt grading 4.7% lead, 12.6% zinc and 65 g/t silver.

Saskatchewan

Cameco Corporation commenced feasibility studies on its Hanson Lake project situated 65 km west of Flin Flon, Manitoba. Late in the year, shareholders of Trimin Resources Inc. approved the sale of the company's 32.9% interest in the project to Billiton Metals Canada Inc. The Hanson Lake deposit has an estimated reserve of 9.8 Mt grading 0.95% copper, 5.76% zinc, 0.42% lead, 0.51 g/t gold and 25 g/t silver.

Manitoba

Hudson Bay Mining and Smelting Co., Limited (HBMS) continued production from its Chisel Lake open pit in 1990. In October, an underground fire at the Ruttan mine, near Leaf Rapids, destroyed the ore conveyor system and air, water and electrical lines. The mine was closed for two weeks. A new conveyor system is expected to be operational in mid-January 1991. In November, HBMS discovered a new high-grade zone of zinc-copper mineralization beneath the current workings of the Trout Lake mine. A new 652-m circular shaft and a new ore-handling system were completed at Trout Lake to allow for the hoisting of 300 t/h to the surface.

HBMS has proposed to upgrade its Flin Flon smelting complex with an investment of $170 million. The modernization will reduce operating costs while allowing for a 25% reduction in SO_2 emissions by 1994 as required by Manitoba legislation. HBMS has requested government assistance under the Acid Rain Abatement Program.

Ontario

Falconbridge Limited continues to develop its No. 3 mine at Kidd Creek near Timmins. The internal shaft is being sunk from the 4600 level to the 6800 level. Mine output has been falling as the Kidd Creek orebody decreases in width with increased depth. Active exploration in the lower levels of the mine is continuing.

A significant new copper-zinc discovery was made by Minnova Inc. about 1.5 km from the main shaft of its Winston Lake mine near Schreiber. Referred to as the Deep Pick zone, the massive sulphide deposit is about three times deeper than the Winston Lake orebody.

Quebec

At the Mobrun mine near Rouyn-Noranda, Audrey Resources Inc. continued its drilling on the 1100 lens. A new discovery, the C lens, was located about 50 m south of the 1100 lens at a depth of about 610 m. A feasibility study, completed in November, estimated capital costs of $90 million for a 3000 t/d operation through a new shaft or $40 million to mine the orebodies at 2000 t/d through the existing Mobrun workings. The project's ore reserves are 25 Mt grading 0.75% copper, 3.53% zinc, 30.8 g/t silver and 1.1 g/t gold.

Near Joutel, Breakwater Resources Ltd. brought its 500 t/d Estrades polymetallic massive sulphide mine into production at a capital cost of $15 million. Ore from the underground mine is custom milled at Noranda's Mattagami mill. Proven reserves at Estrades are 941 400 t grading 10.7% zinc, 0.94% copper, 0.92% lead, 182 g/t silver and 5.6 g/t gold.

Abcourt Mines Inc.'s Abcourt mine near Barraute closed at the end of March due to exhaustion of reserves.

Deak Resources Corporation is seeking financing to bring the former producing MacDonald mine, north of Rouyn-Noranda, back into production by mid-1991. Ore from the mine would be milled at Falconbridge's Kidd Creek mill with concentrates likely being shipped to Noranda's CEZ refinery at Valleyfield. The custom milling arrangement would be temporary until Deak Resources could complete a base-metal circuit at its Kerr mill in Virginiatown, Ontario.

The legal dispute between Aur Resources Inc. and Louvem Mines Inc. over the ownership of the Louvicourt massive sulphide project near Val-d'Or was settled in September. The settlement allowed for the commencement of a $4.6 million exploration program which will include drilling of pilot holes in preparation for shaft-sinking in the spring of 1991, environmental and engineering studies and metallurgical testwork. Undiluted geological reserves at Louvicourt presently stand at 33.7 Mt grading 3.6% copper, 1.6% zinc, 19.3 g/t silver and 0.9 g/t gold, using a cutoff of 1% copper equivalence.

Exploration by partners VSM Exploration Inc. and Serem Quebec Inc. on the Grevet project near Lebel-sur-Quévillon continued throughout the year. Reserves at the III and IV zones were increased and a new high-grade zone, the 97 zone, was discovered. The partners have optioned other properties in the vicinity. The preliminary estimated reserve for the III and IV zones is currently 10.2 Mt grading 8.27% zinc, 0.44% copper and 34.8 g/t silver.

Bonanza Métals Inc. has been examining the possible re-opening of the Poirier mine near Joutel at an estimated cost of $13.9 million. Remaining reserves are estimated at 1.1 Mt grading 1.38% copper and 9.05% zinc below the 850 level, and 133 000 t grading 6.17% zinc above the 850 level.

New Brunswick

Eleven hundred workers at Brunswick Mining and Smelting Corporation Limited's Brunswick mine at Bathurst went on strike on July 1, 1990. They were joined by 470 workers from the company's Belledune lead smelter on July 22. The union is demanding higher wages, better benefits and improved health and safety conditions in the smelter. Force majeure was declared by the company on concentrates and refined lead, although management staff have maintained production from both mine and smelter at 25% capacity.

There was still no settlement in the dispute by year-end.

Breakwater Resources Ltd. became owner of the Caribou mine by acquiring former owner, Bathurst Base Metals Ltd. The mine was placed back into production in March after being closed since August 1989. Since re-opening the mine, Breakwater increased the mining rate to 3000 t/d, improved mill recoveries and concentrate grade, and undertook a $30 million development program which included the sinking of a 471-m production shaft. In October, Breakwater suspended operations at Caribou based on projections of falling base-metal prices.

A 10 900 t bulk sample from Stratabound Minerals Corp.'s Captain North Extension zinc-lead-silver deposit was run through the Heath Steele mill. A feasibility study on mining the Captain North Deposit was to be undertaken in late 1990.

Marshall Minerals Corp. announced its intent to sell its wholly owned Restigouche deposit west of Bathurst. The property contains proven reserves of 998 000 t grading 7.72% zinc, 0.32% copper, 5.99% lead, 124 g/t silver and 1.2 g/t gold.

NovaGold Resources Inc. and partner Costigan Gold Corporation intersected high-grade copper-zinc mineralization on their Sewell Brook property near Plaster Rock. Diamond drilling, which continues to delineate the deposit, has identified separate lead-zinc and copper lenses.

Nova Scotia

Westminer Canada Limited began mining the Gays River orebody northeast of Halifax in January at a rate of 725 t/d. Mining operations by the former operator were suspended in 1981 due to grade and ground control problems. Westminer is using a lower-tonnage, more selective mining method to increase grades to the mill.

Newfoundland

Newfoundland Zinc Mines Limited's zinc mine near Daniel's Harbour closed in August due to exhaustion of reserves. The mine, operated by Teck Corporation, had a capacity of 40 000 t/y of zinc in concentrate.

In April, BP Canada Inc. announced a new base-metal discovery at Daniel's Pond 20 km south of Buchans. The discovery is 20 km west of the BP/Noranda Duck Pond deposit where drill indicated reserves of 4.3 Mt grading 3.58% copper, 1.05% lead, 6.73% zinc, 68.3 g/t silver and 1.0 g/t gold will have to be expanded to be economically viable.

CANADIAN RESERVES

Canada remains the world's largest producer of zinc concentrates, accounting for 22% of the Western World total in 1990. The low level of base-metal exploration in the early and mid-1980s resulted in a decline in Canada's reserve base. However, buoyant base-metal prices in recent years have resulted in increased exploration expenditures, which have led to a number of discoveries. Given favourable long-term prices, a number of these could be brought on stream in the next few years. This new capacity would allow Canada to retain its top position in world concentrate production. However, to replace expected declining reserves in the later part of the decade, a high level of base-metal exploration must be maintained.

WORLD DEVELOPMENTS

Western World mine production rose by about 5% in 1990 to 5 322 000 t compared to an increase of 0.7% in 1989. The strongest increases came from the United States and Australia. Lower output from Peru, Canada and several other countries slightly offset these increases.

Europe

European output of zinc concentrates accounted for 17% of Western World production in 1990, down from the previous year. Reduced output came from the 60 000 t/y Black Angel mine in Greenland as operations ceased in August. In Yugoslavia, the 4000 t/y Brskovo mine also closed. A reduction in output also occurred in Sweden despite the commissioning by Boliden Mineral

AB of the Kamkberg and Kedtrask mines with a combined capacity of 7000 t/y and a 1000 t/y expansion at Vielle-Montagne SA's Nygruvan-Knallagruvan mines.

Australia

Australian mine output accounted for 17% of Western World production in 1990. Concentrate production rose for the fourth consecutive year. Pancontinental Mining Ltd. opened its new Thalanga mine in Queensland. Initial production was from an open pit with underground mining to commence in 1991. Capacity will be 48 000 t/y zinc. Also in Queensland, M.I.M. Holdings Limited officially opened the Hilton mine at Mt. Isa with the commissioning of a 750 000 t/y concentrator. The opening of the Hilton mine is part of an eventual 50 000 t/y expansion at Mt. Isa.

At Denehurst Ltd.'s Woodlawn mine in New South Wales, work progressed on a decline to access the Currawong orebody. A capacity increase of 10 000 t/y of contained zinc is planned for 1991 when the Currawong mine comes into production.

In Western Australia, Murchison Zinc Co. Pty. Ltd. opened its Scuddles mine and 800 000 t/y concentrator at Golden Grove. Production at full capacity will be 95 000 t/y of contained zinc. The Broken Hill Proprietary Company Limited expanded capacity at its Cadjebut mine by 20 000 t/y to bring annual production capacity to 65 000 t/y of contained zinc.

Aberfoyle Limited's Hellyer mine in Tasmania, which opened in 1989, neared full capacity of 25 000 t/y of contained zinc. The plant was debottlenecked to further increase capacity. The output from Hellyer will be offset by the closure in December of Aberfoyle's Que River mine, also in Tasmania.

United States

Production of zinc concentrates from the United States represented 10% of the Western World total in 1990, up from 5% in 1989. The large increase was due predominantly to the start-up of Cominco Ltd.'s Red Dog mine in Alaska. Lesser contributions were made by expansions at the Pinos Altos and Bunker Hill mines and from several mines which opened in 1989 but which reached full capacity in 1990.

The Red Dog mine, 200 km north of the Arctic Circle, shipped its first concentrates at the end of July. Some technical problems were experienced in the concentrator. When at full capacity in 1991, Red Dog is expected to produce 325 000 t/y of contained zinc in concentrates. Red Dog, with reserves of 77 Mt grading 17.1% zinc, 5.0% lead and 82 g/t silver, is being mined at a rate of 5450 t/d.

Bunker Hill Mining Company (U.S.) Inc.'s mine at Kellogg, Idaho undertook an expansion of 11 000 t/y of contained zinc in an attempt to lower operating costs. Cyprus Minerals Company announced plans to increase zinc production at its Pinos Altos mine in New Mexico by 6000 t/y of contained zinc in concentrates. Late in the year, Equinox Resources Ltd. announced that it had begun mine construction at its Van Stone project in Washington with start-up scheduled for February 1991. The mine will produce 15 000 t/y of contained zinc in concentrates.

Peru

Peru's mine output for the year represented 11% of the Western World total. As in 1989, production was plagued by continued rampant inflation, political instability, drought and shortages of foreign exchange.

Labour disputes affected production at: Cia. Minera San Ingnacio de Morococha, S.A.'s San Vicente mine; Centromin Perú S.A.'s Cerro de Pasco, Yauricocha and Morococha mines; and Minera de Santa Luisa S.A.'s Huanzala mine. Sabotage by terrorists also disrupted production at Centromin's Casapalca mine.

The Arcata mine of Minas de Arcata S.A. expanded its operation by 2500 t/y of contained zinc. Minero Peru Comercial SA opened its new Iscaycruz mine with a capacity of 1500 t/y of contained zinc.

SMELTING

Western World production of refined zinc reached 5 169 000 t in 1990, a slight decrease from the 1989 level. Limited new smelter capacity came on stream during the year but this was offset by disruptions in several countries due to technical problems and labour disputes. Smelter capacity utilization worldwide was over 90%. Increases in metal production took place in all regions except the Americas where a small increase in the United States was more than offset by decreases in Canada and Peru.

Europe

European refined zinc production rose in 1990. In Belgium, debottlenecking of Vielle-Montagne SA's Balen electrolytic refinery added 20 000 t/y of capacity. The Overpelt refinery operated at 75% capacity in January when a rectifier failed, but was back to normal in mid-February. Technical problems continued to plague German smelters. Production at Ruhr-Zink GmbH's Datteln plant was reduced due to upgrading for environmental improvements and capacity expansion. Damages to a sinter machine and a brick-lined condenser caused temporary closures at Metallgesellschaft AG's Duisburg smelter and refinery. M.I.M. Holdings Limited of Australia announced its intention to purchase a 50% stake in the Duisburg plant.

Italian State holding company GEPI, bought Metaleurop S.A.'s 51% interest in Pertusola Sud SpA which operates the 100 000 t/y Crotone smelter. The move is part of the government's plan to nationalize the Italian zinc industry.

Peru

The economic, political and technical problems which affected Peruvian mine output in 1990 also influenced metal production. State-owned Centromin Perú S.A. declared force majeure in January during a ten-day strike at its Oroya smelter. Minero Peru Comercial SA's 102 000 t/y Cajamarquilla refinery operated well below capacity for much of the year due to power shortages, a lack of spare parts, terrorist activity and a six-week strike in August and September. The company declared a four-week force majeure due to roaster damage caused by the power shortages. The damage resulted in a loss of 20 000 t of production.

Australia

Pasminco Ltd. undertook a modernization program to increase output by 20 000 t at its 200 000 t/y Risdon smelter in Tasmania. The company announced that it had deferred an A$275 million, 100 000 t expansion program due to production and environmental problems. The Risdon plant lost about 8000 t of production due to storage tank explosions and a five-day strike over restructuring of the workforce.

Japan

M.I.M. Holdings Limited, together with Nippon Mining Company Limited and Mitsui Mining & Smelting Co. Ltd., announced that they plan to launch a feasibility study to construct a 120 000 t/y smelter/refinery on the island of Hokkaido. Also planned is an 84 000 t/y expansion by Dowa Mining Co. Ltd. at its Iijima smelter. Continued strong demand for zinc in Japan, because of greater use of galvanized steel, was the principal reason for consideration of the smelter projects.

CONSUMPTION AND USES

Western World consumption reached 5 208 000 t in 1990, a slight decrease from the 1989 level, after seven years of steady growth following the 1981/82 recession. Decreased demand due to economic downturns in North America, Brazil and the United Kingdom was offset by increases in continental Europe and in Asia. Zinc is used extensively in the automobile and construction industries for corrosion protection and is greatly affected by the fortunes of these activities. Zinc remains the most cost-effective means of protecting steel against corrosion. Use of zinc for galvanizing has grown steadily in recent years and this trend is expected to continue in the future.

Zinc is widely used because of its special qualities. These are: its low melting point which facilitates shaping by casting; its high electrochemical activity which provides cathodic corrosion and contact protection (galvanizing) for iron and steel products; and its ability to alloy readily with copper to make brass. About 46% of zinc consumption is in galvanizing. The automotive industry is the largest consumer of galvanized steel. Consumer demand for increased corrosion protection has resulted in car makers using more zinc-coated steel in bodywork. Zinc coatings are applied by electro-galvanizing for exposed painted parts requiring high surface quality, and by hot-dip galvanizing for unpainted parts.

Galvanized steel is used in construction for structural components, roofing, siding and reinforcing bars. Zinc and zinc-aluminum thermally sprayed coatings are utilized for long-term corrosion protection of large steel structures such as bridges and hydroelectric transmission towers. The manufacture of brass and bronze is the second most important use of zinc, accounting for 20% of consumption. These alloys are used in plumbing fittings, heating and air conditioning components and other products. The third most important use of zinc is in the die-casting industry for products such as builders' hardware and automobile fittings. The development of new alloys and manufacturing techniques, such as thin-walled die-casting, has taken place in recent years to make zinc alloy castings more competitive relative to plastics and other substitute materials. The balance of zinc consumption is for items such as zinc semi-manufactures, oxides, chemicals and zinc dust. Zinc oxide is an important component in the manufacture of tires and rubber products.

Galfan, a zinc alloy developed by the International Lead-Zinc Research Organization, Inc. (ILZRO), continues to outperform normal galvanized steel and other coatings, such as Galvalume, in corrosion protection. Galfan, which contains 90% zinc, 5% aluminum and a small but significant amount of rare earth elements, was first used commercially in Japan in 1983. There is a growing acceptance of this alloy and worldwide production is expected to approach 300 000 t in 1990. Another advantage is that only minor modifications are necessary to adapt existing galvanizing lines to Galfan, compared to the major cost of converting a line to Galvalume (55% aluminum, 43.4% zinc and 1.6% silicon).

INTERNATIONAL LEAD AND ZINC STUDY GROUP

The International Lead and Zinc Study Group was formed in 1959 to improve market information and to provide opportunities for regular inter-governmental consultations on lead and zinc markets. Particular attention is given to providing regular and frequent information on supply and demand and its probable development.

The Study Group is headquartered in London, England. Its membership includes most major lead- and zinc-producing and consuming countries. While it has an extensive information-gathering and dissemination role, the Group has no market intervention powers. It holds a general session each year in the fall. Member countries' delegations include industry representatives as advisors. Canada has been an active member since its inception, and chaired the Group in 1988 and 1989.

The 35th Session of the Study Group was held in Geneva, Switzerland, in October 1990 and was attended by representatives of 30 member countries as well as by observers from several nations and organizations. In addition to statistical trends and the economic outlook for lead and zinc, the 1990 session stressed environmental issues of concern to the industry.

PRICES AND STOCKS

Zinc prices remained strong throughout the first half of 1990, sustaining the high levels of the previous two years before falling in the second half of the year. The average price for 1990 was US69¢/lb with the year's highest price of 84.8¢ recorded in May and the lowest price being 56.1¢ at the end of November.

Zinc prices on the London Metal Exchange (LME) began the year at about US60¢/lb and fell to 56.8¢ in mid-January. Prices then rose to the year's high in mid-May due to tightness in the concentrate market, technical problems at mines and smelters, strong demand and low stocks. Concerns about upcoming labour negotiations kept prices high through June and early July. When an early settlement of the Trail dispute became evident, the price dropped, reaching 67.2¢ on July 30. Despite the drop after the Trail settlement, zinc prices remained fairly high until mid-September when they began dropping again in response to basic market fundamentals of weakening demand, rising stocks and projections of an oversupply in 1991. Zinc dropped to 56.1¢ at the end of November, the lowest price since the LME switched to Special High Grade zinc in September 1988. It closed out the year at 56.7¢/lb.

All Canadian slab zinc producers began quoting LME-based prices during the year and were joined by most U.S. producers. The switch to LME-based prices caused much concern among consumers who feared that price volatility would lead to lower demand and an increase in the use of substitute materials. Many consumers, in particular zinc die-casting alloyers, found themselves struggling with fluctuating prices because of their inexperience at hedging. Like the North American zinc suppliers, many began basing their prices on LME prices for Special High Grade zinc. The LME contract for High Grade zinc was terminated in March.

Total reported stocks of refined zinc stood at 592 000 t at the end of 1989, which represented 4.8 weeks of metal consumption. Stocks steadily declined throughout the first half of 1990, falling to 3.5 weeks of consumption at the end of June. Stocks then rose, reaching 520 000 t by year-end, still well below the level at the beginning of the year.

HEALTH AND ENVIRONMENT

Canada's four zinc smelters all use roast-leach-electrolysis technology. Three of these smelters recover a high percentage of the sulphur contained in the original feed as sulphuric acid or elemental sulphur. The proposed modernization of Hudson Bay Mining and Smelting Co., Limited's smelter in Flin Flon will include pressure leach technology which captures sulphur in its elemental form instead of sulphur dioxide. The creation of elemental sulphur in the zinc plant will result in a 25% reduction in sulphur dioxide emissions for the Flin Flon complex, allowing it to meet Manitoba's sulphur dioxide emission regulations.

A high level of interest in the recycling of zinc-bearing materials has taken place in the past few years. The current practice of disposing of these materials in landfill sites creates potentially hazardous environmental problems due to the presence of toxic metals such as cadmium. The decreasing space available for landfill and the associated increases in disposal costs have provided a further incentive for recycling. Zinc-bearing materials include flue dusts from electric arc furnaces in steel mills and sludges from zinc-plating operations. Several pilot-scale processes are now in the testing stage to assess the viability of commercially recycling zinc-bearing materials.

Environmental issues such as metals toxicity, mine-site reclamation, recycling and hazardous waste disposal are having an increasing influence on the metals industry. In an attempt to address environmental issues affecting the zinc industry, twelve primary zinc producers and two non-primary producers from North America have formed the American Zinc Association. The group will be based in Washington and serve as an industry spokesman on environmental issues.

OUTLOOK

The consumption of zinc is strongly influenced by the fortunes of the automobile and construction industries. These, in turn, are affected by the general performance of world economies. Although growth in industrial activity is expected to remain strong in 1991 in continental Europe and in Asia, the economic downturn seen in North America, Brazil and the United Kingdom is expected to continue. Western World zinc consumption could rise by about 1% in 1991, being particularly steady in the galvanizing sector.

A considerable increase in Western World mine production is expected in 1991. New projects in Australia and the United States should reach full operating capacity, and normal production levels are expected to be re-established in Canada upon the resolution of labour disputes and operating difficulties. Due to 1990 production shortfalls in Canada and Peru, however, tightness in the concentrate market may prevail in the first quarter of the year.

Capacity utilization at zinc smelters will remain high because limited additional capacity has come on stream in recent years. A metal surplus of about 200 000-250 000 t is likely for 1991.

Prices, which remained relatively high in the latter part of 1990, are expected to drop in 1991, reflecting an oversupply of metal, weak demand and a return to normal stock levels. The average zinc price for 1991 is forecast to be about US51¢/lb.

In the longer term, zinc consumption in the Western World is projected to grow at an annual average rate of 1.5% to the end of this century. Although zinc use in galvanizing will see steady growth, particularly in the continuous galvanizing line, demand will continue to fall in die-casting where thin-walled die-cast technology is implemented to keep zinc cost-competitive with substitute materials.

In 1991, Canadian mine production should return to normal levels after a year in which the industry faced a number of labour disputes and mine closures. New capacity in the Yukon will help to offset lost production from New Brunswick. Increased base-metal exploration in the late 1980s and in 1990 has resulted in the discovery of several new deposits which could be developed in the early 1990s, given favourable zinc prices.

Note: Information contained in this review was current as of mid-January 1991.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EEC MFN	Japan MFN
2603.00	Copper ores and concentrates						
2603.00.00.30	Zinc content	Free	Free	Free	Free	Free	Free
2607.00	Lead ores and concentrates						
2607.00.00.30	Zinc content	Free	Free	Free	1.3¢/kg on lead content	Free	Free
2608.00	Zinc ores and concentrates						
2608.00.00.30	Zinc content	Free	Free	Free	1.3¢/kg on lead content	Free	Free
2616.10	Silver ores and concentrates	Free	Free	Free	Free	Free	Free
2616.10.00.30	Zinc content	Free	Free	Free	Free	Free	Free
26.20	Ash and residues (other than from the manufacture of iron or steel), containing metals or metallic compounds						
	Containing mainly zinc						
2620.11	Hard zinc spelter	Free	Free	Free	1.2%	Free	Free
2817.00	Zinc oxide; zinc peroxide	10.5%	Free	7.3%	Free	11%	6.5%
28.33	Sulphates; alums; peroxosulphates (persulphates)						
2833.26	Of zinc	9.2%	6%	3.6%	0.9%	9%	5.8%
79.01	Unwrought zinc						
	Zinc, not alloyed						
7901.11	Containing by weight 99.99% or more of zinc	Free	Free	Free	1.2%	3.5%	8 yen/kg
7901.12	Containing by weight less than 99.99% of zinc	Free	Free	Free	15.2%	3.5%	8 yen/kg
7901.20	Zinc alloys						
7901.20.10	Containing by weight 90% or more but less than 97.5% of zinc	Free	Free	Free	15.2%	3.5%	7.2-7.8 yen/kg
7901.20.20	Containing by weight less than 90% of zinc	17.5%	11.5%	12.2%	15.2%	3.5%	7.2-7.8 yen/kg
7902.00	Zinc waste and scrap	Free	Free	Free	Free	Free	1.9%
79.03	Zinc dust, powders and flakes						
7903.10	Zinc dust	Free	Free	Free	0.5¢/kg	4.4%	5.8%
7903.90	Other						
7903.90.10	Powders, not alloyed	4%	Free	2.8%	0.5¢/kg	4.4%	5.8%
7903.90.20	Alloyed powders; flakes	10.2%	6.5%	7.1%	7.6%	4.4%	5.8%

7904.00	Zinc bars, rods, profiles and wires						
7904.00.10	Bars, rods or profiles, containing by weight 90% or more of zinc	Free	Free	Free	3.3%	8%	4.8%
7904.00.21	Bars, rods or profiles; wire, coated or covered	10.2%	6.5%	7.1%	3.3%	8%	4.8%
7904.00.22	Wire, not coated or covered	8%	5%	5.6%	3.3%	8%	4.8%
7905.00	Zinc plates, sheets, strip and foil containing by weight 90% or more of zinc						
7905.00.11	Of a thickness exceeding 0.15 mm but less than 4.75 mm, for making offset printing plates; of a thickness exceeding 0.15 mm but less than 4.75 mm, not polished, coated on one side with acid-resisting material, imported for use by grinders and polishers, to be pepared for use in photo-engraving	Free	Free	Free	3.3%	8%	7.2%
7905.00.19	Other	5.5%	3.5%	3.8%	3.3%	8%	7.2%
7905.00.20	Containing by weight less than 90% of zinc	10.2%	6.5%	7.1%	3.3%	8%	7.2%
7906.00	Zinc tubes, pipes and tube or pipe fittings (for example, couplings, elbows, sleeves)	10.2%	6.5%	7.1%	3.0%	8%	4.8%
79.07	Other articles of zinc						
7907.10	Gutters, roof capping, skylight frames and other fabricated building components	10.2%	6.5%	7.1%	4.5%	8%	4.9%
7907.90	Other						
7907.90.10	Anodes for electroplating	Free	Free	Free	2.7%-4.5%	7%	5.8%
7907.90.20	Discs or slugs, containing by weight 90% or more of zinc	5.5%	3.5%	3.8%	2.7%-4.5%	7%	5.8%
7907.90.90	Other	10.2%	6.5%	7.1%	2.7%-4.5%	7%	5.8%
7907.90.90.11	Not alloyed	10.2%	6.5%	7.1%	2.7%-4.5%	7%	5.8%
7907.90.90.12	Alloyed	10.2%	6.5%	7.1%	2.7%-4.5%	7%	5.8%

Sources: Customs Tariff, effective January 1991, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States effective January 1, 1990; Official Journal of the European Communities, Vol. 33, No. L247, 1990, "Conventional" column; Custom Tariff Schedules of Japan, 1990.
1 GATT rate is shown, lower tariff rates may apply circumstantially.
Note: Where there is a tariff "range" a complete match of the HS code was not available; therefore, the high and low for the product in question is shown.

Zinc

TABLE 1. CANADA, ZINC PRODUCTION AND TRADE, 1989 AND 1990, AND CONSUMPTION, 1987-89

Item No.		1989		1990p	
		(tonnes)	($000)	(tonnes)	($000)
Production					
	All forms[1]				
	Newfoundland	27 362	58 882	21 498	41 426
	Nova Scotia	x	x	x	x
	New Brunswick	201 550	433 736	249 605	480 989
	Quebec	100 638	216 573	103 414	199 279
	Ontario	266 158	572 772	281 131	541 740
	Manitoba	72 096	155 150	73 694	142 008
	Saskatchewan	x	x	x	x
	British Columbia	119 376	256 897	59 103	113 892
	Yukon	154 709	332 934	170 128	327 836
	Northwest Territories	329 001	708 009	317 298	611 434
	Total	1 272 854	2 739 182	1 285 439	2 477 041
	Mine output[2]	1 216 139		1 183 082	
	Refined[3]	669 677		579 000	
Exports				(Jan.-Sept.)	
2608.00.30	Zinc content in zinc ores and concentrates				
	Belgium	226 158	172 586	174 041	133 318
	West Germany	69 688	64 224	84 526	84 035
	Japan	71 971	70 109	52 145	61 483
	South Korea	65 711	64 322	43 055	46 148
	France	30 614	32 618	47 720	44 991
	Italy	32 570	28 072	37 055	35 775
	Netherlands	33 033	33 100	27 665	26 667
	Other countries	78 845	74 858	104 176	81 718
	Total	608 590	539 898	570 383	514 135
2600.00	Zinc content in other ores and concentrates[4]	6 791	7 886	3 444	684
2620.11	Ash and residues containing hard zinc spelter				
	United Kingdom	93	42	219	175
	France	75	29	143	120
	United States	1 217	1 234	26	44
	South Korea	609	144	91	16
	Other countries	53	35	206	133
	Total	2 047	1 487	684	491
2620.19	Ash and residues containing mainly zinc, n.e.s.				
	United States	7 124	4 446	4 240	4 609
	United Kingdom	396	404	531	659
	India	201	97	549	474
	France	315	166	330	210
	Taiwan	192	239	117	156
	South Korea	164	225	58	53
	Other countries	340	255	130	128
	Total	8 731	5 836	5 955	6 294
2817.00	Zinc oxide; zinc peroxide				
	United States	36 698	78 613	21 283	38 053
	U.S.S.R.	3 236	5 369	306	476
	Other countries	92	110	102	206
	Total	40 027	84 094	21 691	38 738
2833.26	Zinc sulphate	147	31	–	–
7901.11	Zinc not alloyed unwrought containing by weight 99.99% or more of zinc				
	United States	138 711	280 905	154 437	290 564
	Japan	4 482	9 242	4 470	8 595
	Taiwan	1 751	4 086	3 212	6 111
	Kenya	694	1 407	701	1 272
	Italy	523	867	546	1 052
	Ecuador	272	565	357	695
	Singapore	549	1 268	299	579
	Philippines	882	1 840	216	439
	Brazil	384	739	179	348
	Portugal	299	534	100	162
	Argentina	1 339	2 623	–	–
	Other countries	1 118	2 462	1 940	3 391
	Total	151 004	306 538	166 457	313 208
7901.12	Zinc not alloyed unwrought containing by weight less than 99.99% of zinc				
	United States	276 379	550 639	129 287	250 926
	Japan	13 940	28 081	11 304	21 622
	Taiwan	8 162	17 289	5 807	10 941
	United Kingdom	11 457	22 772	5 519	9 722
	Indonesia	5 106	9 883	5 213	8 815
	Italy	4 231	8 621	2 965	5 123
	Israel	2 627	5 357	2 508	4 807

TABLE 1 (cont'd)

Item No.		1989 (tonnes)	1989 ($000)	Jan.-Sept. 1990P (tonnes)	Jan.-Sept. 1990P ($000)
Exports (cont'd)					
	Philippines	3 307	6 848	2 070	3 824
	Singapore	2 185	4 402	1 501	2 591
	New Zealand	8 786	15 480	581	1 111
	Greece	1 691	3 237	698	1 018
	Other countries	6 186	12 705	5 869	10 417
	Total	344 057	685 314	173 322	330 917
7901.20	Zinc alloys unwrought				
	Hong Kong	2 370	4 764	1 212	2 189
	People's Republic of China	1 032	2 194	375	701
	Malaysia	804	1 730	121	234
	Philippines	650	1 525	122	186
	United States	1 679	3 226	94	147
	Taiwan	1 636	3 646	59	116
	Indonesia	2 096	4 526	39	69
	United Kingdom	1 788	3 638	–	–
	Japan	1 254	2 741	–	–
	Other countries	470	1 054	554	899
	Total	13 779	29 044	2 576	4 541
7902.00	Zinc waste and scrap				
	United States	4 255	3 884	20 465	10 585
	Taiwan	4 098	3 592	5 057	4 506
	People's Republic of China	2 196	568	1 061	255
	Other countries	871	465	570	466
	Total	11 420	8 514	27 154	15 818
7903.10	Zinc dust				
	United States	4 894	12 488	3 802	8 829
	Other countries	293	438	250	416
	Total	5 187	12 928	4 052	9 245
7903.90	Zinc powders and flakes				
	United States	9	41	329	743
	Taiwan	25	35	–	–
	South Korea	5	52	–	–
	France	78	63	–	–
	Other countries	–	–	18	14
	Total	116	193	348	757
7904.00	Zinc bars, rods, profiles and wire				
	United States	–	–	59	290
	Bolivia	231	171	–	–
	Other countries	20	6	–	–
	Total	251	177	59	290
7905.00	Zinc plates, sheets, strip and foil				
	United States	51	186	53	194
	Other countries	3	11	1	1
	Total	54	198	54	196
7906.00	Zinc pipes or tubes and fittings				
	United States	65	207	18	151
	Other countries	9	51	4	11
	Total	74	258	22	163
7907.90	Articles of zinc, n.e.s.				
	United States	2 231	3 287	946	5 474
	Brazil	139	265	–	–
	United Kingdom	146	225	...	9
	People's Republic of China	257	66	–	–
	Other countries	507	1 130	2	26
	Total	3 281	4 986	948	5 512
Imports					
2608.00.00.30	Zinc content in zinc ores and concentrates	34 605	36 108	87 094	111 166
2603.00.00.30	Zinc content in copper ores and concentrates	451	953	637	1 032
2607.00.00.30	Zinc content in lead ores and concentrates	2 865	5 022	3 074	4 494
2620.19	Ash and residues containing mainly zinc, n.e.s.	293	213	389	287
2817.00	Zinc oxides; zinc peroxide	1 917	2 272	1 729	2 387
2833.26	Zinc sulphate	2 682	1 531	1 997	1 072
7901.11	Zinc not alloyed unwrought containing by weight 99.99% or more of zinc	934	1 912	2 416	4 683
7901.12	Zinc not alloyed unwrought containing by weight less than 99.99% of zinc	574	1 172	2 145	4 331
7901.20	Zinc alloys unwrought	3 219	7 111	3 567	7 218
7902.00	Zinc waste and scrap	1 379	1 588	1 417	1 614
7903.10	Zinc dust	658	1 440	474	1 027
7903.90	Zinc powders and flakes	269	678	202	468
7904.00	Zinc bars, rods, profiles and wire	817	2 046	1 976	4 316
7905.00	Zinc plates, sheets, strip and foil	534	1 391	422	1 241
7906.00	Zinc pipes or tubes and fittings	654	2 767	1 114	4 011
7907.90	Articles of zinc, n.e.s.	2 378	9 593	1 441	5 434
	Total	54 229	75 797	110 094	154 781

TABLE 1 (cont'd)

	1987			1988			1989		
	Primary	Secondary[5]	Total	Primary	Secondary[5]	Total	Primary	Secondary[5]	Total
				(tonnes)					
Consumption[5]									
Zinc used for or in the production of:									
Copper alloys (brass, bronze, etc.)	10 848	–	10 848	7 338	–	7 338	3 552	–	3 552
Galvanizing: electro	4 552	–	4 552	4 879	–	4 879	4 853	–	4 853
hot dip	65 060	x	x	73 315	x	x	73 910	x	x
Zinc die-cast alloy	15 265	x	x	22 264	x	x	22 062	x	x
Other products (including rolled and ribbon zinc, zinc oxides)	28 746	x	x	34 022	x	x	33 538	x	x
Total	124 471	7 188	131 569	141 818	8 987	150 805	137 915	8 390	146 305
Consumer stocks, year-end	14 164	535	14 699	12 293	761	13 054	13 344	327	13 671

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] New refined zinc produced from domestic primary materials (concentrates, slags, residues, etc.) plus estimated recoverable zinc in ores and concentrates shipped for export. [2] Zinc content of ores and concentrates produced. [3] Refined zinc produced from domestic and imported ores. [4] Includes H.S. classes 2603.00.30 and 2607.00.30. [5] Consumer survey does not represent 100% of Canadian consumption and is therefore consistently less than apparent consumption.
[p] Preliminary; – Nil; x Confidential; n.e.s. Not elsewhere specified; . . . Amount too small to be expressed.
Note: Totals may not add due to rounding.

TABLE 2. CANADA, ZINC PRODUCTION, EXPORTS[1] AND DOMESTIC SHIPMENTS, 1970, 1975, 1980 AND 1983-90

	Production		Exports		
	All Forms[2]	Refined[3]	In Ores and Concentrates	Refined	Total
			(tonnes)		
1970	1 135 714	417 906	809 248	318 834	1 128 082
1975	1 055 151	426 902	705 088	247 474	952 562
1980	883 697	591 565	434 178	471 949	906 127
1983	987 713	617 033	626 178	500 448	1 126 626
1984	1 062 701	689 841	539 633	529 659	1 069 292
1985	1 049 275	692 406	396 103	555 621	951 724
1986	988 173	570 981	450 249	427 176	877 425
1987	1 157 936	609 909	613 185	441 227	1 054 412
1988	1 370 000	703 206	816 884[r]	551 521[r]	1 368 405[r]
1989	1 272 854	669 677	615 381	495 061	1 110 442
1990[p]	1 285 439	579 000	575 876[a]	339 779[a]	915 655

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Beginning in 1988 exports are based on the new Harmonized System and may not be in complete accordance with previous method of reporting. Ores and concentrates include HS classes 2608.00.30, 2603.00.30 and 2607.00.30. Refined includes HS classes 7901.11 and 7901.12. [2] New refined zinc produced from domestic primary materials (concentrates, slags, residues, etc.) plus estimated recoverable zinc in ores and concentrates shipped for export. [3] Refined zinc produced from domestic and imported ores.
[a] Exports are January-September figures; [p] Preliminary; [r] Revised.

TABLE 3. WESTERN WORLD, PRIMARY ZINC STATISTICS, 1986-90

	1986	1987	1988	1989	1990
			(000 tonnes)		
Mine production (zinc content)	5 067	5 343	5 053	5 088	5 322
Metal production	4 855	5 058	5 240	5 217	5 169
Metal consumption	4 890	5 047	5 293	5 233	5 208

Source: International Lead and Zinc Study Group.

TABLE 4. WESTERN WORLD ZINC MINE PRODUCTION, 1988-90

	1988	1989	1990p
		(000 tonnes)	
Europe			
Germany, Federal Republic of	75	64	62
Ireland	177	169	170
Spain	278	266	259
Sweden	193	164	151
Yugoslavia	71	68	56
Others	271	260	233
Total	1 065	991	931
Africa			
South Africa[1]	90	77	76
Zaire	76	75	75
Zambia	30	28	30
Others	65	79	82
Total	261	259	263
Oceania			
Australia	739	811	918
Americas			
Brazil	99	100	106
Canada	1 347	1 215	1 183
Mexico	288	284	301
Peru	485	598	582
United States	256	288	536
Others	100	163	138
Total	2 575	2 648	2 846
Asia			
Japan	147	132	125
Others	266	247	239
Total	413	379	364
Total Western World	5 053	5 088	5322

Source: International Lead and Zinc Study Group.
[1] Includes Namibia.
p Preliminary.

TABLE 5. WESTERN WORLD ZINC METAL PRODUCTION, 1988-90

	1988	1989	1990
		(000 tonnes)	
Europe			
Belgium	298	287	303
Finland	156	163	168
France	274	266	274
Germany, Federal Republic of	356	353	335
Italy	242	246	244
Netherlands	210	203	209
Norway	122	121	120
Spain	256	257	262
United Kingdom	77	80	95
Yugoslavia	129	121	123
Others	31	31	11
Total	2 151	2 127	2 144
Africa			
South Africa[1]	85	85	92
Zaire	61	54	55
Others	58	41	42
Total	204	180	189
Americas			
Argentina	33	32	30
Brazil	139	156	161
Canada	703	670	580
Mexico	191	194	203
Peru	125	138	94
United States	330	358	368
Total	1 521	1 548	1 436
Asia			
Japan	678	665	687
Korea, Republic of	224	240	255
Others	160	163	158
Total	1 062	1 068	1 100
Oceania			
Australia	302	294	300
Total Western World	5 240	5 217	5 169

Source: International Lead and Zinc Study Group.
[1] Includes Namibia.

TABLE 6. WESTERN WORLD ZINC CONSUMPTION, 1988-90

	1988	1989	1990
		(000 tonnes)	
Europe			
Belgium	175	175	185
France	290	279	290
Germany, Federal Republic of	450	453	460
Italy	254	262	262
Spain	127	116	119
United Kingdom	193	195	190
Yugoslavia	118	107	100
Others	248	259	252
Total	1 855	1 846	1 858
Africa			
South Africa[1]	88	98	98
Others	67	72	72
Total	155	170	170
Oceania			
Australia	90	88	78
New Zealand	18	20	23
Total	108	108	101
Americas			
Brazil	143	155	120
Canada	165	151	140
Mexico	116	105	110
United States	1 089	1 059	1 010
Others	166	136	120
Total	1 679	1 606	1 500
Asia			
India	142	135	142
Japan	774	769	801
Korea, Republic of	173	196	227
Others	407	403	409
Total	1 496	1 503	1 579
Total Western World	5 293	5 233	5 208

Source: International Lead and Zinc Study Group.
[1] Includes Namibia.

TABLE 7. CANADA, PRIMARY ZINC METAL CAPACITY, 1990

Company and Location	Annual Rated Capacity
	(000 tonnes of slab zinc)
Canadian Electrolytic Zinc Limited (CEZ)	
Valleyfield, Quebec	230
Falconbridge Limited	
Timmins, Ontario	133
Hudson Bay Mining and Smelting Co., Limited (HBMS)	
Flin Flon, Manitoba	82
Cominco Ltd.	
Trail, British Columbia	300
Canada Total	745

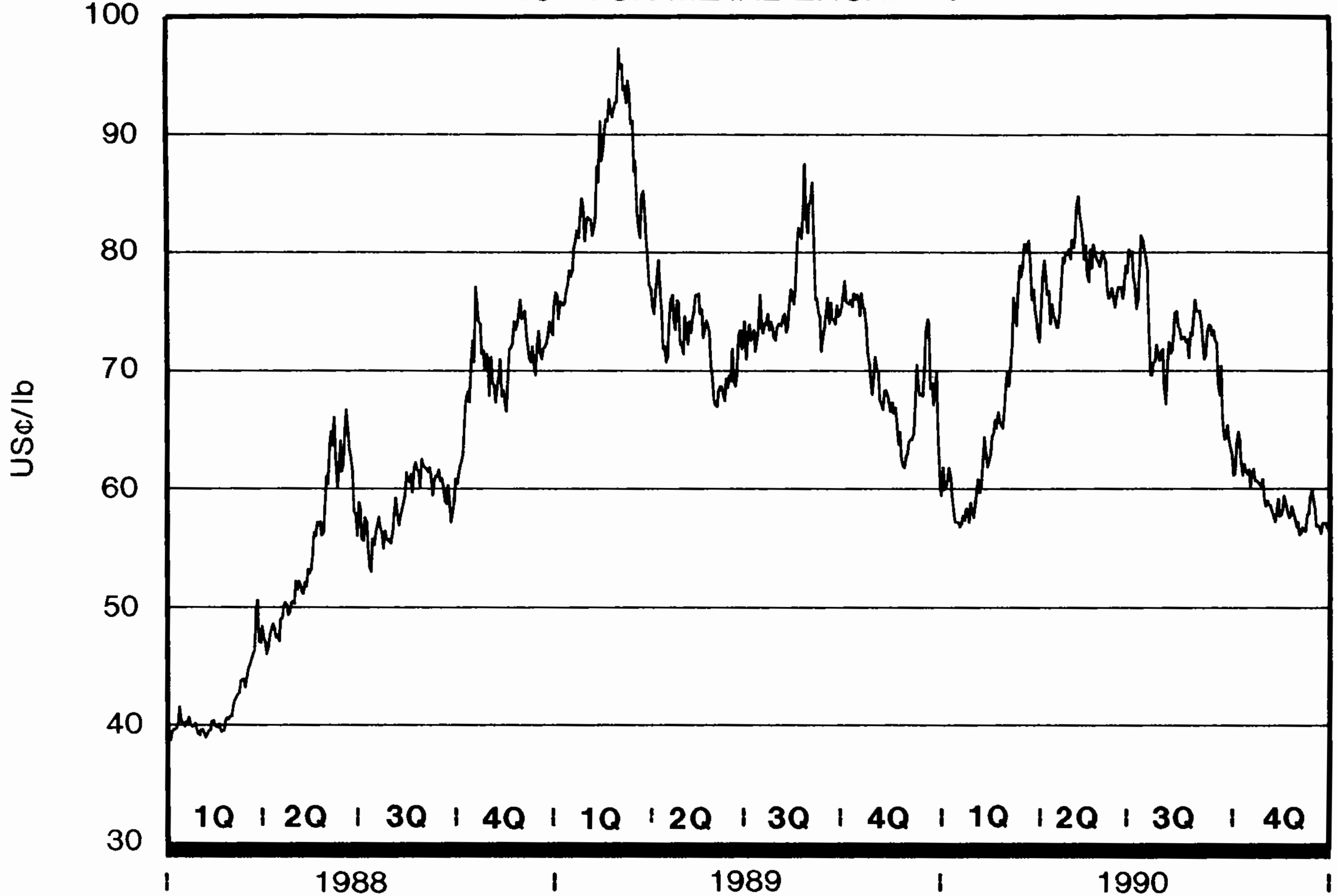
TABLE 8. MONTHLY AVERAGE ZINC PRICES, 1989 AND 1990

	American Producer High Grade	LME Special High Grade Settlement
	(US¢/lb)	
1990		
January	67.9	58.7
February	65.9	63.3
March	76.9	75.6
April	81.7	76.5
May	85.3	80.6
June	87.3	77.8
July	87.3	74.3
August	84.1	73.3
September	84.3	69.8
October	75.5	61.4
November	70.0	58.0
December	70.0	57.4
Year Average	78.0	68.9
1989		
January	70.5	78.7
February	83.5	87.7
March	95.0	89.0
April	88.9	75.2
May	85.7	73.9
June	80.5	69.8
July	80.0	73.3
August	82.4	78.5
September	81.1	73.9
October	79.9	71.9
November	76.3	65.2
December	73.0	66.0
Year Average	81.5	75.2

Sources: Metals Week; Reuters.

DAILY ZINC PRICES 1988–90

LONDON METAL EXCHANGE



Principal Canadian Nonferrous and Precious Metal Mine Production in 1989, with Highlights for 1990

PRINCIPAL CANADIAN NONFERROUS AND PRECIOUS METAL MINE PRODUCTION IN 1989, WITH HIGHLIGHTS FOR 1990

Company and Mine/Mill Location	Capacity	Grades of Ore Milled						Ore Milled	Metal Contained in All Concentrates Produced						1990 Highlights
		Cu	Ni	Pb	Zn	Ag	Au		Copper	Nickel	Lead	Zinc	Silver	Gold	
	(tonnes per day)	(percent)				(grams/tonne)		(tonnes)	(tonnes)				(kilograms)		
NEWFOUNDLAND															
Hope Brook Gold Inc. Hope Brook mine Couteau Bay	3 140	–	–	–	–	0.41	4.11	735 541	–	–	–	–	236	2 623	A new system for treatment of effluents was installed in 1990.
Newfoundland Zinc Mines Limited Daniel's Harbour	1 450	–	–	–	7.10	–	–	435 137	–	–	–	30 339	–	–	Mine closed in August 1990 due to exhaustion of reserves.
NOVA SCOTIA															
Rio Algom Limited East Kemptville	9 000	0.09	–	–	0.22	–	–	3 323 601	318	–	–	477	–	–	Zinc produced as a by-product of tin mining.
Westminer Canada Limited Gays River mine	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Mine re-opened early 1990 after being closed since 1982.
NEW BRUNSWICK															
Breakwater Resources Ltd. Caribou mine Bathurst	2 500	0.33	–	3.05	6.44	96.69	1.41	258 548	352	–	2 586	9 176	6 227	54	Breakwater Resources acquired ownership in 1990 and suspended operations in October due to unfavorable market conditions.
Brunswick Mining and Smelting Corporation Limited, No. 12 mine Bathurst	10 250	0.40	–	3.48	8.89	109.8	–	3 022 622	9 248	–	74 165	222 388	291 892	–	Workers walked out in July with strike continuing into 1991.
Gordex Minerals Limited Cape Spencer	635	–	–	–	–	0.07	1.99	25 495	–	–	–	–	1	35	Mine closed in 1989 due to low gold prices.
Noranda Inc. Heath Steele and Stratmat mine Bathurst	2 500	0.57	–	2.35	6.50	63.19	–	203 482	722	–	3 348	10 202	7 434	–	
NovaGold Resources Inc. Murray Brook mine Bathurst	907	–	–	–	–	61.71	1.85	98 430	–	–	–	–	1 033	119	Production began September 1989.
QUEBEC															
Abcourt Mines Inc. Abcourt mine Barraute	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Mine closed March 1990 due to exhaustion of reserves.
Agnico-Eagle Mines Limited Joutel Division Joutel	1 630	–	–	–	–	1.95	6.48	381 044	–	–	–	–	635	2 240	A promising gold mineralized zone was intersected adjacent to the mine.
La Ronde mine Cadillac	1 996	0.15	–	–	–	6.55	4.66	629 427	729	–	–	–	3 960	2 641	
American Barrick Resources Corporation Camflo Division Val-d'Or	1 210	–	–	–	–	0.24	3.46	443 289	–	–	–	–	97	1 434	Reserves expected to last for two more years. Exploration program is being carried out to find new reserves.

Audrey Resources Inc. Mobrun mine Rouyn–Noranda	1 440	0.70	–	–	2.40	19.37	1.96	124 284	760	–	–	2 740	118	85	
Aurizon Mines Ltd. Sleeping Giant mine Val–d'Or	900	–	–	–	–	8.43	6.79	143 159	–	–	–	–	1 085	917	Mining operations were suspended because of low gold prices.
Bachelor Lake Gold Mines Inc. Desmaraisville	450	–	–	–	–	0.48	5.06	83 188	–	–	–	–	36	392	Closed temporarily in 1989.
Belmoral Mines Ltd. Ferderber mine and Dumont mine Val–d'Or	1 360	–	–	–	–	1.06	6.99	216 507	–	–	–	–	203	1 446	Aur Resources acquired 50% of this operation.
BP Resources Canada Limited Les Mines Selbaie A–1 open pit, B and A–2 underground mines Joutel	6 760	0.96	–	0.11	2.10	49.13	0.45	2 736 459	24 572	–	–	52 301	98 287	957	
Breakwater Resources Ltd. Estrades mine Mattagami	–	–	–	0.15	4.20	71.59	0.17	139 706	–	–	121	5 338	8 479	7	Mine opened in 1990 ore milled at Noranda's Mattagami Mill.
Cambior inc. Pierre Beauchemin mine Rouyn	1 152	–	–	–	–	0.75	4.35	390 851	–	–	–	–	252	1 601	
Lucien E. Béliveau mine Val–d'Or	1 597	–	–	–	–	–	3.70	126 552	–	–	–	–	–	442	
Chimo mine Val–d'Or	770	–	–	–	–	0.66	4.87	49 608	–	–	–	–	16	217	Cambior inc. acquired a 100% interest in Chimo in 1990.
Campbell Resources Inc. Joe Mann, Cedar Bay and S-3 mines, common mill	3 175	0.42	–	–	–	5.59	6.00	340 136	1 404	–	–	–	1 329	1 850	The S-3 mine shut down in 1990 because of exhaustion of reserves.
Inco Gold Company Mines Casa Berardi La Sarre	1 200	–	–	–	–	1.11	5.49	335 540	–	–	–	–	335	1 666	Golden Pond West opened in 1990.
LAC Minerals Ltd.–Cambior inc. Joint Venture Cadillac	3 130	–	–	–	–	0.17	6.75	1 143 053	–	–	–	–	182	7 300	
LAC Minerals Ltd. Est–Malartic Division Malartic	2 000	–	–	–	–	0.58	2.91	567 172	–	–	–	–	288	1 521	
Terrains Aurifères Division Cadillac	1 590	–	–	–	–	0.82	5.72	465 204	–	–	–	–	327	2 439	
Minnova Inc. Lake Dufault Division Ansil mine Noranda	1 450	7.22	–	–	–	25.5	1.88	217 724	15 144	–	–	–	4 342	350	
Lake Shortt Division Desmaraisville	1 150	–	–	–	–	0.16	3.87	347 140	–	–	–	–	50	1 239	
Opemiska Division Perry, Springer and Cooke mines Chapais	2 800	1.29	–	–	–	11.66	2.23	382 000	4 739	–	–	–	3 755	755	
Muscocho Explorations Ltd. Montauban mine Montauban	400	–	–	–	–	75.19	3.74	120 021	–	–	–	–	2 725	375	Mine shut down in 1990 due to exhaustion of reserves.

PRINCIPAL CANADIAN NONFERROUS AND PRECIOUS METAL MINE PRODUCTION IN 1989, WITH HIGHLIGHTS FOR 1990 (cont'd)

Company and Mine/Mill Location	Capacity	Grades of Ore Milled						Ore Milled	Metal Contained in All Concentrates Produced						1990 Highlights
		Cu	Ni	Pb	Zn	Ag	Au		Copper	Nickel	Lead	Zinc	Silver	Gold	
	(tonnes per day)	(percent)				(grams/tonne)		(tonnes)	(tonnes)				(kilograms)		
QUEBEC (cont'd)															
Noranda Inc.															
Division Mines Gaspé E zone Murdochville	10 002	1.68	–	–	–	14.0	0.07	689 670	10 918	–	–	–	8 206	12	New E-29 orebody will extend the life of the mine to year 2003.
Horne Division Rouyn–Noranda	3 860	0.70	–	–	–	6.86	8.26	113 897	496	–	–	–	219	502	
Mattagami Division Isle Dieu and Norita mines Matagami	4 175	1.31	–	0.30	16.70	65.59	0.38	314 345	3 919	–	722	50 573	16 255	109	
Placer Dome Inc.															
Sigma mine	1 335	–	–	–	–	0.82	5.01	451 121	–	–	–	–	334	2 150	
Kiena mine Val-d'Or	1 250	–	–	–	–	0.72	4.53	470 829	–	–	–	–	323	2 060	
Société Minière Sphinx Inc. Duvay mine Amos	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Started in 1990.
Westminer Canada Limited Copper Rand and Portage mines Chibougamau	3 080	1.63	–	–	–	8.82	4.49	413 366	6 600	–	–	–	2 459	1 685	Company lockout resulted in closure of mines in May 1990. Portage mine re-started in October while Copper Rand mine resumed production in November.
ONTARIO															
Agnico-Eagle Mines Limited Silver Division Cobalt	245	–	–	–	–	617.14	–	45 630	–	–	–	–	25 306	–	Closed in 1989.
American Barrick Resources Corporation Holt–McDermott mine Kirkland Lake	1 350	–	–	–	–	0.34	4.11	507 251	–	–	–	–	148	1 971	
Bond Gold Canada Inc. Pickle Lake	250	–	–	–	–	3.33	23.62	110 677	–	–	–	–	332	2 311	
Canamax Resources Inc.															
Kremzar mine Wawa	550	–	–	–	–	0.31	4.22	191 015	–	–	–	–	48	754	The Kremzar mine was put under care and maintenance because of low gold prices.
Bell Creek mine Timmins	400	–	–	–	–	0.51	6.96	132 054	–	–	–	–	58	864	
Citadel Gold Mines Inc. Surlaga mine Wawa	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Mine closed end of 1989.
Corona Corporation Renabie mine Wawa	635	–	–	–	–	1.20	6.62	229 237	–	–	–	–	234	1 386	
Dickenson Mines Limited Red Lake	907	–	–	–	–	1.37	10.63	251 290	–	–	–	–	289	2 372	

Eastmaque Gold Mines Ltd. Kirkland Lake	2 270	–	–	–	–	0.82	1.51	698 532	–	–	–	–	326	602	
ERG Resources Inc. Timmins	40 000	–	–	–	–	0.34	0.45	5 443 108	–	–	–	–	655	970	Production stopped in 1990 because of lower than expected head grade and mill recovery.
Falconbridge Limited															
Sudbury operations (5 mines) Falconbridge and Strathcona mills	9 075	1.05	1.35	–	–	4.63	0.12	2 630 836	26 700	31 242	–	–	9 987	258	East mine closed in 1990.
Timmins operations	13 500	3.0	–	0.10	5.0	51.43	–	4 138 577	120 434	–	2 928	185 635	183 622	–	Work continuing on the development of new No. 3 mine.
Kidd Creek Gold Hoyle Pond mine Owl Creek mine	540	–	–	–	–	5.14	13.71	173 824	–	–	–	–	440	2 218	
Giant Yellowknife Mines Limited															Schumacher mine closed in 1989 and Hoyle mine opened in 1990. Royal Oak Resources Inc. purchased control of the Pamour Group of Companies.
Pamour No. 1 mill	2 900	–	–	–	–	1.03	2.79	1 115 837	–	–	–	–	360	2 211	
Shumacher mill	2 585	0.03	–	–	–	2.95	2.54	134 865	28	–	–	–	278	308	
Golden Shield Resources Ltd. Kerr mine Virginiatown	1 225	–	–	–	–	0.24	3.90	166 922	–	–	–	–	35	559	The Kerr mine was partly reactivated in 1990.
Hemlo Gold Mines Inc. Golden Giant mine Marathon	3 000	–	–	–	–	1.23	11.90	1 020 002	–	–	–	–	554	11 769	
Inco Limited Sudbury and Shebandowan	57 517	1.03	1.15	–	–	5.90	0.38	11 582 209	111 039	107 416	–	–	52 951	2 623	
Lac d'Amiante du Québec, Ltée (LAQ) Aquarius mill	270	–	–	–	–	0.99	7.82	38 287	–	–	–	–	31	267	
LAC Minerals Ltd. Macassa Division															
Macassa Circuit	455	–	–	–	–	2.61	17.90	149 923	–	–	–	–	293	2 567	
Tailing Circuit	680	–	–	–	–	1.47	2.95	150 741	–	–	–	–	100	281	Close in 1990.
Minnova Inc. Winston Lake mine Winston Lake	1 000	0.92	–	–	15.76	31.99	1.08	303 000	2 563	–	–	45 832	6 870	184	Zinc-copper gold mine and 1000 t/d mill opened in 1988 achieved full production in 1989.
Muscocho Explorations Ltd. Wawa	405	–	–	–	–	10.29	5.90	127 202	–	–	–	–	127	719	
Noranda Inc.															
Geco Division Manitouwadge	3 810	1.46	–	–	2.76	42.86	0.11	1 357 602	18 231	–	–	30 752	40 723	72	
Lyon Lake Division Ignace	2 788	1.25	–	1.0	9.0	156.69	0.45	341 827	3 815	–	2 992	29 688	46 080	120	
Orofino Resources Limited Scadding Twp.	120	–	–	–	–	–	5.59	36 623	–	–	–	–	–	182	
Placer Dome Inc.															
Campbell mine Red Lake	1 089	–	–	–	–	1.92	22.83	381 925	–	–	–	–	696	8 332	
Detour Lake mine N.E. Ontario	2 185	–	–	–	–	1.82	5.31	816 466	–	–	–	–	1 325	4 046	
Dome mine South Porcupine	3 400	–	–	–	–	0.72	3.91	1 193 855	–	–	–	–	756	4 483	
Dona Lake mine Pickle Lake	499	–	–	–	–	0.05	6.93	163 393	–	–	–	–	84	1 056	

PRINCIPAL CANADIAN NONFERROUS AND PRECIOUS METAL MINE PRODUCTION IN 1989, WITH HIGHLIGHTS FOR 1990 (cont'd)

Company and Mine/Mill Location	Capacity	Grades of Ore Milled						Ore Milled	Metal Contained in All Concentrates Produced						1990 Highlights
		Cu	Ni	Pb	Zn	Ag	Au		Copper	Nickel	Lead	Zinc	Silver	Gold	
	(tonnes per day)	(percent)				(grams/tonne)		(tonnes)	(tonnes)				(kilograms)		
ONTARIO (cont'd)															
St. Andrew Goldfields Ltd. Stock Twp. mine	455	-	-	-	-	0.45	4.29	47 412	-	-	-	-	19	192	Closed in 1989.
Teck-Corona Corporation Joint Venture															
David Bell mine	1 250	-	-	-	-	1.10	23.62	425 150	-	-	-	-	425	9 710	
Williams mine Hemlo	6 000	-	-	-	-	1.15	8.43	1 922 548	-	-	-	-	444	15 369	
Timmins Nickel Inc. Redstone and Langmuir mines Timmins	272	-	2.25	-	-	-	-	56 245	-	1 076	-	-	-	-	Langmuir No. 1 deposit brought into production late in 1990.
MANITOBA															
Granges Inc. Abermin Corporation Tartan Lake mine Flin Flon	350	-	-	-	-	0.34	6.27	100 915	-	-	-	-	27	539	Closed in 1989.
Hudson Bay Mining and Smelting Co., Limited (9 mines), Flin Flon and Snow Lake concentrators	10 520	2.23	-	0.27	4.98	21.37	1.76	1 628 959	33 754	-	2 735	71 903	22 413	1 906	New shaft and ore handling system completed at Trout Lake mine, 1990.
Ruttan mine Leaf Rapids	6 700	1.12	-	-	1.34	12.21	0.62	1 732 723	17 701	-	-	18 802	11 208	609	
Hudson Bay/Outokumpu Mines Ltd. Joint Venture Namew Lake mine Flin Flon	1 905	0.57	1.56	-	-	-	-	250 301	1 281	3 309	-	-	-	-	
Inco Limited Thompson underground and open-pit mines, Birchtree Thompson district	14 025	0.16	2.53	-	-	5.14	0.10	2 594 548	4 004	60 025	-	-	8 014	208	
LynnGold Resources Inc. MacLellan mine Lynn Lake	1 100	-	-	-	-	19.36	5.59	355 419	-	-	-	-	2 765	1 712	Closed in 1989.
Pioneer Metals Corporation Puffy Lake mine Sherridon	1 000	-	-	-	-	0.86	2.61	291 801	-	-	-	-	206	626	Closed in 1989.
SASKATCHEWAN															
Cameco Corporation Star Lake mine La Ronge	200	-	-	-	-	1.03	10.63	31 995	-	-	-	-	28	315	Mine closed in 1989.
Corona Corporation Jolu mine La Ronge	400	-	-	-	-	4.46	15.02	160 311	-	-	-	-	64	2 355	Mine is expected to close in 1991 unless new reserves are found.

BRITISH COLUMBIA

BHP - Utah Mines Ltd. Island Copper mine Port Hardy	49 895	0.43	–	–	–	1.68	0.15	17 508 665	61 458	–	–	–	14 082	1 428	
Brenda Mines Ltd. Peachland	30 000	0.16	–	–	–	1.64	0.02	11 562 612	16 386	–	–	–	9 463	138	Mine closed in June 8, 1990 due to rock slide and to ore exhaustion.
Cheni Gold Mines Inc. Lawyers mine North Central, B.C.	500	–	–	–	–	248.23	10.97	140 577	–	–	–	–	27 277	1 425	
Chevron Minerals Ltd. North American Metals Corp. Golden Bear mine	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Production started in February 1990. Owner took a writedown of $34 million dollars due to start-up problems.
Cominco Ltd. Sullivan mine Kimberley	8 000	–	–	4.40	5.40	35.31	–	1 653 616	–	–	64 251	80 542	51 772	–	Shut down January 31 due to increasing production cost and re-opened in November 1990 after labour contract settlement.
Corona Corporation Nickel Plate mine Hedley	2 500	–	–	–	–	3.74	2.78	1 065 026	–	–	–	–	3 176	2 472	Mine closed for much of 1990.
Gibraltar Mines Limited Mill	36 290	0.29	–	–	–	1.03	–	11 980 282	27 846	–	–	–	5 964	–	
Bioleach plant McLeese Lake	19 908	0.14	–	–	–	–	–	7 257 478	4 009	–	–	–	–	–	
Highland Valley Copper (Partnership of Cominco Ltd.– Rio Algom Limited– Teck Corporation) Logan Lake	133 000	0.43	–	–	–	1.65	0.03	32 323 627	113 126	–	–	–	38 696	248	
Minnova Inc. Samatosum mine Adams Lake	422	1.0	–	2.16	3.83	891.43	1.44	83 733	694	–	1 369	2 733	61 418	77	Underground definition drilling commenced in November 1990.
MinVen Gold Corporation Blackdome mine Williams Lake	180	–	–	–	–	62.57	23.66	73 778	–	–	–	–	3 615	1 660	Mine closed in 1990.
Noranda Inc. Bell Copper mine Babine Lake	15 420	0.50	–	–	–	1.3	0.21	5 443 108	18 547	–	–	–	3 243	761	
Placer Dome Inc. Equity Silver mine Houston	9 000	0.29	–	–	–	113.49	0.96	3 114 365	6 305	–	–	–	216 387	1 779	Mine to close in 1992.
Princeton Mining Corporation Similco mine Princeton	22 680	0.46	–	–	–	3.53	0.15	7 540 520	26 330	–	–	–	13 442	538	
Skylark Resources Ltd. Greenwood	408	–	–	0.31	0.48	578.74	4.63	11 703	–	–	29	45	530	43	Suspended operations in 1990.
Skyline Gold Corporation Iskut River	320	0.66	–	–	–	36.24	18.17	94 982	584	–	–	–	2 296	1 375	The Johny Mountain mine was closed in 1990.
Teck Corporation Afton mine Kamloops	9 000	0.43	–	–	–	9.57	0.22	2 547 553	8 763	–	–	–	1 468	454	
Beaverdell mine Beaverdell	100	–	–	0.29	0.36	306.99	–	36 560	–	–	93	115	9 652	–	Mine to close in Feb. 1991.

PRINCIPAL CANADIAN NONFERROUS AND PRECIOUS METAL MINE PRODUCTION IN 1989, WITH HIGHLIGHTS FOR 1990 (cont'd)

Company and Mine/Mill Location	Capacity	Grades of Ore Milled Cu	Ni	Pb	Zn	Ag	Au	Ore Milled	Metal Contained in All Concentrates Produced Copper	Nickel	Lead	Zinc	Silver	Gold	1990 Highlights
	(tonnes per day)	(percent)				(grams/tonne)		(tonnes)	(tonnes)				(kilograms)		
BRITISH COLUMBIA (cont'd)															
Treminco Resources Ltd. Silvana mine New Denver	109	–	–	6.78	7.37	558.9	–	22 226	–	–	1 439	1 493	12 133	–	Extended mill operation to a seven-day-week.
Westmin Resources Limited H-W, Lynx mines Buttle Lake	3 990	2.14	–	0.26	3.98	33.6	2.13	1 229 262	24 598	–	2 629	43 971	29 145	1 343	Technical problems plagued the H-W mine in 1990.
YUKON TERRITORY															
Canamax Resources Inc. Ketza River	290	–	–	–	–	0.51	11.32	119 789	–	–	–	–	52	1 216	Closed in 1990.
Curragh Resources Inc. Faro mine	13 500	–	–	2.93	4.69	34.90	0.21	4 354 487	–	–	105 992	170 884	89 523	308	Grum and Vangorda mines to start-up in 1991 and replace depleting reserves at the Faro mine.
NORTHWEST TERRITORIES															
Cominco Ltd. Polaris mine Little Cornwallis Island	2 100	–	–	3.50	14.10	–	–	1 023 304	–	–	34 536	140 110	–	–	
Echo Bay Mines Ltd. Lupin mine Contwoyto Lake	1 034	–	–	–	–	1.61	10.32	625 214	–	–	–	–	1 005	6 083	
Giant Yellowknife Mines Limited Yellowknife Division															
Giant mine	1 130	–	–	–	–	2.74	0.82	357 401	–	–	–	–	819	2 585	
Giant mill–tailings operations Yellowknife	9 070	–	–	–	–	2.54	2.26	992 647	–	–	–	–	503	448	The tailings operation closed in 1990 due to exhaustion of tailings to reprocess.
Nanisivik Mines Ltd. Baffin Island	1 887	–	–	0.40	8.40	32.0	–	705 998	–	–	2 292	57 238	16 502	–	
NERCO Minerals Company Con and Rycon mines Yellowknife	725	–	–	–	–	3.91	12.69	243 062	–	–	–	–	809	2 951	
NorthWest Gold Corp. Colomac mine	–	–	–	–	–	–	–	–	–	–	–	–	–	–	The mine opened in 1990.
Treminco Resources Ltd. Ptarmigan mine Yellowknife	181	–	–	–	–	2.63	14.22	43 699	–	–	–	–	90	556	
CANADA	660 269	0.45	0.13	0.21	0.78	11.27	0.96	175 158 617	728 116	203 067	302 226	1 263 277	1 421 921	153 577	

– Nil.
Note: Not included in the above are several small mine/mill operations and operations that were not officially in production in 1989, or for which no information was available to enable the completion of a reliable production assessment. The overall contribution to the Canadian production total in 1989 from these omitted operations is estimated to be less than one percent.

STATISTICAL REPORT

This statistical summary of the mineral industry in Canada has been compiled by the staff of the Mineral and Metal Statistics Division, Mineral Policy Sector, Energy, Mines and Resources Canada (EMR) under the general direction of Henry Martin, A/Director. This report was prepared by Jane Currie with significant contributions to its development made by D. Pilsworth and A.B. Siminowski.

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Statistics contained in this summary are obtained from a variety of sources. Principal sources include the statistical survey program of Energy, Mines and Resources Canada, Statistics Canada and Labour Canada. The statistical survey program of the Mineral and Metal Statistics Division of EMR is conducted jointly with the provincial governments and Statistics Canada in order to minimize the reporting burden on the mineral industry. The cooperation of the companies providing information is greatly appreciated. Sources for the international mineral statistics include the U.S. Bureau of Mines, the American Bureau of Metal Statistics, the World Bureau of Metal Statistics, "Metals Week," "Northern Miner," Metallgesellschaft and the "Engineering and Mining Journal."

STATISTICAL TABLES

Table No.

Table No.

SECTION 6: EMPLOYMENT, SALARIES AND WAGES

SECTION 7: MINING, EXPLORATION AND DRILLING

SECTION 8: TRANSPORTATION

SECTION 9: INVESTMENT AND FINANCE

SECTION 10: RESEARCH AND DEVELOPMENT

CANADA, GENERAL ECONOMIC INDICATORS, 1975–89

		1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989p
Gross domestic product, current dollars	$ million	171 540	197 924	217 879	241 604	276 069	309 891	355 994	374 750	405 425	444 735	479 988	504 631	550 334	601 508	648 537
Gross domestic product, constant dollars (1981=100)	"	283 187	300 638	311 347	325 751	338 362	343 384	355 994	344 082	354 780	377 865	395 878	408 143	426 411	447 779	460 595
Mining's gross domestic product (1981 = 100)	"	19 521	19 586	18 894	17 879	20 215	19 660	17 453	16 463	17 019	20 606	21 516	20 388	21 554	23 451	23 254
Manufacturing's gross domestic product (1981 = 100)	"	51 601	55 382	57 391	60 006	62 254	59 461	61 648	54 844	57 954	64 598	68 235	69 016	73 000	77 428	78 886
Industrial production's gross domestic product (1981 = 100)	"	75 171	80 223	82 920	85 799	89 491	86 880	88 675	80 910	84 982	95 499	100 811	100 732	106 421	112 991	114 229
Value of manufacturing industry shipment	"	88 427	98 076	109 747	129 019	152 133	165 985	190 581	183 652	200 155	229 848	248 673	253 343	272 037r	294 436r	303 184
Value of mineral production	"	13 347	15 693	18 473	20 319	26 135	31 926	32 420	33 831	38 540	43 789	44 730	32 446	36 361	36 961	39 122
Merchandise exports	"	33 616	38 166	44 495	53 361	65 582	76 681	84 432	84 560	90 700	112 219	120 258	119 889	126 120	137 294	139 647
Merchandise imports	"	33 962	36 606	41 523	49 048	61 157	67 903	77 140	66 739	73 054	91 493	102 783	110 079	114 767	127 486	134 255
Balance of payments, current account	"	–4 631	–4 096	–4 322	–4 903	–4 864	–1 130	–6 131	2 906	2 942	2 695	–1 991	–10 578	–9 360	–10 316	–19 659
Corporation profits before taxes	"	19 663	19 985	21 090	25 360	34 884	36 456	32 638	21 110	32 684	45 855	49 490	45 199	56 270	62 268	60 503
Business investment, current dollars	"	35 602	40 462	43 485	47 496	56 096	64 065	76 672	71 067	70 862	73 309	81 312	88 792	102 292	117 679	128 071
Business investment, constant dollars (1981 = 100)	"	49 418	52 453	53 587	55 638	61 399	68 103	76 672	67 088	65 972	67 635	73 870	78 949	89 052	101 672	108 721
Population	000s	22 697	22 993	23 258	23 476	23 671	23 936	24 342	24 634	24 886	25 124	25 360	25 353	25 617	25 909r	26 223
Labour force	"	9 974	10 203	10 500	10 895	11 231	11 573	11 904	11 958	12 183	12 399	12 639	12 870	13 011	13 276r	13 504
Employed	"	9 284	9 477	9 651	9 987	10 395	10 708	11 006	10 644	10 734	11 000	11 311	11 634	11 861	12 245r	12 486
Unemployed	"	690	726	849	908	836	865	898	1 314	1 448	1 399	1 328	1 236	1 150	1 031	1 018
Unemployment rate	percent	6.9	7.1	8.1	8.3	7.4	7.5	7.5	11.0	11.9	11.3	10.5	9.6	8.8	7.8	7.5
Labour income	$ million	95 277	110 419	122 476	133 383	150 172	169 736	196 002	209 449	219 352	236 257	254 777	271 809	296 002	322 717	352 730
Consumer price index	1981 = 100	58.5	62.9	67.9	73.9	80.7	88.9	100.0	110.8	117.2	121.8	126.3	131.0	136.3	141.4	147.9

Source: Statistics Canada, Catalogue No. 11-010 June 1990, and 26-202.

p Preliminary; r Revised.

TABLE 1. MINERAL PRODUCTION OF CANADA, 1988, 1989 AND 1990 AND AVERAGE 1986-90

	Unit of Measure	1988		1989		1990p		Average 1986-90	
	(000)	(Quantity)	($000)	(Quantity)	($000)	(Quantity)	($000)	(Quantity)	($000)
Metals									
Antimony	kg	3 171	8 094	2 818	6 957	653	1 379	2 831	7 692
Bismuth	kg	181	2 811	157	2 315	100	899	151	1 838
Cadmium	kg	1 664	31 747	1 711	28 027	1 643	14 388	1 597	17 689
Calcium	kg	x	x	x	x	x	x	298	3 260
Cesium, pollucite	kg	x	x	x	x	x	x	134	475
Cobalt	kg	2 398	45 090	2 344	45 781	2 291	52 490	2 364	47 328
Columbium (Niobium) (Cb_2O_5)	kg	x	x	x	x	x	x	3 288	20 469
Copper	kg	758 478	2 393 568	704 432	2 388 748	779 566	2 494 596	747 030	2 125 277
Germanium	kg	–	–	x	x	x	x	2	578
Gold	g	134 813	2 331 989	159 494	2 315 860	164 991	2 378 344	135 603	2 183 991
Ilmenite	t	x	x	x	x	x	x	526	23 135
Indium	g	x	x	x	x	x	x	5 528	1 538
Iron ore	t	39 934	1 323 249	39 445	1 369 193	36 443	1 312 245	37 938	1 348 595
Iron remelt	t	x	x	x	x	x	x	794	180 820
Lead	kg	351 148	356 064	268 887	279 643	224 000	268 128	310 319	305 261
Lithium	kg	x	x	x	x	x	x	784	3 213
Magnesium	kg	x	x	x	x	x	x	7 655	33 641
Molybdenum	kg	13 535	121 105	13 543	111 728	13 481	98 906	13 316	109 633
Nickel	kg	198 744	2 790 417	195 554	3 042 278	196 606	2 023 952	188 726	2 021 758
Platinum group	g	12 541	190 914	9 870	141 730	11 209	205 553	11 348	182 755
Rare earths	t	x	x	–	–	–	–	x	x
Rhenium	kg	x	x	x	x	x	x	1	1 164
Rubidium	kg	x	x	–	–	x	x	2	26
Selenium	kg	321	8 790	213	4 138	389	5 676	341	6 563
Silver	kg	1 443	386 271	1 312	274 737	1 400	255 588	1 324	323 134
Strontium	kg	x	x	x	x	x	x	x	x
Tantalum (Ta_2O_5)	kg	18	1 695	97	10 540	100	8 439	58	5 302
Tellurium	kg	19	1 007	8	591	13	1 049	15	753
Tin	kg	x	x	x	x	x	x	3 464	30 990
Tungsten (WO_3)	kg	x	x	x	x	x	x	494	x
Uranium (U)	kg	12 066	1 018 665	10 995	912 684	9 458	867 972	11 527	1 004 773
Yttrium (Y_2O_3)	kg	x	x	x	x	x	x	52	2 126
Zinc	kg	1 370 000	2 264 611	1 272 854	2 739 182	1 285 439	2 477 041	1 214 881	2 031 335
Total metals			13 607 895		13 982 451		12 777 666		12 029 813
Nonmetals									
Arsenious trioxide	t	x	2 366	x	1 286	x	288	5	1 013
Asbestos	t	710	251 088	701	267 341	665	256 111	681	249 316
Barite	t	51	4 014	39	3 069	48	3 987	44	3 880
Fluorspar	t	x	x	x	x	x	x	16	3 317
Gemstones	kg	488	2 143	901	3 238	229	499	359	1 758
Graphite	t	x	x	x	x	x	x	4	3 562
Gypsum	t	8 814r	85 650r	8 196	86 127	8 202	80 862	8 622	84 539
Magnesite	t	x	x	x	x	x	x	166	20 099
Marl	t	x	x	x	x	x	x	4	62
Mica	t	x	x	x	x	x	x	15	5 342
Nepheline syenite	t	540	21 775	551	23 077	536	24 309	520	21 749
Peat	t	736	82 832	812	99 666	749	89 535	739	85 534
Perlite	t	x	x	x	x	x	x	x	x
Potash (K_2O)	t	8 154	1 167 747	7 014	1 017 525	7 015	907 168	7 321	884 351
Potassium sulphate	t	x	x	x	x	x	x	1	411
Quartz[1]	t	. .	. .	. .	. .	. .	. .	1 060	17 326
Salt	t	10 687	246 722	11 057	228 476	11 097	239 864	10 660	238 631
Serpentine	t	x	x	x	x	x	x	4	657
Soapstone, talc and pyrophyllite	t	146	16 023	145	15 108	137	15 365	138	14 997
Sodium sulphate	t	331	25 016	327	26 344	347	28 508	344	27 885
Sulphur in smelter gas	t	856	85 179	809	86 909	929	93 411	815	83 650
Sulphur, elemental	t	5 981	444 007	5 750	419 541	5 802	363 707	6 062	521 549
Titanium dioxide	t	x	x	x	x	x	x	768	249 183
Tremolite	t	x	x	x	x	x	x	x	x
Total nonmetals			2 710 298r		2 594 865		2 385 190		2 518 872
Fuels									
Coal	t	70 644	1 804 330	70 527	1 907 080	68 450	1 871 000	65 729	1 789 920
Natural gas	000m^3	90 911	5 207 061	96 117	5 394 275	98 334	5 597 924	87 105	5 287 492
Natural gas by-products	m^3	22 556	1 593 637	23 055	1 620 282	23 317	2 208 700	21 923	1 820 274
Petroleum, crude	m^3	93 806	9 167 921	90 641	10 862 909	89 608	13 831 848	89 732	11 123 113
Total fuels			17 772 949		19 784 546		23 509 472		20 020 799
Structural materials									
Clay products	$	. .	196 724	. .	200 138	. .	143 072	. .	186 041
Cement	t	12 350	971 293	12 591	960 000	11 252	864 929	11 881	923 559
Lime	t	2 518	191 672	2 552	201 571	2 404	180 256	2 409	182 485
Sand and gravel	t	287 653r	865 900r	274 848	874 078	250 070	794 130	269 833	799 308
Stone	t	120 126r	637 993r	118 016	661 415	112 005	650 670	112 208	604 355
Total structural materials			2 863 583r		2 897 202		2 633 058		2 695 747
Other minerals			–		–		–		4 323
Total all minerals			36 954 725r		39 259 064		41 305 385		37 265 230

[1] Beginning in 1988, production for quartz is included in sand and gravel.
p Preliminary; . . Not available; – Nil; x Confidential; r Revised.
Note: Totals may not add due to rounding. Confidential values are included in totals.

TABLE 2. CANADA, VALUE OF MINERAL PRODUCTION, PER CAPITA VALUE OF MINERAL PRODUCTION, AND POPULATION, 1961-90

	Metallics	Industrial Minerals	Fuels	Other Minerals[1]	Total	Per Capita Value of Mineral Production	Population of Canada
			($ million)			($)	(000)
1961	1 387	542	674		2 603	142.72	18 238
1962	1 496	574	811		2 881	155.05	18 583
1963	1 510	632	885		3 027	159.91	18 931
1964	1 702	691	973		3 365	174.44	19 291
1965	1 908	761	1 046		3 715	189.11	19 644
1966	1 985	844	1 152		3 981	198.88	20 015
1967	2 285	861	1 235		4 381	214.98	20 378
1968	2 493	886	1 343		4 722	228.12	20 701
1969	2 378	893	1 465		4 736	225.51	21 001
1970	3 073	931	1 718		5 722	268.68	21 297
1971	2 940	1 008	2 014		5 963	276.46	21 568
1972	2 956	1 085	2 368		6 408	293.92	21 802
1973	3 850	1 292	3 227		8 370	379.69	22 043
1974	4 825	1 731	5 202		11 753	525.55	22 364
1975	4 795	1 898	6 653		13 347	588.05	22 697
1976	5 315	2 269	8 109		15 693	682.51	22 993
1977	5 988	2 612	9 873		18 473	794.24	23 258
1978	5 698	2 986	11 578		20 261	863.05	23 476
1979	7 951	3 514	14 617		26 081	1 101.83	23 671
1980	9 697	4 201	17 944		31 842	1 330.29	23 936
1981	8 753	4 485	19 046	136	32 420	1 331.86	24 342
1982	6 874	3 703	23 038	216	33 831	1 373.37	24 634
1983	7 399	3 741	27 154	245	38 539	1 548.68	24 885
1984	8 670	4 318	30 399	401	43 789	1 742.92	25 124
1985	8 709	4 859	31 120	41	44 730	1 763.79	25 360
1986	8 798	4 863	18 763	22	32 446	1 279.77	25 353
1987	10 962	5 125	20 274	–	36 361	1 419.39	25 617
1988	13 608	5 574	17 773	–	36 955	1 426.33r	25 909r
1989	13 982	5 492	19 785	–	39 259	1 497.12	26 223
1990p	12 778	5 018	23 509	–	41 305	1 553.77	26 584

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] 1981-86 – Other minerals may include arsenious trioxide, bentonite, calcium, cesium, cobalt, diatomite, ilmenite, indium, iron remelt, lithium, marl, magnesium, niobium, perlite, rhenium, serpentine, sodium antimonate, strontium, tin, tungsten or yttrium for which the value of production may be confidential in that year. Beginning 1987, this category was discontinued.
p Preliminary; r Revised; – Nil.
Note: Beginning 1986, bentonite, diatomite and sodium antimonate are reported in industrial minerals. Totals may not add due to rounding.

TABLE 3. CANADA, VALUE OF MINERAL PRODUCTION BY PROVINCES, TERRITORIES AND MINERAL CLASSES, 1989

	Metals		Industrial Minerals		Fuels		Total	
	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)
Alberta	359	. . .	704 989	12.8	15 750 483	79.6	16 455 830	41.9
Ontario	5 569 930	39.8	1 603 326	29.2	83 953	0.4	7 257 208	18.5
British Columbia	1 828 639	13.1	456 155	8.3	1 838 487	9.3	4 123 281	10.5
Saskatchewan	458 143	3.3	954 116	17.4	1 599 012	8.1	3 011 271	7.7
Quebec	1 750 826	12.5	1 104 992	20.1	–	–	2 855 818	7.3
Manitoba	1 463 608	10.5	113 749	2.1	90 878	0.5	1 668 235	4.2
Northwest Territories	934 861	6.7	25 911	0.5	188 513	1.0	1 149 286	2.9
Newfoundland	822 268	5.9	74 169	1.4	–	–	896 437	2.3
New Brunswick	582 439	4.2	247 894	4.5	33 740	0.2	864 073	2.2
Yukon	528 196	3.8	5 714	0.1	–	–	533 910	1.4
Nova Scotia	43 184	0.3	198 838	3.6	199 480	1.0	441 502	1.1
Prince Edward Island	–	–	2 214	. . .	–	–	2 214	. . .
Total	13 982 451	100.0	5 492 067	100.0	19 784 546	100.0	39 259 064	100.0

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . . Amount too small to be expressed.
Note: Totals may not add due to rounding.

TABLE 3a. CANADA, VALUE OF MINERAL PRODUCTION BY PROVINCES, TERRITORIES AND MINERAL CLASSES, 1990p

	Metals		Industrial Minerals		Fuels		Total	
	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)
Alberta	4 303	. . .	617 525	12.3	18 716 834	79.6	19 338 662	46.8
Ontario	4 913 736	38.5	1 410 109	28.1	95 809	0.4	6 419 655	15.5
British Columbia	1 700 118	13.3	441 130	8.8	1 966 351	8.4	4 107 599	9.9
Saskatchewan	280 640	2.2	834 296	16.6	2 114 885	9.0	3 229 821	7.8
Quebec	1 903 433	14.9	1 064 354	21.2	–	–	2 967 787	7.2
Manitoba	1 111 716	8.7	100 335	2.0	117 879	0.5	1 329 930	3.2
Northwest Territories	881 914	6.9	24 501	0.5	261 114	1.1	1 167 529	2.8
New Brunswick	596 003	4.7	252 692	5.0	37 400	0.2	886 094	2.1
Newfoundland	790 133	6.2	71 440	1.4	–	–	861 573	2.1
Yukon	537 090	4.2	4 042	0.1	–	–	541 133	1.3
Nova Scotia	58 579	0.5	194 511	3.9	199 200	0.8	452 290	1.1
Prince Edward Island	–	–	3 312	0.1	–	–	3 312	. . .
Total	12 777 666	100.0	5 018 247	100.0	23 509 472	100.0	41 305 385	100.0

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary; – Nil; . . . Amount too small to be expressed.
Note: Totals may not add due to rounding.

TABLE 4. CANADA, VALUE OF MINERAL PRODUCTION BY PROVINCES AND TERRITORIES, 1984–90

	1984	1985	1986	1987	1988	1989	1990p
				($ million)			
Alberta	26 429	27 030	16 331	17 080	15 062	16 456	19 339
Ontario	4 531	4 630	4 825	5 652	6 896	7 257	6 420
British Columbia	3 346	3 541	3 160	3 615	3 943	4 123	4 108
Saskatchewan	3 758	3 797	2 525	3 151	3 043	3 011	3 230
Quebec	2 167	2 243	2 191	2 780	2 711	2 856	2 968
Manitoba	812	862	764	1 000	1 627	1 668	1 330
Northwest Territories	777	865	788	870	957	1 149	1 168
New Brunswick	613	509	502	624	911	864	886
Newfoundland	979	870	817	743	864	896	862
Yukon	70	60	176	437	492	534	541
Nova Scotia	304	321	367	407	453	442	452
Prince Edward Island	2	2	2	3	2	2	3
Total	43 789	44 730	32 446	36 361	36 961	39 259	41 305

Source: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary.
Note: Totals may not add due to rounding.

TABLE 5. CANADA, PERCENTAGE CONTRIBUTION OF PROVINCES AND TERRITORIES, TO TOTAL VALUE OF MINERAL PRODUCTION, 1984–90

	1984	1985	1986	1987	1988	1989	1990p
Alberta	60.4	60.4	50.3	47.0	40.8	41.9	46.8
Ontario	10.3	10.4	14.9	15.5	18.7	18.5	15.5
British Columbia	7.6	7.9	9.7	9.9	10.7	10.5	9.9
Saskatchewan	8.6	8.5	7.8	8.7	8.2	7.7	7.8
Quebec	4.9	5.0	6.8	7.6	7.3	7.3	7.2
Manitoba	1.9	1.9	2.4	2.8	4.4	4.2	3.2
Northwest Territories	1.8	1.9	2.4	2.4	2.6	2.9	2.8
New Brunswick	1.4	1.1	1.5	1.7	2.5	2.2	2.1
Newfoundland	2.2	1.9	2.5	2.0	2.3	2.3	2.1
Yukon	0.2	0.1	0.5	1.2	1.3	1.4	1.3
Nova Scotia	0.7	0.7	1.1	1.1	1.2	1.1	1.1
Prince Edward Island	...	...	...	...	...	...	...
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary; ... Amount too small to be expressed.
Note: Totals may not add due to rounding.

TABLE 6. CANADA, PRODUCTION OF LEADING MINERALS, 1989 AND 1990

		1989	1990p	Percent Change 1990/1989	1989	1990p	Percent Change 1990/1989
		(000 tonnes except where noted)			($ millions)		
Metals							
Copper		704.4	779.6	10.7	2 388.7	2 494.6	4.4
Zinc		1 272.9	1 285.4	1.0	2 739.2	2 477.0	–9.6
Gold	kg	159 494.5	164 990.9	3.4	2 315.9	2 378.3	2.7
Nickel		195.6	196.6	0.5	3 042.3	2 024.0	–33.5
Iron ore		39 445.0	36 442.7	–7.6	1 369.2	1 312.2	–4.2
Uranium	tU	10 994.8	9 458.0	–14.0	912.7	868.0	–4.9
Lead		268.9	224.0	–16.7	279.6	268.1	–4.1
Silver	t	1 312.4	1 399.6	6.6	274.7	255.6	–7.0
Platinum group	kg	9 869.5	11 208.8	13.6	141.7	205.6	45.0
Molybdenum	t	13 543.0	13 480.7	–0.5	111.7	98.9	–11.5
Nonmetals							
Potash (K_2O)		7 014.1	7 014.5	...	1 017.5	907.2	–10.8
Sulphur, elemental		5 749.8	5 802.3	0.9	419.5	363.7	–13.3
Asbestos		701.2	665.3	–5.1	267.3	256.1	–4.2
Salt		11 057.4	11 096.6	0.4	228.5	239.9	5.0
Sulphur in smelter gas		808.8	929.3	14.9	86.9	93.4	7.5
Peat		812.2	748.8	–7.8	99.7	89.5	–10.2
Structurals							
Cement		12 590.6	11 252.0	–10.6	960.0	864.9	–9.9
Sand and gravel		274 847.9	250 069.8	–9.0	874.1	794.1	–9.1
Stone		118 015.7	112 005.0	–5.1	661.4	650.7	–1.6
Lime		2 551.9	2 403.7	–5.8	201.6	180.3	–10.6
Clay products		..	..	..	200.1	143.1	–28.5
Fuels							
Petroleum	000 m^3	90 640.5	89 607.6	–1.1	10 862.9	13 831.8	27.3
Natural gas	million m^3	96 116.8	98 333.6	2.3	5 394.3	5 597.9	3.8
Natural gas by-products	000 m^3	23 055.2	23 316.7	1.1	1 620.3	2 208.7	36.3
Coal		70 527.0	68 450.0	–2.9	1 907.1	1 871.0	–1.9

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary; .. Not available; ... Amount too small to be expressed.
Note: Figures have been rounded.

TABLE 7. VALUE OF LEADING MINERALS IN THE PROVINCES, TERRITORIES AND CANADA, 1989 AND 1990

	Value of Production			
	1989	1990p	Change 1990/1989	1990p Proportion of Provincial Total
	($ million)		(percent)	
Newfoundland				
Iron ore	722.5	695.8	–3.7	80.8
Gold	x	x	31.7	x
Zinc	58.9	41.4	–29.6	4.8
Asbestos	24.9	26.3	5.9	3.1
Sand and gravel	18.0	17.4	–3.3	2.0
Total	896.4	861.6	–3.9	100.0
Prince Edward Island				
Sand and gravel	2.2	3.3	49.6	100.0
Total	2.2	3.3	49.6	100.0
Nova Scotia				
Coal	199.5	199.2	–0.1	44.0
Gypsum	53.8	54.2	0.6	12.0
Salt	x	x	17.8	x
Cement	x	x	–9.6	x
Tin	x	x	–10.0	x
Stone	33.7	28.7	–14.9	6.3
Total	441.5	452.3	2.4	100.0
New Brunswick				
Zinc	433.7	481.0	10.9	54.3
Potash (K_2O)	x	x	4.7	x
Lead	67.8	61.4	–9.5	6.9
Coal	33.7	37.4	10.8	4.2
Peat	24.9	28.3	13.5	3.2
Total	864.1	886.1	2.5	100.0
Quebec				
Gold	536.7	567.8	5.8	19.1
Iron ore	x	x	11.6	x
Copper	220.9	301.5	36.5	10.2
Stone	230.5	248.1	7.7	8.4
Titanium dioxide	x	x	–12.8	x
Zinc	216.6	199.3	–8.0	6.7
Total	2 855.8	2 967.8	3.9	100.0
Ontario				
Nickel	2 010.1	1 316.6	–34.5	20.5
Gold	1 142.4	1 148.1	0.5	17.9
Copper	922.1	886.6	–3.8	13.8
Uranium (U)	500.3	635.4	27.0	9.9
Zinc	572.8	541.7	–5.4	8.4
Cement	444.4	401.8	–9.6	6.3
Total	7 257.2	6 419.7	–11.5	100.0
Manitoba				
Nickel	1 032.2	707.3	–31.5	53.2
Copper	171.2	178.1	4.0	13.4
Zinc	155.1	142.0	–8.5	10.7
Petroleum, crude	90.1	116.7	29.6	8.8
Total	1 668.2	1 329.9	–20.3	100.0

TABLE 7 (cont'd)

	Value of Production			
	1989	1990p	Change 1990/1989	1990p Proportion of Provincial Total
	($ million)		(percent)	
Saskatchewan				
Petroleum, crude	1 237.3	1 688.0	36.4	52.3
Potash (K_2O)	x	x	–13.7	x
Natural gas	238.9	314.0	31.4	9.7
Uranium (U)	412.3	232.6	–43.6	7.2
Total	3 011.3	3 229.8	7.3	100.0
Alberta				
Petroleum, crude	9 055.3	11 394.4	25.8	58.9
Natural gas	4 624.7	4 716.5	2.0	24.4
Natural gas by-products	1 570.2	2 120.2	35.0	11.0
Coal	500.3	485.8	–2.9	2.5
Sulphur, elemental	374.8	315.2	–15.9	1.6
Total	16 455.8	19 338.7	17.5	100.0
British Columbia				
Copper	1 045.6	1 106.2	5.8	26.9
Coal	1 059.0	1 048.5	–1.0	25.5
Natural gas	472.3	509.1	7.8	12.4
Petroleum, crude	268.9	338.1	25.7	8.2
Gold	227.0	232.2	2.3	5.7
Sand and gravel	156.6	158.7	1.4	3.9
Zinc	256.9	113.9	–55.7	2.8
Total	4 123.3	4 107.6	–0.4	100.0
Yukon				
Zinc	332.9	327.8	–1.5	60.6
Lead	98.3	127.5	29.7	23.6
Gold	82.1	66.3	–19.2	12.3
Silver	14.9	15.4	3.9	2.9
Total	533.9	541.1	1.4	100.0
Northwest Territories				
Zinc	708.0	611.4	–13.6	52.4
Petroleum, crude	178.1	250.4	40.6	21.4
Gold	177.3	217.1	22.5	18.6
Lead	41.3	45.6	10.3	3.9
Total	1 149.3	1 167.5	1.6	100.0
Canada				
Petroleum, crude	10 862.9	13 831.8	27.3	33.5
Natural gas	5 394.3	5 597.9	3.8	13.6
Copper	2 388.7	2 494.6	4.4	6.0
Zinc	2 739.2	2 477.0	–9.6	6.0
Gold	2 315.9	2 378.3	2.7	5.8
Natural gas by-products	1 620.3	2 208.7	36.3	5.3
Nickel	3 042.3	2 024.0	–33.5	4.9
Coal	1 907.1	1 871.0	–1.9	4.5
Iron ore	1 369.2	1 312.2	–4.2	3.2
Potash (K_2O)	1 017.5	907.2	–10.8	2.2
Grand Total	39 259.1	41 305.4	5.2	100.0

Sources: Energy, Mines and Resources Canada; Statistics Canada
p Preliminary; x Confidential.

TABLE 8. PRODUCTION OF LEADING MINERALS, BY PROVINCES AND TERRITORIES IN CANADA, 1989

	Unit of Measure	Nfld.	P.E.I.	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskat-chewan	Alberta	British Columbia	Yukon	N.W.T.	Total Canada
	(000)													
Petroleum, crude	m3	–	–	–	–	–	244	723	11 633	74 141	2 016	–	1 885	90 641
	$	–	–	–	–	–	33 225	90 101	1 237 265	9 055 286	268 909	–	178 123	10 862 909
Natural gas	000 m3	–	–	–	–	–	493	–	4 841	79 805	10 844	–	135	96 117
	$	–	–	–	–	–	50 728	–	238 918	4 624 671	472 252	–	7 706	5 394 275
Nickel	kg	–	–	–	–	–	130 632	64 922	–	–	–	–	–	195 554
	$	–	–	–	–	–	2 010 119	1 032 160	–	–	–	–	–	3 042 278
Zinc	kg	27 362	–	x	201 550	100 638	266 158	72 096	x	–	119 376	154 709	329 001	1 272 854
	$	58 882	–	x	433 736	216 573	572 772	155 150	x	–	256 897	332 934	708 009	2 739 182
Copper	kg	–	–	x	7 802	65 135	271 914	50 484	x	–	308 348	–	–	704 432
	$	–	–	x	26 456	220 874	922 068	171 191	x	–	1 045 617	–	–	2 388 748
Gold	g	x	–	x	359	36 966	78 675	4 056	2 829	25	15 635	5 652	12 208	159 494
	$	x	–	x	5 215	536 743	1 142 361	58 896	41 078	359	227 020	82 070	177 260	2 315 860
Coal	t	–	–	3 512	520	–	–	–	10 816	30 878	24 801	–	–	70 527
	$	–	–	199 480	33 740	–	–	–	114 550	500 320	1 058 990	–	–	1 907 080
Natural gas by-products	m3	–	–	–	–	–	–	11	124	22 213	679	–	28	23 055
	$	–	–	–	–	–	–	777	8 279	1 570 206	38 336	–	2 684	1 620 282
Iron ore	t	20 662	–	–	–	15 363	3 347	–	–	–	73	–	–	39 445
	$	722 527	–	–	–	x	x	–	–	–	2 616	–	–	1 369 193
Potash (K_2O)	t	–	–	–	x	–	–	–	x	–	–	–	–	7 014
	$	–	–	–	x	–	–	–	x	–	–	–	–	1 017 525
Cement	t	x	–	x	–	3 171	5 779	x	x	x	x	–	–	12 591
	$	x	–	x	–	186 457	444 408	x	x	x	x	–	–	960 000
Uranium (U)	kg	–	–	–	–	–	4 099	–	6 896	–	–	–	–	10 995
	$	–	–	–	–	–	500 348	–	412 336	–	–	–	–	912 684
Sand and gravel	t	4 241	826	6 585	9 249	36 025	92 264	13 880	12 960	41 959	52 469	2 367	2 023	274 848
	$	18 039	2 214	22 049	16 023	107 586	324 649	37 347	27 031	145 072	156 580	5 675	11 813	874 078
Stone	t	705	–	6 732	2 365	42 584	58 250	2 857	–	374	3 421	–	727	118 016
	$	4 463	–	33 718	18 976	230 455	330 353	12 566	–	3 619	22 922	–	4 344	661 415
Sulphur, elemental	t	–	–	–	–	–	–	–	21	5 326	403	–	–	5 750
	$	–	–	–	–	–	–	–	1 887	374 786	42 867	–	–	419 541
Lead	kg	–	–	–	65 180	–	1 074	1 365	–	–	67 006	94 529	39 734	268 887
	$	–	–	–	67 787	–	1 117	1 419	–	–	69 686	98 310	41 323	279 643
Silver	kg	x	–	x	191	148	349	36	x	–	498	71	18	1 312
	$	x	–	x	40 063	30 940	72 959	7 579	x	–	104 251	14 851	3 820	274 737
Asbestos	t	62	–	–	–	530	–	–	–	–	109	–	–	701
	$	24 874	–	–	–	184 199	–	–	–	–	58 268	–	–	267 341
Salt	t	–	–	x	x	x	7 282	–	312	1 426	–	–	–	11 057
	$	–	–	x	x	x	138 505	–	17 597	17 189	–	–	–	228 476
Lime	t	–	–	–	x	x	1 656	x	–	195	177	–	–	2 552
	$	–	–	–	x	x	126 496	8 300	–	16 379	16 758	–	–	201 571
Clay products	$	x	–	x	x	x	136 844	x	x	x	x	–	–	200 138
Platinum group	g	–	–	–	–	–	x	x	–	–	–	–	–	9 870
	$	–	–	–	–	–	x	x	–	–	–	–	–	141 730
Molybdenum	kg	–	–	–	–	–	–	–	–	–	13 543	–	–	13 543
	$	–	–	–	–	–	–	–	–	–	111 728	–	–	111 728
Peat	t	1	–	x	251	335	x	x	x	93	–	–	–	812
	$	77	–	x	24 910	41 516	x	x	x	18 626	–	–	–	99 666
Sulphur, in smelter gas	t	–	–	2	107	38	520	3	–	. . .	71	. . .	67	809
	$	–	–	338	15 796	6 661	46 140	526	–	2	8 940	39	8 468	86 909
Total leading minerals	$	885 006	2 214	350 750	854 873	2 323 307	7 118 306	1 638 881	2 987 460	16 452 663	4 086 100	533 878	1 143 550	38 376 989
Total all minerals	$	896 437	2 214	441 502	864 073	2 855 818	7 257 208	1 668 235	3 011 271	16 455 830	4 123 281	533 910	1 149 286	39 259 064
Leading minerals as % of all minerals		98.7	100.0	79.4	98.9	81.4	98.1	98.2	99.2	100.0	99.1	100.0	99.5	97.8

Sources: Energy, Mines and Resources Canada; Statistics Canada
– Nil; . . . Amount too small to be expressed; x Confidential.
Note: Totals may not add due to rounding. Confidential values included in totals.

TABLE 8a. PRODUCTION OF LEADING MINERALS, BY PROVINCES AND TERRITORIES IN CANADA, 1990p

	Unit of Measure	Nfld.	P.E.I.	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskat-chewan	Alberta	British Columbia	Yukon	N.W.T.	Total Canada
	(000)													
Petroleum, crude	m3	–	–	–	–	–	240	730	11 776	72 841	2 103	–	1 918	89 608
	$	–	–	–	–	–	44 290	116 734	1 687 964	11 394 359	338 074	–	250 427	13 831 848
Natural gas	000 m3	–	–	–	–	–	457	–	5 786	81 652	10 324	–	115	98 334
	$	–	–	–	–	–	51 519	–	313 979	4 716 450	509 072	–	6 904	5 597 924
Copper	kg	–	–	x	6 475	94 207	277 067	55 641	x	–	345 685	–	–	779 566
	$	–	–	x	20 719	301 461	886 609	178 051	x	–	1 106 184	–	–	2 494 596
Zinc	kg	21 498	–	x	249 605	103 414	281 131	73 694	x	–	59 103	170 128	317 298	1 285 439
	$	41 426	–	x	480 989	199 279	541 740	142 008	x	–	113 892	327 836	611 434	2 477 041
Gold	g	x	–	x	744	39 388	79 647	2 382	3 295	x	16 106	4 602	15 063	164 991
	$	x	–	x	10 730	567 778	1 148 112	34 339	47 502	x	232 163	66 342	217 131	2 378 344
Natural gas by-products	m3	–	–	–	–	–	–	11	126	22 486	664	–	29	23 317
	$	–	–	–	–	–	–	1 145	12 842	2 120 225	70 705	–	3 783	2 208 700
Nickel	kg	–	–	–	–	–	128 402	68 203	–	–	–	–	–	196 606
	$	–	–	–	–	–	1 316 618	707 335	–	–	–	–	–	2 023 952
Coal	t	–	–	3 350	550	–	–	–	9 480	30 280	24 790	–	–	68 450
	$	–	–	199 200	37 400	–	–	–	100 100	485 800	1 048 500	–	–	1 871 000
Iron ore	t	19 955	–	–	–	15 300	1 084	–	–	–	103	–	–	36 443
	$	695 824	–	–	–	x	x	–	–	–	3 620	–	–	1 312 245
Potash (K_2O)	t	–	–	–	x	–	–	–	x	–	–	–	–	7 015
	$	–	–	–	x	–	–	–	x	–	–	–	–	907 168
Uranium (U)	kg	–	–	–	–	–	4 894	–	4 564	–	–	–	–	9 458
	$	–	–	–	–	–	635 359	–	232 614	–	–	–	–	867 972
Cement	t	x	–	x	–	2 845	5 158	x	x	x	x	–	–	11 252
	$	x	–	x	–	165 547	401 793	x	x	x	x	–	–	864 929
Sand and gravel	t	4 093	1 323	6 012	10 398	29 633	80 735	10 697	10 274	40 460	52 517	1 763	2 164	250 070
	$	17 445	3 312	18 862	18 453	86 795	283 947	36 219	23 269	131 498	158 705	4 015	11 609	794 130
Stone	t	1 116	–	5 298	2 756	41 923	53 416	2 488	–	345	3 641	–	1 022	112 005
	$	5 951	–	28 698	17 290	248 116	308 119	9 554	–	3 914	22 478	–	6 550	650 670
Sulphur, elemental	t	–	–	–	–	–	–	–	63	5 310	430	–	–	5 802
	$	–	–	–	–	–	–	–	4 482	315 239	43 985	–	–	363 707
Lead	kg	–	–	x	51 278	–	x	1 908	–	–	20 449	106 489	38 091	224 000
	$	–	–	x	61 380	–	x	2 284	–	–	24 478	127 468	45 595	268 128
Asbestos	t	66	–	–	–	503	–	–	–	–	96	–	–	665
	$	26 337	–	–	–	177 135	–	–	–	–	52 639	–	–	256 111
Silver	kg	x	–	x	115	146	367	34	x	–	623	84	29	1 400
	$	x	–	x	20 954	26 701	66 934	6 230	x	–	113 726	15 427	5 344	255 588
Salt	t	–	–	x	x	x	6 138	–	409	1 354	–	–	–	11 097
	$	–	–	x	x	x	115 306	–	20 422	16 085	–	–	–	239 864
Platinum group	g	–	–	–	–	–	x	x	–	–	–	–	–	11 209
	$	–	–	–	–	–	x	x	–	–	–	–	–	205 553
Lime	t	–	–	–	x	x	1 442	x	–	240	217	–	–	2 404
	$	–	–	–	x	x	102 243	6 316	–	18 706	19 075	–	–	180 256
Clay products	$	x	–	x	x	x	90 157	x	x	x	x	–	–	143 072
Molybdenum	kg	–	–	–	–	–	–	–	–	–	13 481	–	–	13 481
	$	–	–	–	–	–	–	–	–	–	98 906	–	–	98 906
Sulphur in smelter gas	t	–	–	1	74	114	638	4	–	. . .	50	. . .	47	929
	$	–	–	118	10 025	14 494	55 619	650	–	1	6 423	28	6 053	93 411
Peat	t	2	–	x	275	297	–	x	x	64	–	–	–	749
	$	96	–	x	28 273	35 839	–	x	x	13 129	–	–	–	89 535
Total leading minerals	$	854 416	3 312	364 414	884 846	2 462 807	6 282 465	1 305 287	3 204 245	19 331 346	4 075 569	541 115	1 164 830	40 474 650
Total all minerals	$	861 573	3 312	452 290	886 094	2 967 787	6 419 655	1 329 930	3 229 821	19 338 662	4 107 599	541 133	1 167 529	41 305 385
Leading minerals as % of all minerals		99.2	100.0	80.6	99.9	83.0	97.9	98.1	99.2	100.0	99.2	100.0	99.8	98.0

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary; – Nil; . . . Amount too small to be expressed; x Confidential.
Note: Totals may not add due to rounding. Confidential values included in totals.

TABLE 9. CANADA, PERCENTAGE CONTRIBUTION OF LEADING MINERALS TO TOTAL VALUE OF MINERAL PRODUCTION, 1984–90

	1984	1985	1986	1987	1988	1989	1990p
Petroleum, crude	40.6	41.2	29.6	33.4	24.8	27.7	33.5
Natural gas	18.1	18.0	17.3	12.7	14.1	13.7	13.6
Copper	3.1	3.3	4.4	5.3	6.5	6.1	6.0
Zinc	3.4	2.9	3.7	4.1	6.1	7.0	6.0
Gold	2.9	2.7	5.2	6.1	6.3	5.9	5.8
Natural gas by-products	6.5	6.3	5.6	5.2	4.3	4.1	5.3
Nickel	2.7	2.7	3.0	3.5	7.5	7.7	4.9
Coal	4.1	4.1	5.3	4.5	4.9	4.9	4.5
Iron ore	3.4	3.3	4.1	3.8	3.6	3.5	3.2
Potash (K_2O)	2.0	1.4	1.8	2.0	3.2	2.6	2.2
Uranium (U)	2.1	2.2	3.2	3.3	2.8	2.3	2.1
Cement	1.6	1.8	2.5	2.7	2.6	2.4	2.1
Sand and gravel	1.2	1.4	2.1	2.1	2.3	2.2	1.9
Stone	0.9	0.9	1.5	1.6	1.7	1.7	1.6
Sulphur, elemental	1.4	2.3	2.6	1.4	1.2	1.1	0.9
Lead	0.4	0.3	0.7	1.1	1.0	0.7	0.6
Asbestos	0.9	0.7	0.7	0.7	0.7	0.7	0.6
Silver	1.1	0.7	0.8	1.2	1.0	0.7	0.6
Salt	0.5	0.5	0.7	0.7	0.7	0.6	0.6
Platinum group	0.3	0.3	0.6	0.5	0.5	0.4	0.5
Lime	0.4	0.4	0.5	0.5	0.5	0.5	0.4
Clay products	0.3	0.3	0.6	0.6	0.5	0.5	0.3
Molybdenum	0.2	0.2	0.3	0.2	0.3	0.3	0.2
Sulphur in smelter gas	0.1	0.2	0.2	0.3	0.2	0.2	0.2
Peat	0.1	0.1	0.2	0.2	0.2	0.3	0.2
Other minerals	1.7	1.8	2.8	2.3	2.5	2.2	2.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary.
Note: Totals may not add due to rounding.

TABLE 10. PRODUCTION OF CANADA'S TEN LEADING[1] MINERAL COMMODITIES, 1983–90

	Unit	1983	1984	1985	1986	1987	1988	1989	1990p
	(000)								
Petroleum	m^3	78 751	83 680	85 564	85 468	89 140	93 806	90 641	89 608
Natural gas	000 m^3	72 229	78 266	84 344	71 896	78 267	90 911	96 117	98 334
Copper	kg	653 040	721 826	738 637	698 527	794 149	758 478	704 432	779 566
Zinc	kg	987 713	1 062 701	1 049 275	988 173	1 157 936	1 370 000	1 272 854	1 285 439
Gold	g	73 512	83 446	87 562	102 899	115 818	134 813	159 494	164 991
Natural gas by–products	m^3	18 013	19 640	19 682	19 127	21 560	22 556	23 055	23 317
Nickel	kg	125 022	173 725	169 971	163 639	189 086	198 744	195 554	196 606
Coal	t	44 787	57 402	60 436	57 811	61 211	70 644	70 527	68 450
Iron ore	t	32 962	39 930	39 502	36 167	37 702	39 934	39 445	36 443
Potash (K_2O)	t	6 294	7 527	6 661	6 753	7 668	8 154	7 014	7 015

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Based on contribution in 1989 to value of mineral production.
p Preliminary.

TABLE 11. WESTERN WORLD PRODUCTION OF CERTAIN MAJOR METALS, 1984-89

	1984	1985	1986	1987	1988	1989p
			(000 t)			
Primary aluminum						
Europe[1]	3 814.0	3 641.3	3 715.7	3 751.2r	3 803.8	3 914.7
Asia[1]	1 184.0	1 155.5r	1 066.4	948.9r	1 013.0	1 134.1
Africa	413.0	473.2	552.2	571.6	597.0	603.3
North and South America	6 367.0	5 945.6	5 787.1	6 387.6r	7 031.4	7 284.4
Australia and Oceania	998.0	1 095.2	1 113.0	1 276.2	1 407.0	1 501.0
Western World Total	12 776.0	12 311.0r	12 234.4	12 935.5r	13 852.2	14 437.5
Lead (refined production)[2]						
Europe[1]	1 595.0	1 602.9	1 590.2	1 622.2r	1 681.9	1 638.3
Asia[1]	510.0	541.3	565.8	584.7r	604.0	612.7
Africa	126.0	156.9	141.7r	157.0r	166.5	148.9
North and South America	1 578.0	1 706.0	1 590.8r	1 666.5r	1 738.2	1 806.6
Australia and Oceania	226.0	221.7	175.0	220.7	197.0	198.0
Western World Total	4 035.0	4 228.8	4 063.5r	4 251.1r	4 387.6	4 404.5
Copper (refined production)						
Europe[1]	1 395.0	1 452.8	1 487.6	1 449.1r	1 547.2	1 666.1
Asia[1]	1 328.0	1 401.8r	1 445.6r	1 464.2r	1 457.9	1 511.4
Africa	1 005.0	991.6	970.1	986.4r	898.7	825.8
North and South America	3 275.0	3 300.1r	3 384.2	3 537.4r	3 907.7	4 078.9
Australia and Oceania	197.0	194.3	185.1	207.8	222.7	255.0
Western World Total	7 200.0	7 340.6r	7 472.6r	7 644.9r	8 034.2	8 337.2
Zinc (smelter production)						
Europe[1]	1 941.0	1 965.2	1 986.7	2 077.0	2 137.7	2 111.8
Asia[1]	940.0	1 003.7	981.8	1 008.0r	1 061.0	1 067.3
Africa	221.0	216.2	196.5	187.3	203.2	187.4
North and South America	1 478.0	1 517.7	1 379.0	1 455.1r	1 519.0	1 543.8
Australia and Oceania	302.0	288.7	303.1	310.2	302.5	293.7
Western World Total	4 882.0	4 991.5r	4 847.1r	5 037.6r	5 223.4	5 204.0
Tin (smelter production)						
Europe[1]	25.0	26.0	22.8	23.0	21.7	17.9
Asia[1]	96.0	91.4	89.7	88.8	98.2	97.0
Africa	6.0	5.7	4.0	4.1	3.9	3.1
North and South America	42.0	43.6	39.5r	38.2r	51.5	61.8
Australia and Oceania	3.0	2.7	1.4	0.6	0.7	0.7
Western World Total	172.0	169.4r	157.4r	154.7r	176.0	180.5

Source: Metallgesellschaft AG, Metallstatistik (preliminary issue) Western World 1985-89, June 1990.
1 Excluding Eastern countries. 2 Includes secondary lead.
p Preliminary; r Revised.
Note: Totals may not add due to rounding.

TABLE 12. CANADA'S WORLD ROLE AS A PRODUCER OF CERTAIN IMPORTANT MINERALS, 1988p

		World	Rank of Five Leading Countries 1	2	3	4	5
			Canada	United States	South Africa	Namibia	Australia
	t	36 840	12 393[a]	5 190	3 850	3 600	3 530
Uranium (U concentrates)[1]	% of western world total		33.6	14.1	10.5	9.8	9.6
			Canada	U.S.S.R.	Australia	China	Peru
	000 t	7 141	1 370	960[e]	739	527	485
Zinc (mine production)	% of world total		19.2	13.4	10.3	7.4	6.8
			United States	**Canada**	Iran	China	Japan
	000 t	96 179	14 869	9 512	8 437	8 074	6 260
Gypsum	% of world total		15.5	9.9	8.8	8.4	6.5
			U.S.S.R.	**Canada**	East Germany	West Germany	France
	000 t	31 646	11 100	8 328	3 510	2 290	1 502
Potash (K_2O equivalent)	% of world total		35.1	26.3	11.1	7.2	4.7
			Australia	**Canada**	Norway	South Africa	Malaysia
	000 t	5 667	1 622	1 025[eb]	875	700[ec]	460
Titanium concentrates (ilmenite)	% of world total		28.6	18.1	15.4	12.4	8.1
			U.S.S.R.	**Canada**	Brazil	Zimbabwe	China
	000 t	4 363	2 600[e]	710	230	190	150[e]
Asbestos	% of world total		59.6	16.3	5.3	4.4	3.4
			U.S.S.R.	**Canada**	New Caledonia	Australia	Indonesia
	000 t	847	205	199	69	62	60
Nickel (mine production)	% of world total		24.2	23.5	8.1	7.3	7.1
			United States	Chile	**Canada**	U.S.S.R.	Mexico
	t	95 997	43 051	17 000	13 535	11 500	4 296
Molybdenum (Mo content)	% of world total		44.8	17.7	14.1	12.0	4.5
			South Africa	U.S.S.R.	**Canada**	Japan	Colombia
Platinum group metals	kg	270 373	133 278	121 000	12 541	1 848	815
(mine production)	% of world total		49.3	44.8	4.6	0.7	0.3
			United States	U.S.S.R.	**Canada**	Poland	Mexico
	000 t	39 400	9 618	6 965	6 017	5 004	2 144
Sulphur, elemental	% of world total		24.4	17.7	15.3	12.7	5.4
			United States	U.S.S.R.	**Canada**	Australia	Brazil
	000 t	17 482	3 944	2 440[e]	1 535	1 141	873
Aluminum (primary metal)	% of world total		22.6	14.0	8.8	6.5	5.0
			U.S.S.R.	Australia	**Canada**	United States	China
	000 t	3 419	520[e]	457	351	394	312[e]
Lead (mine production)	% of world total		15.2	13.4	10.3	11.5	9.1
			Zaire	Zambia	U.S.S.R.	**Canada**	Cuba
	t	25 826	10 139	5 025	3 000[e]	2 398	2 200[e]
Cobalt (mine production)	% of world total		39.3	19.5	11.6	9.3	8.5
			Chile	United States	U.S.S.R.	**Canada**	Zambia
	000 t	8 751	1 451	1 420	990	758	476
Copper (mine production)	% of world total		16.6	16.2	11.3	8.7	5.4
			U.S.S.R.	Japan	United States	Belgium	**Canada**
	t	21 711	2 650[e]	2 614	1 885	1 807	1 664
Cadmium (refined production)	% of world total		12.2	12.0	8.7	8.3	7.7
			Mexico	United States	U.S.S.R.	Peru	**Canada**
	t	14 325	2 412	1 661	1 580	1 552	1 443
Silver (mine production)	% of world total		16.8	11.6	11.0	10.8	10.1
			South Africa	U.S.S.R.	United States	Australia	**Canada**
	t	1 910	621	280[e]	205	152	135
Gold (refined production)	% of world total		32.5	14.7	10.7	8.0	7.1

[1] Total of western world.
[a] Does not include some 70 tU recovered by Elliot Lake producers from refinery/conversion facility wastes; [b] Titaniferous slag with 80% TiO_2 content; [c] Titaniferous slag with 85% TiO_2 content; [p] Preliminary; [e] Estimated.

TABLE 13. CANADA, CENSUS VALUE ADDED, TOTAL ACTIVITY, MINING AND MINERAL MANUFACTURING INDUSTRIES, 1982–88

	1982	1983	1984	1985	1986	1987	1988
				($ million)			
Mining							
Metallic minerals							
Nickel–copper–zinc	1 144.9	1 567.3	2 008.1	1 868.5	1 712.9	2 391.5	4 405.0
Gold	566.2	693.6	660.8	635.3	975.3	1 307.2	1 393.0
Uranium	600.1	496.9	772.5	813.1	802.0	898.3	858.6
Silver–lead–zinc	351.1	294.2	465.7	275.3	332.2	562.0	837.8
Iron	761.4	644.6	681.4	817.1	713.8	787.2	678.2
Miscellaneous metal mines	73.7	33.2	72.1	65.4	54.5	84.6	103.8
Total	3 497.4	3 729.8	4 660.6	4 474.7	4 590.7	6 030.8	8 276.4
Industrial minerals							
Potash	488.5	455.4	717.1	428.8	396.4	578.9	956.2
Stone	109.4	119.5	160.1	207.5	277.6	331.3	354.3r
Sand and gravel	75.6	90.3	104.9	132.9	220.0	306.5	287.3
Miscellaneous nonmetals	183.5	201.8	240.5	226.8	289.1	267.9	261.7
Asbestos	267.3	254.9	252.7	217.6	157.1	147.6	137.9
Peat	41.1	43.0	47.1	63.0	74.6	93.5	77.3r
Gypsum	26.6	35.1	40.2	50.7	56.6	67.2	64.1
Total	1 192.0	1 200.0	1 562.6	1 327.3	1 471.3	1 792.9	2 139.0r
Fuels							
Petroleum and natural gas	18 899.8	22 171.3	25 008.2	25 428.7	15 044.3	15 843.7	13 405.4
Coal	838.0	911.1	1 314.2	1 264.5	1 110.4	1 136.4	1 279.5
Total	19 737.8	23 082.4	26 322.4	26 693.2	16 154.7	16 980.1	14 684.9
Total mining industry	24 427.2	28 012.2	32 545.6	32 495.2	22 216.7	24 803.8	25 100.3r
Mineral manufacturing							
Primary metal industries							
Primary steel	2 149.9	2 464.9	2 939.6	3 105.9	3 001.6	3 424.6	..
Smelting and refining	1 493.0	1 912.4	2 236.9	2 202.4	2 372.8	3 050.9	..
Wire and wire products industries[1]	532.9	554.6	704.2	812.9	848.8	821.0	..
Aluminum rolling, casting and extruding	289.9	328.2	394.7	384.3	424.9	503.3	..
Iron foundries	279.9	326.0	447.7	471.5	510.7	479.7	..
Metal rolling, casting and extruding, n.e.s.	169.2	234.1	323.1	355.2	397.1	424.9	..
Steel pipe and tube	320.3	213.4	389.6	388.2	331.0	385.4	..
Copper and alloy rolling, casting and extruding	101.6	117.7	147.8	134.7	144.0	129.6	..
Total	5 336.7	6 151.3	7 583.6	7 855.0	8 030.9	9 219.5	..
Nonmetallic mineral products industries							
Other nonmetallic mineral products industries	426.7	487.6	571.5	672.4	781.7	924.7	..
Ready–mix concrete industries	388.6	405.0	397.5	455.3	626.3	748.4	..
Concrete products industries	349.7	333.6	376.5	463.9	522.2	590.8	..
Cement industries	387.4	407.5	421.9	490.7	500.2	558.4	..
Glass industries	339.6	403.8	460.9	466.4	482.4	532.7	..
Glass products industries	144.9	209.8	258.1	320.7	294.9	336.7	..
Clay products (domestic clay)	57.1	78.2	87.7	92.9	129.4	148.2	..
Clay products (imported clay)	37.9	37.2	37.3	41.4	98.6	130.4	..
Abrasive industries	80.4	91.4	101.9	97.8	100.5	105.2	..
Lime industries	60.1	66.2	75.4	70.1	78.0	87.4	..
Total	2 272.4	2 520.3	2 788.7	3 171.8	3 614.3	4 163.0	..
Fabricated metal products industries							
Stamped and pressed metal products industries	1 265.1	1 303.6	1 417.2	1 612.4	1 729.2	2 069.7	..
Fabricated structural metal products industries	976.1	795.3	817.4	930.9	1 111.3	1 177.6	..
Hardware, tool and cutlery industry	653.8	650.7	786.7	932.0	993.4	1 025.5	..
Other metal fabricating industries	667.2	690.5	745.5	735.0	729.6	856.4	..
Ornamental and architectural metal products industries	529.5	491.2	519.9	608.4	722.2	813.1	..
Machine shop industry	444.7	451.3	549.5	611.2	636.6	692.4	..
Power boiler and heat exchanger industry	310.0	319.1	298.1	351.1	357.7	407.7	..
Heating equipment industry	188.5	182.0	162.6	243.9	262.6	269.5	..
Total	5 034.8	4 883.7	5 296.9	6 024.8	6 542.6	7 311.9	..

TABLE 13 (cont'd)

	1982	1983	1984	1985	1986	1987	1988
				($ million)			
Petroleum and coal products industries							
Petroleum refining	2 108.4	2 563.7	2 498.2	2 478.8	1 755.6	1 860.1	..
Other petroleum and coal products industries	39.9	52.6	42.1	41.0	98.9	107.5	..
Manufacturers of lubricating oil and greases	31.7	24.8	56.1	75.7	82.5	99.0	..
Total	2 180.0	2 641.1	2 596.4	2 595.5	1 936.9	2 066.5	..
Total mineral manufacturing	14 824.0	16 196.4	18 265.6	19 647.0	20 124.7	22 760.9	..
Total mining and mineral manufacturing	39 251.2	44 208.6	50 811.2	52 142.2	42 341.4	47 564.8	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Wire and wire products have been included in Primary Metal Industries.
[r] Revised; .. Not available; n.e.s. Not elsewhere specified.
Note: Totals may not add due to rounding.

TABLE 14. CANADA, GROSS DOMESTIC PRODUCT OF INDUSTRIAL PRODUCTION, MINING AND MINERAL MANUFACTURING AT FACTOR COST AT 1986 PRICES, 1983–89

	1983	1984	1985	1986	1987	1988	1989p
				($ million)			
Total industrial production	102 435.6	114 882.6	121 272.9	120 356.8	125 721.6	131 996.4	132 099.6
Total mining	15 836.8	18 027.2	18 825.2	17 502.3	18 723.0	20 219.8	19 774.2
Metals							
Gold mines	610.1	679.0	740.1	880.6	988.2	1 137.3	1 507.2
Other metal mines	1 761.7	2 516.3	2 382.5	2 346.5	2 730.7	2 746.6	2 515.7
Iron mines	379.2	444.6	585.8	452.7	506.1	545.1	561.4
Fuels							
Crude oil and natural gas	9 587.3	9 899.3	10 593.7	9 762.6	10 486.2	11 354.9	11 341.8
Nonmetals							
Asbestos	103.8	124.9	110.2	102.0	93.7	98.1	113.5
All nonmetals	396.5	514.1	448.3	485.4	579.5	601.2	580.6
Potash	247.7	336.2	280.5	309.9	369.8	422.3	401.7
Salt	109.9	135.9	132.9	135.6	126.0	131.4	129.7
Coal	505.7	807.5	825.2	755.3	845.7	982.5	985.1
Quarry and sand pits	407.7	470.9	541.2	643.7	692.6	713.1	665.1
Services related to mining	2 136.2	2 473.8	2 663.2	1 937.9	1 674.3	1 909.6	1 374.1
Mineral manufacturing							
Primary metals	4 909.8	6 004.0	6 351.6	6 127.9	6 725.2	7 114.2	7 043.3
Primary steel	2 403.6	2 731.8	2 816.3	2 625.9	2 784.7	2 926.5	2 938.3
Steel pipe and tube mills	154.9	305.0	342.1	277.8	327.7	386.0	348.1
Iron foundries	314.6	435.7	439.2	460.9	433.0	464.6	430.5
Nonferrous smelting and refining	1 537.9	1 855.1	1 989.0	1 954.5	2 296.8	2 417.2	2 382.1
Nonmetallic mineral products	2 382.3	2 607.7	2 845.4	2 970.9	3 252.7	3 297.1	3 248.6
Cement	355.6	354.2	387.0	384.0	428.6	431.4	429.2
Concrete products	321.0	350.7	422.7	448.5	486.5	530.4	539.9
Ready-mix concrete	362.1	392.9	448.4	506.9	575.7	577.3	556.7
Glass and glass products	569.4	647.1	689.3	647.8	685.8	645.8	661.0
Miscellaneous nonmetallic products	653.0	740.6	769.3	786.7	854.1	890.5	884.1
Petroleum and coal products	1 777.5	1 792.8	1 746.0	1 731.6	1 875.7	1 951.6	2 006.8

Source: Statistics Canada.
p Preliminary.

TABLE 15. CANADA, GROSS DOMESTIC PRODUCT BY INDUSTRIES AT FACTOR COST AT 1986 PRICES, 1983–89

	1983	1984	1985	1986	1987	1988	1989p
				($ million)			
Gross domestic product, all industries	394 994.9	418 716.4	438 450.1	451 839.6	470 948.6	491 013.8	506 092.9
Agriculture	10 142.0	9 814.3	9 404.2	11 056.7	10 067.2	8 023.2	9 211.2
Fishing and trapping	852.3	776.7	945.2	980.2	918.6	935.9	1 012.4
Forestry	2 419.9	2 720.3	2 635.3	2 691.0	2 870.3	2 696.1	2 742.5
Mines (including milling), quarries and oil wells	15 836.8	18 027.2	18 825.2	17 502.3	18 723.0	20 219.8	19 774.2
Manufacturing	72 235.6	81 552.0	86 150.2	86 789.7	90 261.6	94 692.3	95 118.4
Construction	26 695.8	25 012.7	26 953.0	28 082.0	29 741.8	31 624.1	32 988.3
Transportation and storage	17 316.5	19 356.4	19 763.4	20 253.8	21 492.5	22 724.4	22 838.3
Communications	11 401.4	11 954.3	12 634.8	13 247.9	14 259.3	15 537.2	17 398.0
Electric power, gas and water utilities	13 124.0	13 793.5	14 885.1	15 198.0	15 862.1	16 179.6	16 294.2
Trade, wholesale	17 944.7	19 358.2	21 765.8	23 312.0	25 250.6	27 343.0	28 093.8
Trade, retail	24 534.7	25 982.5	27 375.2	28 269.4	29 973.2	31 305.3	31 868.6
Finance, insurance and real estate	58 055.7	61 786.9	65 747.8	69 033.6	72 038.7	75 404.0	78 956.6
Community, business and personal services	44 363.8	46 960.0	48 776.9	52 119.1	54 864.8	58 056.0	61 446.2
Government service	30 301.8	30 773.9	30 954.5	31 365.5	31 700.7	32 039.5	32 671.2

Source: Statistics Canada.
p Preliminary.

TABLE 16. CANADA, GROSS DOMESTIC PRODUCT AT FACTOR COST IN CURRENT DOLLARS FOR SELECTED INDUSTRIES BY PROVINCE, 1986

	Newfound-land	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskat-chewan	Alberta	British Columbia	Yukon and N.W.T.	Canada
						($ million)						
Agriculture and related services industries	21.0	107.6	159.2	144.5	1 965.8	2 575.6	1 057.5	2 597.0	1 932.2	564.9	0.1	11 125.4
Logging and forestry industries	45.8	2.3	79.0	189.6	584.3	509.2	26.6	33.4	82.7	1 131.5	1.4	2 685.8
Fishing and trapping industries	143.0	42.8	293.4	70.4	74.8	46.2	18.0	7.5	6.5	270.4	5.7	978.7
Mining, quarrying and oil well industries[1]	360.6	0.8	156.2	142.7	952.9	2 184.9	301.0	1 447.6	10 172.5	1 411.3	478.9	17 609.4
Manufacturing industries	578.1	97.7	1 526.2	1 337.0	21 694.9	46 636.0	2 027.5	930.4	4 064.9	7 257.9	10.6	86 161.4
Construction industries	514.2	110.1	848.0	589.3	6 136.7	10 190.1	1 138.4	1 207.6	3 741.9	3 331.7	278.3	28 086.3
Electric power systems industry, gas distribution systems industry and other utilities industries	343.3	44.0	273.8	541.8	4 409.2	5 044.9	648.9	468.5	1 789.2	1 526.9	71.9	15 162.4
Goods–producing industries	2 006.0	405.3	3 336.0	3 015.3	35 818.6	67 186.9	5 217.9	6 692.0	21 789.9	15 494.6	846.9	161 809.4

Source: Statistics Canada Catalogue No. 15-203.
[1] Cement, lime, clay and clay products (domestic clays) industries are included under "manufacturing."
Note: Totals may not add due to rounding.

TABLE 16a. CANADA, GROSS DOMESTIC PRODUCT AT FACTOR COST IN CURRENT DOLLARS FOR SELECTED INDUSTRIES BY PROVINCE, 1985[r]

	Newfound-land	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskat-chewan	Alberta	British Columbia	Yukon and N.W.T.	Canada
						($ million)						
Agriculture and related services industries	22.4	79.2	138.5	118.5	1 711.4	2 507.8	1 113.5	2 013.1	1 793.4	532.6	0.1	10 030.5
Logging and forestry industries	45.1	1.8	69.7	164.7	528.3	472.7	29.4	30.4	67.4	1 132.2	0.9	2 542.6
Fishing and trapping industries	109.1	29.6	205.6	56.0	56.2	38.1	16.7	6.5	6.1	236.0	5.0	764.9
Mining, quarrying and oil well industries[1]	399.7	1.0	166.7	109.2	857.9	1 994.1	430.3	2 523.8	18 388.8	1 698.3	543.9	27 113.7
Manufacturing industries	458.7	90.4	1 184.8	1 133.0	20 802.3	44 187.8	1 882.3	866.2	4 573.8	6 480.0	12.7	81 672.0
Construction industries	605.2	116.2	981.1	518.0	5 774.9	8 403.0	959.0	1 281.5	3 790.9	3 434.7	276.5	26 141.0
Electric power systems industry, gas distribution systems industry and other utilities industries	331.2	37.4	244.3	452.6	4 233.1	4 546.8	603.1	442.3	1 683.7	1 711.9	64.6	14 351.0
Goods–producing industries	1 971.4	355.6	2 990.7	2 552.0	33 964.1	62 150.3	5 034.3	7 163.8	30 304.1	15 225.7	903.7	162 615.7

Source: Statistics Canada Catalogue No. 15-203.
[1] Cement, lime, clay and clay products (domestic clays) industries are included under "manufacturing."
[r] Revised.
Note: Totals may not add due to rounding.

TABLE 17. CANADA, GROSS DOMESTIC PRODUCT AT FACTOR COST IN CURRENT DOLLARS FOR MINING[1] BY PROVINCE, 1978-86

	Newfound-land	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskat-chewan	Alberta	British Columbia	Yukon and N.W.T.	Canada
						($ million)						
1978	249.2	0.1	83.1	113.7	774.5	1 255.8	190.5	855.7	5 191.2	942.8	294.6	9 951.2
1979	475.6	0.1	102.4	206.4	989.5	1 600.8	354.5	1 014.2	7 409.6	1 621.4	440.4	14 214.8
1980	445.1	0.1	116.1	96.2	1 223.1	2 476.9	428.6	1 304.4	10 033.1	1 479.5	516.7	18 119.5
1981	471.8	0.1	124.9	125.9	1 099.6	1 883.6	290.3	1 298.5	10 593.0	1 264.6	358.4	17 510.6
1982	313.0	0.1	190.0	124.5	866.5	1 356.1	282.2	1 294.3	12 531.2	1 209.7	412.8	18 580.3
1983	367.8	0.1	277.4	94.2	853.6	1 689.4	352.6	1 640.9	14 648.1	1 319.5	443.9	21 687.6
1984r	363.0	0.5	224.9	200.9	793.8	2 186.4	414.7	2 528.3	16 472.6	1 865.3	515.2	25 565.6
1985r	399.7	1.0	166.7	109.2	857.9	1 994.1	430.3	2 523.8	18 388.8	1 698.3	543.9	27 113.7
1986	360.6	0.8	156.2	142.7	952.9	2 184.9	301.0	1 447.6	10 172.5	1 411.3	478.9	17 609.4

Source: Statistics Canada Catalogue No. 15-203.
1 Cement, lime, clay and clay products (domestic clays) industries are not included (see manufacturing).
r Revised.
Note: Totals may not add due to rounding.

TABLE 18. CANADA, GROSS DOMESTIC PRODUCT AT FACTOR COST IN CURRENT DOLLARS FOR MINERAL MANUFACTURING INDUSTRIES BY PROVINCE, 1986

	Primary Metal Industries	Nonmetallic Mineral Products Industries	Fabricated Metal Products Industries	Petroleum and Coal Products Industries	Mineral Manufacturing Industries
		($ million)			
Newfoundland	x	21.1	7.8	x	29.7
Prince Edward Island	–	1.2	3.9	–	5.0
Nova Scotia	x	39.9	46.1	x	310.2
New Brunswick	x	x	47.2	x	246.4
Quebec	1 750.7	x	1 268.9	95.7	x
Ontario	3 524.9	1 627.7	3 843.2	660.4	9 656.1
Manitoba	87.7	80.1	144.9	x	x
Saskatchewan	x	58.1	47.3	x	237.9
Alberta	230.5	251.0	348.8	384.8	1 215.1
British Columbia	405.6	215.5	381.5	x	x
Yukon and Northwest Territories	–	x	–	x	4.4
Canada	6 120.2	2 979.1	6 139.6	1 729.0	16 967.9

Source: Statistics Canada.
x Confidential, included in total; – Nil.

TABLE 18a. CANADA, GROSS DOMESTIC PRODUCT AT FACTOR COST IN CURRENT DOLLARS FOR MINERAL MANUFACTURING INDUSTRIES BY PROVINCE, 1985r

	Primary Metal Industries	Nonmetallic Mineral Products Industries	Fabricated Metal Products Industries	Petroleum and Coal Products Industries	Mineral Manufacturing Industries
	($ million)				
Newfoundland	x	16.3	8.4	x	28.5
Prince Edward Island	–	x	4.1	–	x
Nova Scotia	x	x	47.8	x	73.9
New Brunswick	x	x	40.9	x	140.6
Quebec	1 734.0	596.1	1 286.8	144.0	3 760.9
Ontario	3 551.1	1 340.3	3 511.3	292.3	8 695.0
Manitoba	64.3	65.4	125.6	x	x
Saskatchewan	x	x	46.8	x	209.2
Alberta	293.3	225.2	352.9	919.3	1 790.8
British Columbia	360.7	x	386.0	62.8	x
Yukon and Northwest Territories	–	x	–	x	7.7
Canada	6 079.8	2 574.5	5 810.6	1 529.5	15 994.4

Source: Statistics Canada.
x Confidential, included in total; – Nil; r Revised.
Note: Totals may not add due to rounding.

TABLE 19. CANADA, EXPORTS OF MINERAL COMMODITIES BY COUNTRY AND BY COMMODITY AS DEFINED BY THE HARMONIZED SYSTEM (H.S.), 1989

H.S. Section and Chapter[1]	Description	United States		EEC[2]		Japan		Other		Total	
		($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)
V	**MINERAL PRODUCTS**										
25	Salt, sulphur, earths and stone plastering materials, lime and cement	401 740	29.2	172 447	12.6	58 259	4.2	741 513	54.0	1 373 959	100
26	Ores, slag and ash	589 488	17.9	1 306 463	39.7	923 387	28.1	468 199	14.2	3 287 537	100
27	Mineral fuels, oils and products of their distillation, bituminous substances, mineral waxes[3]	10 283 179	81.8	168 864	1.3	1 495 532	11.9	621 213	4.9	12 568 788	100
VI	**PRODUCTS OF THE CHEMICAL OR ALLIED INDUSTRY**										
28	Inorganic chemicals, compounds of precious metals, radioactive elements, etc.	1 418 643	83.2	163 144	9.6	46 586	2.7	75 919	4.5	1 704 292	100
31	Fertilizers	826 171	56.4	59 278	4.0	75 873	5.2	503 358	34.4	1 464 680	100
XIII	**ARTICLES OF STONE, PLASTER, CEMENT, ASBESTOS, MICA OR SIMILAR MATERIALS; CERAMIC PRODUCTS; GLASS AND GLASSWARE**										
68	Articles of stone, plaster, cement, asbestos, mica or similar materials	277 615	92.3	8 232	2.7	2 081	0.7	12 891	4.3	300 819	100
69	Ceramic products	49 931	83.7	1 035	1.7	367	0.6	8 335	14.0	59 668	100
70	Glass and glassware	339 982	87.1	25 245	6.5	3 530	0.9	21 767	5.6	390 524	100
XIV	**NATURAL OR CULTURED PEARLS, PRECIOUS OR SEMI-PRECIOUS STONES, PRECIOUS METALS, METALS CLAD WITH PRECIOUS METALS AND ARTICLES THEREOF; IMITATION JEWELLERY; COIN**										
71	Natural or cultured pearls, precious stones and metals, coins, etc.	1 210 677	43.1	200 052	7.1	374 821	13.3	1 022 834	36.4	2 808 384	100
XV	**BASE METALS AND ARTICLES OF BASE METAL**										
72	Iron and steel	1 639 708	70.4	174 880	7.5	15 649	0.7	498 361	21.4	2 328 598	100
73	Articles of iron or steel	1 532 905	89.0	41 666	2.4	4 693	0.3	142 160	8.3	1 721 424	100
74	Copper and articles thereof	868 507	58.8	473 989	32.1	6 763	0.5	127 148	8.6	1 476 407	100
75	Nickel and articles therof	166 161	19.2	204 226	23.6	15 036	1.7	479 900	55.5	865 323	100
76	Aluminum and articles thereof	2 702 046	71.8	292 713	7.8	352 702	9.4	417 473	11.1	3 764 934	100
78	Lead and articles thereof	51 809	41.4	35 997	28.8	5 407	4.3	31 904	25.5	125 117	100
79	Zinc and articles thereof	854 867	81.6	44 346	4.2	40 175	3.8	108 810	10.4	1 048 198	100
80	Tin and articles thereof	7 312	81.8	219	2.5	55	0.6	1 352	15.1	8 938	100
81	Other base metals, cermets, and articles thereof	49 998	46.4	17 143	15.9	8 365	7.8	32 249	29.9	107 755	100
	TOTAL	23 270 739	65.7	3 389 939	9.6	3 429 281	9.7	5 315 386	15.0	35 405 345	100

Source: Statistics Canada, Catalogue No. 65-003 (Quarterly).
[1] Chapter refers to a group of commodities covered in a specified chapter of the "Harmonized Commodity Description and Coding System," as of January 1, 1988. Canadian external trade statistics are classified according to the Harmonized System. [2] European Economic Community. [3] Value of coal exports in Chapter 27 is $2225 million.

TABLE 20. CANADA, IMPORTS OF MINERAL COMMODITIES BY COUNTRY AND BY COMMODITY AS DEFINED BY THE HARMONIZED SYSTEM (H.S.), 1989

H.S. Section and Chapter[1]	Description	United States ($000)	United States (%)	EEC[2] ($000)	EEC[2] (%)	Japan ($000)	Japan (%)	Other ($000)	Other (%)	Total ($000)	Total (%)
V	**MINERAL PRODUCTS**										
26	Ores, slag and ash	381 897	48.9	124 685	16.0	0	0.0	273 866	35.1	780 448	100
27	Mineral fuels, oils and products of their distillation, bituminous substances, mineral waxes[3]	2 015 345	31.8	1 832 740	28.9	748	0.0	2 482 963	39.2	6 331 796	100
VI	**PRODUCTS OF THE CHEMICAL OR ALLIED INDUSTRY**										
28	Inorganic chemicals, compounds of precious metals, radioactive elements, etc.	808 455	57.8	105 810	7.6	37 040	2.6	447 022	32.0	1 398 327	100
31	Fertilizers	165 213	89.2	15 509	8.4	533	0.3	3 863	2.1	185 118	100
XIII	**ARTICLES OF STONE, PLASTER, CEMENT, ASBESTOS, MICA OR SIMILAR MATERIALS; CERAMIC PRODUCTS; GLASS AND GLASSWARE**										
68	Articles of stone, plaster, cement, asbestos, mica or similar materials	226 894	63.3	103 024	28.7	4 260	1.2	24 376	6.8	358 554	100
69	Ceramic products	208 210	34.9	218 672	36.6	60 410	10.1	109 538	18.4	596 830	100
70	Glass and glassware	742 926	77.8	95 399	10.0	34 454	3.6	81 913	8.6	954 692	100
XIV	**NATURAL OR CULTURED PEARLS, PRECIOUS OR SEMI-PRECIOUS STONES, PRECIOUS METALS, METALS CLAD WITH PRECIOUS METALS AND ARTICLES THEREOF; IMITATION JEWELLERY; COIN**										
71	Natural or cultured pearls, precious stones and metals, coins, etc.	842 157	53.4	186 651	11.8	7 890	0.5	541 008	34.3	1 577 706	100
XV	**BASE METALS AND ARTICLES OF BASE METAL**										
72	Iron and steel	1 068 466	49.8	439 612	20.5	103 127	4.8	533 640	24.9	2 144 845	100
73	Articles of iron or steel	1 728 859	67.7	304 221	11.9	164 211	6.4	356 464	14.0	2 553 755	100
74	Copper and articles thereof	485 697	71.0	43 112	6.3	10 405	1.5	145 135	21.2	684 349	100
75	Nickel and articles therof	84 438	51.4	12 722	7.7	886	0.5	66 161	40.3	164 207	100
76	Aluminum and articles thereof	1 491 273	87.3	124 425	7.3	6 791	0.4	85 432	5.0	1 707 921	100
78	Lead and articles thereof	21 254	81.9	704	2.7	43	0.2	3 950	15.2	25 951	100
79	Zinc and articles thereof	22 956	76.1	1 231	4.1	146	0.5	5 835	19.3	30 168	100
80	Tin and articles thereof	13 079	23.3	3 811	6.8	248	0.4	38 942	69.4	56 080	100
81	Other base metals, cermets, and articles thereof	128 997	74.9	12 983	7.5	4 698	2.7	25 592	14.9	172 270	100
	TOTAL	10 774 242	53.4	3 645 129	18.1	437 211	2.2	5 323 514	26.4	20 180 096	100

Source: Statistics Canada, Catalogue No. 65-003 (Quarterly).
[1] Chapter refers to a group of commodities covered in a specified chapter of the "Harmonized Commodity Description and Coding System," as of January 1, 1988. Canadian external trade statistics are classified according to the Harmonized System. [2] European Economic Community. [3] Value of coal imports included in Chapter 27 is $782 million.

TABLE 21. CANADA, VALUE OF EXPORTS OF MINERALS, METALS AND THEIR PRODUCTS FOR 1990 (9 MONTHS)

Chapter[1]	Description	United States	EEC	Japan	Other	Total
				($000)		
25	Salt; sulphur; earths and stone, plastering material, lime and cement	393 206	125 859	42 131	516 930	1 078 126
26	Ores, slag and ash	496 020	1 015 326	793 159	333 870	2 638 375
27	Mineral fuels, oils and products of their distillation; bituminous substances; mineral waxes[2]	8 350 672	134 259	1 143 563	466 537	10 095 031
28	Inorganic chemicals; compounds of precious metals, radioactive elements, etc.	993 104	95 092	20 186	74 556	1 182 938
31	Fertilizers	732 216	49 037	48 447	384 607	1 214 307
68	Articles of stone, plaster, cement, asbestos, mica or similar materials	237 737	9 542	1 557	8 343	257 179
69	Ceramic products	35 248	1 419	529	6 427	43 623
70	Glass and glassware	249 608	28 211	1 156	13 646	292 621
71	Natural/cultured pearls, precious stones and metals, coins, etc.	616 392	275 691	321 065	875 849	2 088 997
72	Iron and steel	1 237 065	213 275	10 284	278 549	1 739 173
73	Articles of iron or steel	1 159 708	27 827	4 849	78 450	1 270 834
74	Copper and articles thereof	674 638	299 634	3 846	73 406	1 051 524
75	Nickel and articles thereof	590 999	198 199	19 597	304 181	1 112 976
76	Aluminum and articles thereof	1 911 031	123 905	232 685	265 873	2 533 494
78	Lead and articles thereof	55 251	22 408	6 939	7 181	91 779
79	Zinc and articles thereof	567 907	20 848	30 282	61 615	680 652
80	Tin and articles thereof	5 019	111	94	806	6 030
81	Other base metals; cermets; and articles thereof	96 251	17 238	3 337	22 503	139 329
	Total	18 402 072	2 657 881	2 683 706	3 773 329	27 516 988

Source: Statistics Canada, Catalogue 65-003 (Quarterly).
[1] Chapter refers to a group of commodities covered in a specified chapter of the "Harmonized Commodity Description and Coding System", as of January 1, 1988. Canadian external trade statistics are classified according to the Harmonized System. [2] Total value of coal exports included in Chapter 27 is $1850 million.

TABLE 22. CANADA, VALUE OF IMPORTS OF MINERALS, METALS AND THEIR PRODUCTS FOR 1990 (9 MONTHS)

Chapter[1]	Description	United States	EEC	Japan	Other	Total
				($000)		
25	Salt; sulphur; earths and stone, plastering material, lime and cement	257 832	6 744	2 488	64 305	331 369
26	Ores, slag and ash	319 826	33 802	0	216 903	570 531
27	Mineral fuels, oils and products of their distillation; bituminous substances; mineral waxes[2]	1 750 670	1 436 929	199	2 333 234	5 521 032
28	Inorganic chemicals; compounds of precious metals, radioactive elements, etc.	547 813	71 191	29 016	322 997	971 017
31	Fertilizers	124 858	18 284	692	7 802	151 636
68	Articles of stone, plaster, cement, asbestos, mica or similar materials	186 229	79 445	3 088	22 816	291 578
69	Ceramic products	153 519	157 971	39 857	80 556	431 903
70	Glass and glassware	577 604	70 060	31 715	70 930	750 309
71	Natural/cultured pearls, precious stones and metals, coins, etc.	644 280	115 742	4 867	234 840	999 729
72	Iron and steel	784 428	243 777	76 145	221 633	1 325 983
73	Articles of iron or steel	1 298 687	209 528	137 158	254 183	1 899 556
74	Copper and articles thereof	317 350	31 015	5 756	54 823	408 944
75	Nickel and articles thereof	51 940	25 299	804	61 927	139 970
76	Aluminum and articles thereof	1 025 048	97 931	4 812	60 151	1 187 942
78	Lead and articles thereof	18 286	330	10	2 710	21 336
79	Zinc and articles thereof	20 377	2 200	78	12 056	34 711
80	Tin and articles thereof	9 066	4 153	1	21 780	35 000
81	Other base metals; cermets; and articles thereof	109 349	15 819	4 087	19 625	148 880
	Total	8 197 162	2 620 220	340 773	4 063 271	15 221 426

Source: Statistics Canada, Catalogue 65-006 (Quarterly).
[1] Chapter refers to a group of commodities covered in a specified chapter of the "Harmonized Commodity Description and Coding System", as of January 1, 1988. Canadian external trade statistics are classified according to the Harmonized System. [2] Total value of coal imports included in Chapter 27 is $494 million.

TABLE 23. CANADA, APPARENT CONSUMPTION[1] OF SOME MINERALS AND RELATION TO PRODUCTION[2], 1987–89

	1987			1988			1989p		
	Apparent Consumption	Production	Consumption as % of Production	Apparent Consumption	Production	Consumption as % of Production	Apparent Consumption	Production	Consumption as % of Production
	(tonnes)			(tonnes)			(tonnes)		
Quartz silica	3 450 683	2 661 903	129.6	3 576 484	2 806 775	127.4	2 956 419	2 332 200	126.8
Salt	9 316 467	10 129 053	92.0	8 859 275	10 687 180	82.9	11 280 896	11 057 393	102.0
Lime	2 210 595	2 330 071	94.9	2 427 626	2 517 982	96.4	2 507 422	2 551 934	98.3
Cement	10 386 353	12 603 164	82.4	9 793 869	12 349 873	79.3	11 006 262	12 590 637	87.4
Gypsum	3 606 698	9 093 926	39.7	3 437 390	8 813 760	39.0	3 297 987	8 196 340	40.2
Iron ore	12 927 296	37 701 825	34.3	14 206 084	39 933 862	35.6	14 590 583	39 445 047	37.0
Potash (K_2O)	982 935	7 668 384	12.8	507 278	8 154 428	6.2	367 948	7 014 074	5.2
Asbestos	15 959	664 546	2.4	25 664	710 358	3.6	–	701 227	n.a.

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] "Apparent consumption" is production, plus imports, less exports. [2] "Production" refers to producers' shipments.
p Preliminary; – Nil; n.a. Not applicable.

TABLE 24. CANADA, REPORTED CONSUMPTION OF MINERALS AND RELATION TO PRODUCTION, 1987–89

	Unit of Measure	1987 Consumption	1987 Production	1987 Consumption as % of Production	1988 Consumption	1988 Production	1988 Consumption as % of Production	1989[p] Consumption	1989[p] Production	1989[p] Consumption as % of Production
Metals										
Aluminum[1]	t	413 237[r]	1 540 439	26.8[r]	488 699	1 534 499	31.8	524 737	1 554 753	33.8
Antimony	kg	540 147	3 705 613	14.6	161 391	3 171 482	5.1	220 474	2 817 810	7.8
Bismuth	kg	4 547	165 282	2.8	6 709	180 907	3.7	16 158	156 727	10.3
Cadmium	kg	18 919	1 481 496	1.3	19 988	1 663 978	1.2	26 926	1 710 527	1.6
Chromium (chromite)	t	18 569	–	n.a.	20 137	–	n.a.	21 066	–	n.a.
Cobalt	kg	120 194	2 490 020	4.8	159 290	2 398 345	6.6	147 299	2 344 389	6.3
Copper[2]	t	232 260[r]	794 149	29.2[r]	238 515	758 478	31.4	215 642	704 432	30.6
Lead[3]	t	97 281[r]	373 215	26.1[r]	88 041	351 148	25.1	87 290	268 887	32.5
Magnesium	t	9 469	x	x	14 066	x	x	15 407	x	x
Manganese ore	t	220 053	–	n.a.	160 146	–	n.a.	203 574	–	n.a.
Mercury	kg	35 714	–	n.a.	27 364	–	n.a.	32 226	–	n.a.
Molybdenum (Mo content)	t	970	14 771	6.6	1 213	13 535	9.0	13 543	13 535	100.1
Nickel	t	9 732	189 086	5.1	9 250	198 744	4.7	10 423	195 554	5.3
Selenium	kg	14 570	430 425	3.4	13 541	321 202	4.2	14 806	212 794	7.0
Silver	kg	331 245	1 374 946	24.1	457 698	1 443 166	31.7	531 046	1 312 433	40.5
Tellurium	kg	x	13 164	x	x	19 178	x	x	7 562	x
Tin	t	3 780	x	x	3 489	x	x	3 567	x	x
Tungsten (W content)	kg	729 776	x	x	385 917	x	x	347 442	x	x
Zinc[3]	t	131 659	1 157 936	11.4	150 805	1 370 000	11.0	146 305	1 272 854	11.5
Nonmetals										
Barite	t	15 832	42 103	37.6	22 632	51 450	44.0	16 500	38 511	42.8
Feldspar	t	2 340	–	n.a.	2 574	–	n.a.	2 049	–	n.a.
Fluorspar	t	179 595	x	x	179 194	x	x	162 518	x	x
Mica	kg	4 791	x	x	4 107	x	x	10 198	x	x
Nepheline syenite	t	99 651	506 415	19.7	91 008	539 835	16.9	88 660	551 324	16.1
Phosphate rock	t	2 062 710	–	n.a.	2 027 850	–	n.a.	1 884 742	–	n.a.
Potash (K_2O)	t	288 977	7 668 384	3.8	221 877	8 154 428	2.7	213 523	7 014 074	3.0
Sodium sulphate	t	188 626	342 076	55.1	187 838	330 971	56.8	212 250	327 444	64.8
Sulphur	t	986 443	6 531 940	15.1	1 133 232	6 837 991	16.6	1 080 399	6 558 584	16.5
Talc, etc.	t	65 953	136 418	48.3	70 584	146 493	48.2	70 584	144 828	48.7
Fuels										
Coal	000 t	50 144	61 211	81.9	54 390	70 644	77.0	53 881	70 527	76.4
Crude oil[4]	000 m^3	81 811	89 140	91.8	85 972	93 806	91.6	87 789	90 641	96.9
Natural gas[5]	million m^3	46 000[r]	78 267	58.8	49 058	90 911	54.0	52 336	96 117	54.5

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Consumption of primary refined metal, reported by consumers. [2] Consumption defined as domestic shipments of refined copper plus imports of refined copper. [3] Consumption of primary and secondary refined metal, reported by consumers. [4] Consumption defined as refinery receipts. [5] Consumption defined as domestic sales.

[p] Preliminary; [r] Revised; n.a. Not applicable; x Confidential.

Note: Unless otherwise stated, consumption refers to reported consumption of refined metals or nonmetallic minerals by consumers. Production of metals, in most cases, refers to production in all forms, and includes the recoverable content of ores, concentrates, matte, etc., and metal content of primary products recoverable at domestic smelters and refineries. Production of nonmetals refers to producers' shipments. For fuels, production is equivalent to actual output less waste.

TABLE 25. CANADA, DOMESTIC CONSUMPTION OF PRINCIPAL REFINED METALS IN RELATION TO REFINERY PRODUCTION,[1] 1983–89

	Unit of Measure	1983	1984	1985	1986	1987	1988	1989p
Aluminum								
Domestic consumption[2]	t	332 389	379 249	346 033	388 879r	413 237r	488 699	524 737
Production	t	1 091 213	1 221 985	1 282 316	1 355 161	1 540 439	1 534 499	1 554 753
Consumption of production	%	30.5	31.0	27.0	28.7r	26.8r	31.8	33.8
Copper								
Domestic consumption[3]	t	170 443	231 039	222 466	225 586	232 260r	238 515	215 642
Production	t	464 333	504 262	499 626	493 445	491 124	528 723	515 216
Consumption of production	%	36.7	45.8	44.5	45.7	47.3r	45.1	41.9
Lead								
Domestic consumption[4]	t	88 579	111 642	104 447	94 680	97 281r	88 041	87 290
Production	t	178 043	174 987	173 220	169 934	139 475	179 461	157 330
Consumption of production	%	49.8	63.8	60.3	55.7	69.7r	49.1	55.5
Zinc								
Domestic consumption[4]	t	116 257	119 573	123 256	126 115	131 659	150 805	146 305
Production	t	617 033	682 976	692 406	570 981	609 909	670 333	669 677
Consumption of production	%	18.8	17.5	17.8	22.1	21.6	22.5	21.8

Source: Energy, Mines and Resources Canada.
[1] Production of refined metal from all sources, including metal derived from secondary materials at primary refineries. [2] Consumption of primary refined metal, reported by consumers. [3] Consumption defined as domestic shipments of refined copper plus imports of refined copper. [4] Consumption of primary and secondary refined metal, reported by consumers.
p Preliminary; r Revised.

TABLE 26. AVERAGE ANNUAL PRICES[1] OF SELECTED MINERALS, 1983–89

	Unit of Measure	1983	1984	1985	1986	1987	1988	1989
Aluminum, London Metal Exchange	¢/lb.	65.342	56.526	47.850	52.179	71.004	115.394	88.242
Antimony, New York dealer	$/lb.	0.913	1.512	1.311	1.219	1.116	1.039	0.943
Asbestos, No. 4T cement fibre	C$/t	1 083.000	1 083.000	1 083.000	1 083.000	1 083.000	1 080.000	1 080.000
Bismuth, New York dealer	$/lb.	1.653	4.132	4.932	3.017	3.629	5.726	5.657
Cadmium, New York dealer[2]	$/lb.	1.129	1.693	1.208	1.248	1.768	7.031	6.277
Calcium, metal crowns (Producer Price List)	$/lb.	3.050	3.099	3.504	3.920	3.850	3.850	3.850
Chrome, U.S. metal, 9% carbon	$/lb.	4.450	4.450	4.450	3.021	2.700	2.700	3.621
Cobalt, metal, shot/cathode/250 kg	$/lb.	12.500	12.417	11.700	11.242	7.000	7.532	8.400
Columbium, pyrochlore	$/lb.	3.250	3.250	3.209	2.600	3.250	2.600	..
Copper, electrolytic cathode, COMEX	¢/lb.	71.902	61.320	60.988	61.649	77.837	119.183	129.454
Gold, London[3]	C$/troy oz.	520.792	466.781	433.227	510.628	592.011	538.024	451.691
Iridium, Impala producer	$/troy oz.	600.000	600.000	600.000	600.000	513.750	420.000	420.000
Iron ore, taconite pellets	¢/ltu	80.500	80.500	80.500	80.500	77.548	72.441	72.450
Lead, producer	C¢/lb.	26.770	33.517	26.179	30.885	47.985	46.013	47.171
Magnesium, U.S. primary ingot (Producer Price List)	$/lb.	1.365	1.455	1.480	1.530	1.530	1.563	1.630
Manganese, U.S. metal, regular	¢/lb.	67.583	73.542	80.000	79.450	80.687	86.417	91.000
Mercury, New York dealer	$/flask (76 lb.)	322.443	314.381	310.957	232.785	295.503	335.517	287.722
Molybdenum, dealer, oxide	$/lb.	3.635	3.557	3.247	2.871	2.899	3.449	3.341
Nickel, New York dealer, cathode	$/lb.	2.810	2.221	2.260	1.855	2.278	6.122	5.982
Osmium, New York dealer	$/troy oz.	133.113	466.479	913.125	698.854	632.458	588.750	547.917
Palladium, Impala producer	$/troy oz.	130.000	14.667	126.905	130.595	150.000	150.000	150.000
Platinum, Impala producer	$/troy oz.	475.000	475.000	475.000	519.147	600.000	600.000	600.000
Potash, coarse, major producer, 60% contained, K_2O[4]	$/st	71.500	65.000	55.729	46.750	68.000	86.000	88.000
Rhodium, Impala producer	$/troy oz.	600.000	627.500	892.708	1 194.583	1 240.000	1 275.000	1 275.000
Ruthenium, New York dealer	$/troy oz.	28.529	104.183	100.269	73.423	69.796	62.204	62.258
Selenium, New York dealer	$/lb.	3.722	8.995	7.248	5.596	6.479	10.085	7.451
Silver, Handy & Harman, Toronto	C$/troy oz.	11.421[r]	8.141[r]	6.142[r]	5.470[r]	7.009[r]	6.535[r]	5.499
Sulphur, elemental, North American deliveries	C$/t	60.170	69.222	100.775	107.959	88.234	71.050	72.060
Tantalum, tantalite ore, spot	$/lb.	23.146	29.438	26.292	18.008	20.542	37.700	35.302
Tellurium, major producer, slab	$/lb.	9.000	11.000	11.000	10.000	10.006	14.250[e]	..
Tin, New York dealer	$/lb.	6.013	5.678	5.279	2.941	3.156	3.309	3.973
Titanium, slag	$/lt	150.000	150.000	150.000	150.000	150.000	215.838	x
Tungsten, London Metal Bulletin - ore	$/mtu	79.029	79.146	64.925	42.554	44.492	52.015	50.356
Uranium, U_3O_8[5]	C$/lb.	31.212[r]	27.000[r]	26.000[r]	25.000[r]	23.000[r]	25.000[r]	24.000
Vanadium, pentoxide, metallurgical	$/lb.	3.350	3.350	3.350	3.350	3.350	3.350	..
Zinc, special high grade	C¢/lb.	52.632	63.823	56.876	55.129	57.794	74.988	97.538

Sources: Alberta Energy Resource Industries Monthly Statistics (Sulphur); "Engineering and Mining Journal" (Asbestos); " Industrial Minerals" (Potash); "Metals Week"; "Northern Miner"; Energy, Mines and Resources Canada.

[1] Prices, except where noted, are in United States currency. [2] U.S. producer price is used for 1983-86; New York dealer price is used for 1987-89. [3] Average afternoon fixings of London bullion dealers, converted to Canadian dollars. [4] Annual average not available, indicative price given. [5] From EMR publications on assessment of Canada's uranium supply and demand.

[r] Revised; .. Not available; [e] Estimate; x Confidential.

TABLE 27. CANADIAN AVERAGE ANNUAL PRICES OF SELECTED MINERALS, 1983–89

	Unit of Measure	1983	1984	1985	1986	1987	1988	1989
Aluminum, London Metal Exchange	$/kg	1.775	1.614	1.440	1.598	2.076	3.131	2.304
Antimony, New York dealer	$/kg	2.481	4.316	3.947	3.734	3.262	2.819	2.462
Asbestos, No. 4T cement fibre	$/t	1 083.000	1 083.000	1 083.000	1 083.000	1 083.000	1 080.000	1 080.000
Bismuth, New York dealer	$/kg	4.491	11.795	14.847	9.241	10.609	15.538	14.768
Cadmium, New York dealer[1]	$/kg	3.067	4.833	3.637	3.823	5.168	19.079	16.387
Calcium, metal crowns (Producer Price List)	$/kg	8.286	8.846	10.549	12.007	11.255	10.447	10.051
Chrome, U.S. metal, 9% carbon	$/kg	12.090	12.703	13.396	9.254	7.893	7.327	9.453
Cobalt, metal, shot/cathode/250 kg	$/kg	33.961	35.446	35.222	34.436	20.463	20.439	21.930
Columbium, pyrochlore	$/kg	8.830	9.278	9.660	7.964	9.501	7.055	. .
Copper, electrolytic cathode, COMEX	$/kg	1.953	1.750	1.836	1.888	2.275	3.234	3.380
Gold, London[2]	$/g	16.744	15.007	13.929	16.417	19.034	17.298	14.522
Iridium, Impala producer	$/g	23.773	24.978	26.341	26.802	21.902	16.621	15.991
Iron ore, taconite pellets	¢/mtu	97.638	102.588	108.187	110.082	101.204	87.757	84.440
Lead, producer	¢/kg	59.018	73.892	57.715	68.090	105.789	101.441	103.994
Magnesium, U.S. primary ingot (Producer Price List)	$/kg	3.709	4.153	4.455	4.687	4.473	4.241	4.255
Manganese, U.S. metal, regular	$/kg	1.836	2.099	2.408	2.434	2.359	2.345	2.376
Mercury, New York dealer	$/kg	11.527	11.808	12.317	9.382	11.366	11.980	9.884
Molybdenum, dealer, oxide	$/kg	9.876	10.154	9.775	8.794	8.475	9.359	8.722
Nickel, New York dealer, cathode	$/kg	5.923	6.340	6.804	5.682	6.659	16.613	15.617
Osmium, New York dealer	$/g	5.274	19.419	40.088	31.218	26.963	23.299	20.861
Palladium, Impala producer	$/g	5.151	6.106	5.571	5.834	6.395	5.936	5.711
Platinum, Impala producer	$/g	18.820	19.774	20.853	23.191	25.579	23.744	22.844
Potash, coarse, major producer, 60% contained, K_2O[3]	$/t	97.128	92.775	83.884	71.601	99.392	116.685	114.871
Rhodium, Impala producer	$/g	23.773	26.123	39.192	53.363	52.863	50.456	48.543
Ruthenium, New York dealer	$/g	1.130	4.337	4.402	3.280	2.976	2.462	2.370
Selenium, New York dealer	$/kg	10.112	25.677	21.820	17.142	18.940	27.367	19.452
Silver, Handy & Harman, Toronto	$/kg	452.512	338.909	269.646	244.349	298.804	258.611	209.369
Sulphur, elemental, North American deliveries	$/t	60.170	69.222	100.775	107.959	88.234	71.050	72.060
Tantalum, tantalite ore, spot	$/kg	62.885	84.034	79.150	55.161	60.050	102.302[e]	92.164
Tellurium, major producer, slab	$/kg	24.452	31.401	33.115	30.631	29.250	38.669	. .
Tin, New York dealer	$/kg	16.337	16.209	15.892	9.009	9.226	8.979	10.372
Titanium, slag	$/t	181.933	191.158	201.591	205.121	195.757	261.472	x
Tungsten, London Metal Bulletin - ore	$/mtu	97.392	102.481	88.656	59.125	58.996	64.024	59.631
Uranium, U[4]	$/kg	100.000[r]	90.000[r]	91.000[r]	89.000[r]	79.000[r]	79.000[r]	74.000
Vanadium, pentoxide, metallurgical	$/kg	9.102	9.563	10.085	10.262	9.793	9.091	. .
Zinc, special high grade	$/kg	1.160	1.407	1.254	1.215	1.274	1.653	2.150

Sources: Alberta Energy Resource Industries Monthly Statistics (Sulphur); "Engineering and Mining Journal" (Asbestos); "Industrial Minerals" (Potash); "Metals Week"; "Northern Miner"; Energy, Mines and Resources Canada.

[1] U.S. producer price for 1983-86; New York dealer price for 1987-89 . [2] Average afternoon fixings of London bullion dealers, converted to Canadian dollars.
[3] Annual average not available, indicative price given. [4] From EMR publications on assessment of Canada's uranium supply and demand.
[r] Revised; . . Not available; [e] Estimate; x Confidential.

TABLE 28. CANADA, MINERAL PRODUCTS INDUSTRIES, SELLING PRICE INDEXES, 1983–89

Base (1981=100)	1983	1984	1985	1986	1987	1988	1989p
Iron and steel products industries							
Ferro-alloy and steel foundry industries	104.1	110.5	113.3	114.7	113.3	116.8	123.3
Iron foundries	109.0	112.2	116.6	119.8	121.9	125.6	129.8
Primary steel industries	109.9	113.5	115.7	116.9	118.4	125.2	127.9
Steel pipe and tube industry	108.9	111.0	112.1	112.4	113.0	119.2	121.7
Nonferrous primary metal products industries							
Aluminum rolling, casting and extruding industry	103.6	116.2	111.2	114.4	117.7	138.0	131.7
Copper rolling, casting and extruding industry	99.2	91.4	93.0	95.9	108.6	144.3	157.3
Jewellery and precious metals industries	99.9	90.6	87.7	94.9	99.9	94.6	86.3
Other rolling casting and extruding industry	99.7	106.6	100.9	102.3	108.6	125.7	128.7
Nonferrous metal smelting and refining industries	95.6	98.1	91.7	95.2	106.5	143.8	139.6
Nonmetallic mineral products industries							
Agricultural chemicals industries	100.2	103.8	104.2	101.7	102.1	108.6	109.0
Hydraulic cement industry	123.7	128.0	133.9	137.3	138.4	139.9	143.7
Clay products industry (from domestic clay)	120.5	130.7	143.0	152.6	164.4	169.5	179.5
Clay products industry (from imported clay)	115.5	118.1	121.5	128.1	135.2	143.2	153.2
Concrete products industries	115.0	113.8	114.0	120.5	126.5	136.5	140.0
Glass and glass products industries	114.5	119.0	121.1	126.0	131.0	138.0	139.3
Nonmetallic mineral insulating materials industry	112.7	113.4	120.8	121.8	127.3	133.5	139.0
Refined petroleum and coal products industries	121.8	127.1	133.5	107.2	101.9	95.3	97.0
Fabricated metal products industries							
Agricultural implement industry	119.7	125.3	130.3	133.3	135.7	137.7	140.6
Miscellaneous fabricated structural metal products	108.5	110.8	115.3	118.0	120.6	128.3	134.1
Hardware, tool and cutlery industries	115.7	121.6	128.0	132.5	137.5	144.9	151.3
Heating equipment industry	117.5	121.9	127.2	129.6	132.9	137.9	143.0
Other metal fabricating industries	109.5	114.6	119.1	123.5	126.5	133.2	139.9
Power boiler and heat exchanger industry	110.7	114.2	120.0	130.0	141.5	149.2	157.8
Stamped, pressed and coated metal products industries	112.5	115.8	118.4	123.2	127.1	131.5	133.8
Wire and wire products industries	107.2	113.0	115.5	116.4	118.1	124.4	129.6

Source: Statistics Canada, Catalogue No. 62-011.
p Preliminary.

TABLE 29. CANADA, SELLING PRICE INDEXES OF MINERAL RAW MATERIALS, 1983–89

Base (1981=100)	1983	1984	1985	1986	1987	1988	1989p
Metallic minerals							
Copper concentrates	92.4	80.8	86.6	89.5	106.3	142.1	148.0
Iron ore	105.2	109.5	114.0	115.5	111.4	105.2	98.7
Lead concentrates	57.5	73.1	56.7	67.7	106.2	102.8	104.3
Nickel concentrates	84.5	92.8	99.4	87.2	97.0	229.7	219.5
Other base metals	95.3	104.8	94.8	96.8	103.6	126.1	117.8
Precious metals	99.0	84.9	77.2	86.6	99.2	90.0	76.1
Gold and alloys in primary form	98.0	85.0	78.2	88.1	100.5	91.5	77.3
Platinum	99.6	87.5	74.1	119.3	139.0	121.4	113.9
Silver	111.2	82.1	65.8	59.8	72.9	63.5	51.7
Radio-active concentrates	98.5	95.1	91.9	91.1	89.2	79.1	54.7
Zinc concentrates	96.3	118.4	105.0	101.7	108.0	141.1	187.9
Nonmetal materials							
Asbestos fibres	110.9	110.4	108.0	107.7	107.8	108.7	115.4
Other crude minerals	110.1	114.3	116.0	117.5	117.8	122.9	122.2
Potash (muriate)	91.8	99.5	93.5	92.0	99.0	133.7	129.6
Sand and gravel	108.8	108.2	109.4	112.1	117.3	128.0	140.4
Quartz and silica sand	117.2	114.6	118.4	122.1	122.6	131.4	130.4
Stone	123.6	127.5	133.8	138.9	143.4	149.8	153.0
Building	123.2	127.6	132.9	136.5	141.3	145.3	152.0
Crushed	127.6	134.6	143.3	151.0	157.3	164.7	166.8
Other	123.2	127.6	132.9	136.5	141.3	145.3	152.0
Sulphur	98.9	114.4	167.2	179.1	145.9	117.9	118.0
Mineral fuels							
Coal (thermal)	111.0	118.6	119.5	119.3	120.2	107.0	107.3
Natural gas	134.3	131.4	131.6	129.2	124.9	115.1	109.9
Crude mineral oil	130.0	131.8	138.9	80.1	88.6	69.3	79.2

Source: Statistics Canada, Catalogue No. 62-011.
p Preliminary.

TABLE 30. CANADA, PRINCIPAL STATISTICS OF THE MINERAL INDUSTRY,[1] 1988

	Mining Activity								Total Activity[2]		
		Production and Related Workers			Costs						
	Establish-ments	Employees	Person-Hours Paid	Wages	Fuel and Electricity	Materials and Supplies	Value of Production	Value Added	Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)	(number)	($000)	($000)
Metals											
Nickel–copper–zinc	25	13 590	30 312	581 086	220 516	1 724 460	6 324 576	4 379 601	18 881	818 267	4 404 972
Gold	65	9 813	21 339	410 600	97 746	523 882	2 013 663	1 392 035	12 594	535 109	1 392 955
Uranium	5	4 219	8 595	190 971	52 818	164 474	1 078 198	860 906	5 103	238 012	858 635
Silver–lead–zinc	15	3 060	7 181	127 778	58 939	701 756	1 593 920	833 225	4 443	193 804	837 839
Iron	7	4 631	9 943	201 823	177 896	420 233	1 283 040	684 911	6 095	275 335	678 249
Miscellaneous metal mines[3]	6	827	1 754	27 581	11 797	49 402	163 141	101 941	1 161	40 516	103 790
Total	123	36 140	79 123	1 539 838	619 714	3 584 205	12 456 538	8 252 619	48 277	2 101 043	8 276 440
Industrials											
Potash	10	3 045	6 509	111 023	99 452	153 493	1 212 075	959 129	3 970	155 356	956 241
Stone	127	2 300	5 461	76 165	35 229r	125 736r	506 766	345 802r	2 981	103 586	354 326r
Sand and gravel	147	1 896	4 361	60 399	29 340	94 472	389 896	266 083	2 936	99 479	287 288
Miscellaneous nonmetals[4]	33	1 704	3 862	60 402	27 576	50 240	340 872	263 055	2 452	90 433	261 720
Asbestos	4	2 049	4 631	75 132	33 687	74 243	241 403	133 473	2 720	103 992	137 922
Peat	58	1 321	2 966	26 742	4 985	24 497	105 569r	76 087r	1 581	34 195	77 326r
Gypsum	10	654	1 518	19 247	6 487	20 881	87 975	60 606	956	31 718	64 137
Total	389	12 969	29 307	429 111	236 756r	543 563r	2 884 556r	2 104 236r	17 596	618 761	2 138 960r
Fuels											
Oil, crude and natural gas	801	8 459	17 021	368 423	325 792	1 221 155	14 717 027	13 170 110	33 754	1 698 296	13 405 413
Coal	27	9 142	17 785	379 543	114 494	336 111	1 719 268	1 268 663	11 122	478 005	1 279 531
Total	828	17 601	34 806	747 966	440 286	1 557 266	16 436 295	14 438 773	44 876	2 176 301	14 684 944
Total mineral industry	1 340	66 710	143 237	2 716 915	1 296 756r	5 685 035r	31 777 389r	24 795 628r	110 749	4 896 105	25 100 344r

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Cement manufacturing, lime manufacturing, clay and clay products (domestic clays) are included in the mineral manufacturing industry. [2] Total activity includes sales and head offices.
[3] Includes molybdenum. [4] Includes salt.
r Revised.
Note: Totals may not add due to rounding.

TABLE 30a. CANADA, PRINCIPAL STATISTICS OF THE MINERAL INDUSTRY,[1] 1987

	Mining Activity								Total Activity[2]		
		Production and Related Workers			Costs						
	Establish-ments	Employees	Person-Hours Paid	Wages	Fuel and Electricity	Materials and Supplies	Value of Production	Value Added	Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)	(number)	($000)	($000)
Metals											
Nickel–copper–zinc	25	14 080	31 013	523 140	213 808	1 551 212	4 156 511	2 391 491	18 979	736 910	2 391 483
Gold	51	7 598	16 612	299 136	82 271	421 584	1 815 583	1 311 727	9 757	388 846	1 307 237
Uranium	5	4 393	9 172	185 314	51 401	158 321	1 109 774	900 053	5 289	228 190	898 262
Iron	7	4 319	9 362	171 108	170 958	374 037	1 331 045	786 050	6 039	246 047	787 184
Silver–lead–zinc	14	3 169	7 072	124 145	65 689	591 815	1 225 927	568 423	4 372	181 320	561 993
Miscellaneous metal mines[3]	6	770	1 656	24 276	10 874	42 373	138 522	85 275	1 060	35 415	84 629
Total	108	34 329	74 887	1 327 119	595 001	3 139 342	9 777 362	6 043 019	45 496	1 816 728	6 030 788
Industrials											
Potash	11	3 050	6 599	103 935	98 264	100 334	774 445	575 846	4 094	148 503	578 933
Stone	127	2 244	5 167	69 719	32 926	106 601	458 409	318 882	2 911	91 830	331 308
Sand and gravel	138	1 597	3 679	49 436	27 063	86 967	375 192	261 162	2 827	92 044	306 504
Miscellaneous nonmetals[4]	53	2 001	4 502	66 476	31 495	55 357	357 094	270 242	2 790	96 084	267 860
Asbestos	4	2 185	4 511	69 797	33 248	62 506	238 775	143 021	2 858	97 928	147 621
Peat	59	1 255	2 809	24 472	5 319	22 512	113 865	86 034	1 510	31 518	93 548
Gypsum	10	657	1 549	17 790	6 434	19 695	86 511	60 383	929	27 698	67 175
Total	402	12 989	28 816	401 625	234 749	453 972	2 404 291	1 715 570	17 919	585 605	1 792 949
Fuels											
Oil, crude and natural gas	738	8 500r	17 101r	360 457r	295 041	973 723	16 922 699	15 653 935	33 842r	1 608 305r	15 843 719
Coal	28	8 458	17 242	350 972	109 014	303 112	1 547 994	1 135 868	10 406	448 055	1 136 383
Total	766	16 958r	34 343r	711 429r	404 055	1 276 835	18 470 693	16 789 803	44 248r	2 056 360r	16 980 102
Total mineral industry	1 276	64 276r	138 046r	2 440 173r	1 233 805	4 870 149	30 652 346	24 548 392	107 663r	4 458 693r	24 803 839

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Cement manufacturing, lime manufacturing, clay and clay products (domestic clays) are included in the mineral manufacturing industry. [2] Total activity includes sales and head offices.
[3] Includes molybdenum. [4] Includes salt.
r Revised.
Note: Totals may not add due to rounding.

TABLE 31. CANADA, PRINCIPAL STATISTICS OF THE MINERAL MANUFACTURING INDUSTRIES, 1987

	Mineral Manufacturing Activity								Total Activity[1]		
		Production and Related Workers			Costs						
	Establishments	Employees	Person-Hours Paid	Wages	Fuel and Electricity	Materials and Supplies	Value of Shipments	Value Added	Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)	(number)	($000)	($000)
Primary metal industries											
Primary steel	60	..	..	..	485 392	4 456 810	8 415 637	..	46 493	1 793 886	3 424 603
Smelting and refining	34	..	..	..	446 242	2 220 129r	5 763 398r	..	29 397	1 149 582	3 050 899
Wire and wire products industries[2]	302	..	..	..	39 415	1 150 215	2 001 941	..	15 284	406 338	821 019
Aluminum rolling, casting and extruding	71	..	..	..	33 449	1 169 431	1 701 916	..	6 143	215 473	503 334
Iron foundries	91	..	..	..	44 175	347 018	871 450	..	7 860	242 477	479 674
Metal rolling, casting and extruding n.e.s.	96	..	..	..	28 304	547 807	1 005 297	..	6 403r	183 586	424 892r
Steel pipe and tube	36	..	..	..	22 260	806 033	1 233 548	..	4 964r	170 371	385 442
Copper and alloy rolling, casting and extruding	39	..	..	..	15 298	466 060	607 483	..	2 828	83 237	129 629
Total	729	..	..	..	1 114 535	11 163 503r	21 600 670r	..	119 372r	4 244 950	9 219 492r
Nonmetallic mineral products industries											
Ready-mix concrete	587	..	..	..	59 474	1 035 871r	1 843 392r	730 174	11 910	343 436	748 359
Cement	24	..	..	..	162 830	246 252r	980 231r	546 169	3 646	143 154	558 446
Primary glass and glass containers	23	..	..	..	60 477	280 503r	875 827r	531 144	7 584	244 603	532 673
Glass products	153	..	..	..	14 876	339 711r	688 081r	327 418	6 021	161 356	336 724
Gypsum products	30	..	..	..	33 881	287 614r	642 618r	309 680	2 375	74 702	322 746
Mineral insulating products	43	..	..	..	35 562	465 546r	816 488r	188 780	3 444	117 067	316 997
Other concrete products	248	..	..	..	15 918	235 739r	537 354r	282 644	5 403	129 528	292 084
Structural concrete products	64	..	..	..	5 155	133 247r	305 321r	1 365 819	3 006	87 788	164 719
Clay products (domestic)	34	..	..	..	26 293	49 305r	223 455r	143 341	1 738	54 457	148 230
Other nonmetallic mineral products	153	..	..	..	10 638	129 148r	281 914r	136 147	2 707	64 298	144 926
Concrete pipe	50	..	..	..	5 970	105 054r	242 111r	133 127	1 900	56 655	133 996
Clay products (imported)	56	..	..	..	7 558	52 630r	189 821r	128 400	2 192	52 927	130 436
Refractory products	29	..	..	..	7 019	131 546r	256 599r	109 285	1 772	47 056r	116 742r
Abrasives	29	..	..	..	34 589	132 456r	276 700r	102 183	1 693	48 326	105 199
Lime	14	..	..	..	38 470	31 410r	156 129r	86 904	784	28 587	87 421
Asbestos products industry	10	..	..	..	2 037	32 927r	59 353r	23 151	647	14 929	23 326
Total	1 547	..	..	..	520 747	3 688 959r	8 375 394r	5 144 366	56 822	1 668 869r	4 163 024r

TABLE 31 (cont'd)

	Mineral Manufacturing Activity									Total Activity[1]		
		Production and Related Workers			Costs							
	Establish-ments	Employees	Person-Hours Paid	Wages	Fuel and Electricity	Materials and Supplies	Value of Shipments	Value Added	Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)	(number)	($000)	($000)
Fabricated metal products industries											
Stamped and pressed metal products industries	971	..	..	..	75 267	3 740 056	5 610 044	..	35 329r	887 398	2 069 735
Fabricated structural metal products industries	396	..	..	..	28 878	1 263 621	2 477 554	..	18 615	501 785	1 177 608
Hardware, tool and cutlery industry	855	..	..	..	24 738	747 123	1 794 817	..	22 129	573 057	1 025 466
Other metal fabricating industries	538	..	..	..	31 554	913 311	1 786 377	..	16 358	418 340	856 434
Ornamental and architectural metal products industries	766	..	..	..	22 700	1 008 568	1 836 938	..	19 770	446 010	813 080
Machine shop industry	1 464	..	..	..	19 254	483 560	1 194 506	..	18 398	436 311	692 422
Power boiler and heat exchanger industry	43	..	..	..	4 715	240 407	652 833r	..	4 816	148 645	407 658
Heating equipment industry	163	..	..	..	5 636	317 251	595 940	..	6 252	136 408	269 497
Total	5 196	..	..	..	212 742	8 443 897	15 949 009r	..	141 667r	3 547 954	7 311 900
Petroleum and coal products industries											
Petroleum refining products	30	..	..	..	290 139	15 018 518	16 958 489	..	13 252	647 779	1 860 061
Other petroleum and coal products	62	..	..	..	12 290	260 099	376 200	..	894	28 053	107 478
Lubricating oils and greases	34	..	..	..	5 052	245 136	347 590	..	1 002	32 476	98 976
Total	126	..	..	..	307 481	15 523 753	17 682 279	..	15 148	708 308	2 066 515
Total mineral manufacturing industries	7 598	..	..	..	2 155 505	38 820 112r	63 607 354r	..	333 009r	10 170 081r	22 760 931r

Source: Statistics Canada, Catalogue No. 31-203.
[1] Total activity includes sales and head offices. [2] Wire and wire products have been included in the primary metal industries group.
n.e.s. Not elsewhere specified; . . Not available; r Revised.
Note: Totals may not add due to rounding.

TABLE 32. CANADA, PRINCIPAL STATISTICS OF THE MINERAL INDUSTRY[1] BY REGION, 1988

	Mines, Quarries and Oil Well Activity								Total Activity[2]		
		Production and Related Workers			Costs						
	Establish-ments	Employees	Person-Hours Paid	Wages	Fuel and Electricity	Materials and Supplies	Value of Production	Value Added	Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)	(number)	($000)	($000)
Atlantic Provinces[3]	94	8 410	17 544	283 993	131 867	622 521	1 694 350	939 962	10 646	371 625	943 301
Quebec[3]	190	10 830	23 704	423 695	191 792	671 234	2 069 761	1 206 735	14 581	584 060	1 231 278
Ontario	169	18 264	40 526	750 277	230 471r	1 423 250r	5 670 116	4 016 395r	24 934	1 051 980	4 048 411r
Prairie Provinces	672	17 336	35 846	706 215	501 103	1 770 982	17 653 412r	15 381 357r	45 138	2 153 775	15 573 006r
British Columbia[4]	177	9 921	20 706	450 696	193 139	889 595	3 502 789	2 420 054	12 472	584 959	2 446 838
Yukon and Northwest Territories[5]	38	1 949	4 910	102 040	48 384	307 453	1 186 961	831 124	2 978	149 706	857 510
Total	1 340	66 710	143 237	2 716 915	1 296 756r	5 685 034r	31 777 388r	24 795 628r	110 749	4 896 105	25 100 344r

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Cement manufacturing, lime manufacturing, clay and clay products (domestic clays) are included in the mineral manufacturing industry. [2] Total activity includes sales and head offices.
[3] Includes eastern Canada offshore. [4] Includes western Canada offshore. [5] Includes Arctic Islands.
r Revised.
Note: Totals may not add due to rounding.

TABLE 32a. CANADA, PRINCIPAL STATISTICS OF THE MINERAL INDUSTRY[1] BY REGION, 1987

	Mines, Quarries and Oil Well Activity								Total Activity[2]		
		Production and Related Workers			Costs						
	Establish-ments	Employees	Person-Hours Paid	Wages	Fuel and Electricity	Materials and Supplies	Value of Production	Value Added	Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)	(number)	($000)	($000)
Atlantic Provinces[3]	98	7 605	15 973	247 599	125 248	514 748	1 430 293	790 297	9 938	340 532	793 091
Quebec[3]	187	10 143	22 122	366 103	179 563	618 844	2 075 294	1 276 887	13 919	522 481	1 284 944
Ontario	164	17 666r	39 332r	655 299	217 992	1 270 706	4 461 985	2 973 287	24 158r	928 341r	3 029 158
Prairie Provinces	609	17 100r	35 110r	660 247r	466 664	1 420 593	18 533 898	16 646 641	44 429r	1 979 197r	16 802 623
British Columbia[4]	179	9 828r	20 803r	419 188r	187 182	769 092	3 096 038	2 139 764	12 233r	545 131r	2 150 333
Yukon and Northwest Territories[5]	39	1 934r	4 707r	91 738r	57 155	276 168	1 054 840	721 516	2 986r	143 011r	743 691
Total	1 276	64 276r	138 047r	2 440 174	1 233 804	4 870 151	30 652 348	24 548 392	107 663r	4 458 693r	24 803 840

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Cement manufacturing, lime manufacturing, clay and clay products (domestic clays) are included in the mineral manufacturing industry. [2] Total activity includes sales and head offices.
[3] Includes eastern Canada offshore. [4] Includes western Canada offshore. [5] Includes Arctic Islands.
r Revised.
Note: Totals may not add due to rounding.

TABLE 33. CANADA, PRINCIPAL STATISTICS OF THE MINERAL MANUFACTURING INDUSTRY BY REGION, 1987

	Mineral Manufacturing Activity								Total Activity[1]		
		Production and Related Workers			Costs						
	Establishments	Employees	Person-Hours Paid	Wages	Fuel and Electricity	Materials and Supplies	Value of Shipments	Value Added	Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)	(number)	($000)	($000)
Primary metals industry											
Atlantic Provinces	6	..	..	..	x	x	x	..	x	x	x
Quebec	117	..	..	..	421 808	2 984 396	6 223 122	..	27 020	1 020 157	2 766 763
Ontario	216	..	..	..	508 951	5 731 198	10 707 854	..	62 230	2 325 932	4 407 881
Prairie Provinces	49	..	..	..	x	x	x	..	x	x	x
British Columbia	39	..	..	..	12 398	375 003	950 198	..	6 446	218 621	563 172
Yukon and Northwest Territories	–	..	..	..	–	–	–	..	–	–	–
Canada	427	..	..	..	1 075 121	10 013 289r	19 598 730r	..	104 088r	3 838 613	8 398 472r
Nonmetallic mineral products industry											
Atlantic Provinces	115	..	..	..	21 745r	111 047r	263 244r	..	2 562r	63 196r	127 023r
Quebec	398	..	..	..	134 159	809 324	1 865 522	..	14 409	389 809	916 590
Ontario	548	..	..	..	267 012	2 003 071	4 605 150	..	28 555	869 953	2 346 337
Prairie Provinces	311	..	..	..	61 399	495 105	1 052 365	..	7 305	209 696	495 770r
British Columbia	175	..	..	..	36 433	270 410	588 116	..	3 991	136 216	277 304
Yukon and Northwest Territories	–	..	..	..	–	–	–	..	–	–	–
Canada	1 547	..	..	..	520 748	3 688 957r	8 375 397r	..	56 822	1 668 869r	4 163 024r
Fabricated metal products industry[2]											
Atlantic Provinces	167	..	..	..	4 551r	189 750r	331 894r	..	3 183	72 794r	137 410
Quebec	1 282	..	..	..	59 927	1 975 807	3 810 157	..	35 943	877 107	1 791 293
Ontario	2 850	..	..	..	153 990	6 084 492	11 235 012	..	94 119	2 392 174	5 006 824
Prairie Provinces	655	..	..	..	18 161r	725 060	1 409 957r	..	14 018	331 644	666 326
British Columbia	544	..	..	..	15 529	619 003	1 163 933	..	9 688	280 572	531 066
Yukon and Northwest Territories	–	..	..	..	–	–	–	..	–	–	–
Canada	5 498	..	..	..	252 156	9 594 112	17 950 949r	..	156 951r	3 954 291	8 132 919
Petroleum and coal products industry											
Atlantic Provinces	8	..	..	..	x	x	x	..	x	x	x
Quebec	25	..	..	..	92 738	3 316 671	3 547 825	..	1 437	63 561	120 863
Ontario	48	..	..	..	113 978	5 441 724	6 372 264	..	7 654	354 255	919 861
Prairie Provinces	31	..	..	..	x	x	x	..	x	x	x
British Columbia	13	..	..	..	20 575	1 439 438	1 640 981	..	957	49 026	192 975
Yukon and Northwest Territories	1	..	..	..	x	x	x	..	x	x	x
Canada	126	..	..	..	307 481	15 523 753	17 682 278	..	15 148	708 309	2 066 515

Total mineral manufacturing industry											
Atlantic Provinces	296	..	..	..	x	x	x	..	x	x	x
Quebec	1 822	..	..	..	708 632	9 086 198	15 446 626	..	78 809	2 350 634	5 595 509
Ontario	3 662	..	..	..	1 043 931	19 260 485	32 920 280	..	192 558	5 942 314	12 680 903
Prairie Provinces	1 046	..	..	..	x	x	x	..	x	x	x
British Columbia	771	..	..	..	84 935	2 703 854	4 343 228	..	21 082	684 435	1 564 517
Yukon and Northwest Territories	1	..	..	..	x	x	x	..	x	x	x
Canada	7 598	..	..	..	2 155 505	38 820 112r	63 607 352r	..	333 009r	10 170 081r	22 760 931r

Source: Statistics Canada, Catalogue No. 31-203.
[1] Total activity includes sales and head offices. [2] For reasons of confidentiality, SIC 305 (Wire and wire products), normally included in Primary Metals is included in Fabricated Metal Products.
x Confidential; .. Not available; r Revised; – Nil.

TABLE 34. CANADA, PRINCIPAL STATISTICS OF THE MINERAL INDUSTRY,[1] 1982–88

	Mines, Quarries and Oil Well Activity								Total Activity[2]		
		Production and Related Workers			Costs						
	Establish-ments	Employees	Person-Hours Paid	Wages	Fuel and Electricity	Materials and Supplies	Value of Production	Value Added	Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)	(number)	($000)	($000)
1982	1 247	74 178	141 070	2 008 439	956 296	3 768 771	29 101 618	24 376 549	123 486	3 648 004	24 427 308
1983	1 407	66 629	131 406	1 963 773	1 022 417	3 756 625	32 771 401	27 992 357	113 831	3 687 911	28 012 167
1984	1 381	69 650	140 567	2 295 256	1 204 008	4 290 972	37 976 019	32 481 039	115 790	4 106 049	32 545 525
1985	1 385r	67 308	140 780	2 357 868	1 264 619	4 442 358	38 127 807	34 420 830	117 161	4 413 258	32 495 098
1986r	1 507	64 275	134 885	2 366 813	1 240 371	4 649 767	27 785 615	21 895 474	109 974	4 418 118	22 224 015
1987	1 276	64 276r	138 047r	2 440 174r	1 233 804	4 870 151	30 652 348	24 548 392	107 663r	4 458 693r	24 803 840
1988	1 340	66 710	143 237	2 716 915	1 296 756r	5 685 034r	31 777 388r	24 795 628r	110 749	4 896 105	25 100 344r

Sources: Energy, Mines and Resources Canada; Statistics Canada.
1 Cement manufacturing, lime manufacturing, clay and clay products (domestic clays) are included in the mineral manufacturing industry. 2 Total activity includes sales and head offices.
r Revised.

TABLE 35. CANADA, PRINCIPAL STATISTICS OF THE MINERAL MANUFACTURING INDUSTRY,[1] 1980–87

	Mineral Manufacturing Activity								Total Activity[2]		
		Production and Related Workers			Costs						
	Establish-ments	Employees	Person-Hours Paid	Wages	Fuel and Electricity	Materials and Supplies	Value of Shipments	Value Added	Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)	(number)	($000)	($000)
1980	7 229	270 529	565 988	4 991 451	1 411 101	28 394 177	43 895 507	14 758 224	366 120	7 262 688	15 160 467
1981	7 196	261 364	546 732	5 393 636	1 720 151	34 570 420	51 870 979	16 791 049	361 883	8 076 300	17 200 686
1982	5 687	229 518	475 378	5 333 201	1 728 740	34 241 605	50 045 037	14 497 245	321 785	8 126 238	14 823 990
1983	7 370	216 944	447 947	5 420 307	1 905 777	34 720 416	52 773 875	15 861 491	301 112	8 143 674	16 196 749
1984	7 511	223 816	470 367	5 948 626	2 125 032	37 738 117	57 207 764	17 980 271	304 309	8 719 151	18 265 131
1985	7 625	238 544	506 377	6 507 081	2 229 270	39 497 925	61 241 939	19 305 730	313 850	9 271 447	19 646 938
1986	7 841	248 039	524 184	6 829 899	2 096 145	31 806 478	54 521 641	19 788 464	319 950	9 563 918	20 124 687
1987	7 598	..	..	..	2 155 505	38 040 112r	63 607 352r	..	333 009r	10 170 081r	22 760 931r

Source: Statistics Canada.
1 Includes the following industries: Primary metals; Nonmetallic mineral products; Fabricated metal products; and Refined petroleum and coal products. 2 Total activity includes sales and head offices.
.. Not available; r Revised.

TABLE 36. CANADA, CONSUMPTION OF FUEL AND ELECTRICITY IN THE MINERAL INDUSTRY,[1] 1988

	Unit	Metals	Industrials[2]	Fuels	Total
Coal	000 t	225	23	–	248
	$000	15 076	1 338	–	16 414
Gasoline	000 litres	23 435	17 433	9 869	50 737
	$000	9 556	7 641	3 228	20 425
Fuel oil, kerosene,	000 litres	792 345	291 560	236 853	1 320 758
diesel oil	$000	166 109	72 865	54 670	293 644
Liquefied petroleum	000 litres	98 262	10 731	17 120	126 113
gas	$000	16 712	2 148	2 166	21 026
Natural gas	000 m^3	224 650	655 515	111	880 276
	$000	24 133	55 123	8 590	87 846
Other fuels[3]	$000	19 757	11	–	19 768
Total value of fuels	$000	251 343	139 126	68 654	459 123
Electricity purchased	million kWh	13 264	2 510	8 726	24 501
	$000	368 369	107 496	371 632	847 497
Total value of fuels and electricity purchased, all reporting companies	$000	619 712	246 622	440 286	1 306 620

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Cement manufacturing, lime manufacturing, clay and clay products (domestic clays) are included in the mineral manufacturing industry. [2] Includes structural materials. [3] Includes wood, manufactured gas, steam purchased and other miscellaneous fuels.
– Nil.
Note: Totals may not add due to rounding.

TABLE 37. CANADA, COST OF FUEL AND ELECTRICITY USED IN THE MINERAL INDUSTRY,[1] 1982–88

	Unit	1982	1983	1984	1985	1986	1987	1988
Metals								
Fuel	$000	275 205	270 098	331 231	337 445	276 894	249 932	251 343
Electricity purchased	million kWh	9 891	9 659	11 672	11 504	12 066	12 128	13 264
	$000	232 137	238 458	272 932	281 373	320 828	345 068	368 369
Total cost of fuel and electricity	$000	507 342	508 556	604 163	618 818	597 722	595 000	619 712
Industrials[2]								
Fuel	$000	143 393	157 872	169 486	165 665	153 442	137 873	139 126
Electricity purchased	million kWh	1 782	1 928	2 120	2 122	2 107	2 237	2 510
	$000	57 567	64 052	76 884	82 114	86 571	96 876	107 496
Total cost of fuel and electricity	$000	200 960	221 924	246 370	247 779	240 013	234 749	246 622
Fuels								
Fuel	$000	70 484	68 800	89 237	101 049	73 426	67 103	68 654
Electricity purchased	million kWh	5 780	4 958	5 840	6 569	7 183	7 822	8 726
	$000	176 911	223 136	264 233	296 973	329 208	336 952	371 632
Total cost of fuel and electricity	$000	247 395	291 936	353 470	398 022	402 634	404 055	440 286
Total mineral industry								
Fuel	$000	489 082	496 770	589 954	604 159	503 762	454 908	459 123
Electricity purchased	million kWh	17 453	16 545	19 632	20 195	21 356	22 187	24 501
	$000	466 615	525 646	614 049	660 460	736 607	778 896	847 497
Total cost of fuel and electricity	$000	955 697	1 022 416	1 204 003	1 264 619	1 240 369	1 233 804	1 306 620

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Cement manufacturing, lime manufacturing, clay and clay products (domestic clays) are included in the mineral manufacturing industry. [2] Includes structural materials.

TABLE 38. CANADA, EMPLOYMENT IN THE MINERAL INDUSTRY, STAGE I - MINERAL EXTRACTION AND MILLING (total activity),[1] 1961-90

	Metal Mines	Nonmetal Mines	Structural Materials	Nonfuel Mining	Coal	Crude Oil and Natural Gas	Total Nonfuel and Fuel
SIC#	061	062	081, 082	061, 062 081, 082	063	071	
				(number)			
1961	58 591	11 003	5 235	74 829	10 302	11 184	96 315
1962	58 243	11 408	5 514	75 165	9 897	11 232	96 294
1963	57 119	11 661	5 686	74 466	9 828	11 237	95 531
1964	57 648	11 727	6 044	75 419	9 796	11 242	96 457
1965	60 942	12 116	6 248	79 306	9 697	11 817	100 820
1966	61 670	12 422	6 312	80 404	9 281	12 378	102 063
1967	61 728	13 077	5 779	80 584	8 981	13 113	102 678
1968	63 369	13 673	5 836	82 878	8 427	13 611	104 916
1969	60 550	14 322	5 692	80 564	7 371	14 153	102 088
1970	66 590	15 150	5 510	87 250	7 874	14 970	110 094
1971	66 012	15 105	5 328	86 445	8 069	15 896	110 410
1972	61 994	14 866	5 154	82 014	8 704	16 604	107 322
1973	66 134	15 391	5 276	86 801	7 856	16 786	111 443
1974	70 038	16 198	6 197	92 433	8 142	18 155	118 730
1975	69 161	13 703	6 382	89 246	8 416	18 053	115 715
1976	68 269	15 649	5 685	89 603	8 995	19 096	117 694
1977	67 242	16 608	5 190	89 040	9 781	20 240	119 061
1978	56 447	16 035	4 847	77 329	10 574	22 045	109 948
1979	58 960	16 770	4 692	80 422	10 269	24 554	115 245
1980	66 118	16 979	4 461	87 558	11 416	27 448	126 422
1981	68 712	16 391	4 183	89 286	11 182	28 783	129 251
1982	61 503	13 680	3 491	78 674	13 113	31 699	123 486
1983	52 194	13 170	3 403	68 767	11 646	33 418	113 831
1984	52 683	13 698	3 560	69 941	11 905	33 944	115 790
1985	48 672	12 974	3 941	65 587	12 076	39 498	117 161
1986	46 487	12 376	4 887	63 750	10 747	35 477	109 974
1987	45 496	12 181	5 738	63 415	10 406	33 842r	107 512
1988	48 277	11 679	5 917	65 873	11 122	33 754	110 749
1989p	49 150	11 618	5 886	66 654	10 780	34 673	112 107
1990f	45 461	10 984	6 266	62 711	12 068	34 348	109 127

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Total activity includes sales and head offices.
p Preliminary; f Forecast; r Revised.
SIC: 1980 Standard Industrial Classification.

TABLE 39. CANADA, EMPLOYMENT IN THE NONFUEL MINERAL INDUSTRY, STAGE I – MINERAL EXTRACTION AND MILLING (total activity),[1] 1961-90

	Gold	Uranium	Iron	Nickel, Copper, Zinc	Silver, Lead, Zinc	Other Nonferrous	Asbestos	Peat	Gypsum	Potash	Other Nonmetal	Stone Quarries	Sand and Gravel	Total Nonfuel Mining
SIC #	0611	0616	0617	0612, 0613	0614	0615, 0619	0621	0622	0623	0624	0625, 0629	081	082	
							(number)							
1961	15 994	(2)	8 446	23 351	4 524	6 276	6 773	1 207	549	(3)	2 424	3 173	2 062	74 829
1962	15 425	(2)	9 181	23 383	4 669	5 585	6 936	1 220	594	(3)	2 658	3 221	2 293	75 165
1963	14 639	(2)	9 608	22 703	5 163	5 006	6 828	1 303	677	(3)	2 853	3 477	2 209	74 466
1964	14 012	(2)	9 544	23 848	5 898	4 346	6 544	1 290	710	(3)	3 183	3 718	2 326	75 419
1965	13 155	(2)	11 739	25 892	6 121	4 035	6 536	1 201	646	1 050	2 683	3 511	2 737	79 306
1966	11 656	(2)	11 464	27 651	6 356	4 543	6 736	1 254	585	1 195	2 652	3 701	2 611	80 404
1967	10 355	(2)	10 899	29 288	6 030	5 156	6 931	1 261	505	1 724	2 656	3 381	2 398	80 584
1968	9 001	(2)	11 342	30 557	6 320	6 149	7 213	1 306	489	2 086	2 579	3 340	2 496	82 878
1969	8 221	(2)	10 490	28 679	6 467	6 693	7 242	1 156	657	2 713	2 554	3 252	2 440	80 564
1970	7 185	(2)	11 336	36 253	7 103	4 713	7 664	1 195	671	2 837	2 783	3 023	2 487	87 250
1971	6 148	(2)	11 524	37 713	6 506	4 121	8 101	1 269	603	2 519	2 613	2 832	2 496	86 445
1972	5 579	(2)	10 842	36 012	6 057	3 504	7 843	1 114	670	2 440	2 799	2 803	2 351	82 014
1973	5 603	(2)	13 395	37 602	6 112	3 422	8 027	1 236	676	2 684	2 768	3 097	2 179	86 801
1974	5 665	(2)	15 019	38 876	6 722	3 756	8 131	1 288	671	3 224	2 884	3 458	2 739	92 433
1975	5 798	(2)	16 155	35 538	7 362	4 308	6 042	1 303	576	3 351	2 431	3 544	2 838	89 246
1976	5 051	3 430	16 765	34 049	7 351	1 623	7 900	1 168	591	3 270	2 720	3 217	2 468	89 603
1977	4 643	4 140	15 550	33 703	7 512	1 694	8 302	1 244	652	3 628	2 782	3 004	2 186	89 040
1978	4 943	4 965	12 103	25 610	7 073	1 753	7 752	1 295	683	3 708	2 597	2 876	1 971	77 329
1979	5 013	5 858	14 563	25 116	7 081	1 329	8 067	1 372	738	3 905	2 688	2 860	1 832	80 422
1980	5 839	6 304	13 753	31 063	7 349	1 810	8 055	1 308	715	4 160	2 741	2 660	1 801	87 558
1981	6 809	6 869	12 397	33 246	7 740	1 651	6 829	1 441	711	4 661	2 749	2 418	1 765	89 286
1982	7 350	6 035	10 676	28 851	6 837	1 754	4 973	1 323	614	4 076	2 694	2 028	1 463	78 674
1983	7 956	5 390	8 236	24 953	5 073	586	4 617	1 301	682	3 696	2 874	1 980	1 423	68 767
1984	8 450	6 249	7 843	24 000	5 165	976	4 177	1 369	770	4 508	2 874	2 256	1 304	69 941
1985	7 862	5 989	7 077	22 073	4 724	947	3 569	1 363	753	4 488	2 801	2 340	1 601	65 587
1986	8 562	5 608	6 379	20 616	4 162	1 160	2 766	1 468	990	4 315	2 837	2 627	2 260	63 750
1987	9 757	5 289	6 039	18 979	4 372	1 060	2 858	1 510	929	4 094	2 790	2 911	2 827	63 415
1988	12 594	5 103	6 095	18 881	4 443	1 161	2 720	1 581	956	3 970	2 452	2 981	2 936	65 873
1989p	12 645	4 765	6 303	19 626	4 522	1 289	2 800	1 581	966	3 893	2 378	3 053	2 833	66 654
1990f	10 937	4 320	6 004	18 672	4 302	1 226	2 604	1 403	1 018	3 699	2 260	3 433	2 833	62 711

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Total activity includes sales and head offices. (2) Included in "Other Nonferrous." (3) Included in "Other Nonmetal."
[p] Preliminary; [f] Forecast.
SIC: 1980 Standard Industrial Classification.

TABLE 40. CANADA, EMPLOYMENT IN THE MINERAL INDUSTRY, STAGE II - SMELTING AND REFINING (total activity),[1] 1961-90

	Smelting/ Refining	Iron and Steel Mills	Total Primary Metals	Petroleum Refineries	Total Smelting and Refining
SIC#	295	291	291, 295	3611	
			(number)		
1961	29 938	34 749	64 687	10 660	75 347
1962	29 693	36 593	66 286	10 184	76 470
1963	28 516	38 196	66 712	9 734	76 446
1964	30 153	41 505	71 658	9 547	81 205
1965	31 835	44 274	76 109	8 976	85 085
1966	34 237	45 999	80 236	8 996	89 232
1967	34 764	44 203	78 967	9 147	88 114
1968	34 710	44 634	79 344	9 091	88 435
1969	33 376	42 954	76 330	8 765	85 095
1970	37 298	49 169	86 467	14 725	101 192
1971	36 445	49 601	86 046	14 506	100 552
1972	33 829	49 758	83 587	14 376	97 963
1973	32 396	53 008	85 404	14 843	100 247
1974	35 249	54 253	89 502	15 967	105 469
1975	35 577	54 003	89 580	15 624	105 204
1976	34 246	51 978	86 224	15 105	101 329
1977	35 647	52 709	88 356	16 464	104 820
1978	32 652	56 669	89 321	18 958	108 279
1979	32 869	59 167	92 036	18 037	110 073
1980	36 137	61 238	97 375	18 743	116 118
1981	38 011	56 543	94 554	21 325	115 879
1982	33 215	52 330	85 545	20 155	105 700
1983	31 788	47 693	79 481	17 557	97 038
1984	31 752	48 899	80 651	15 847	96 498
1985	30 567	47 685	78 252	15 326	93 578
1986	29 058	46 461	75 519	13 287	88 806
1987	29 397	46 493	75 890	13 252	89 142
1988[e]	30 195	47 169	77 365	13 566	90 931
1989[p]	31 322	46 748	78 070	13 448	91 518
1990[f]	31 209	44 267	75 476	13 087	88 563

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Total activity includes sales and head offices.
[p] Preliminary; [f] Forecast; [e] Estimate.
SIC: 1980 Standard Industrial Classification.

TABLE 41. CANADA, EMPLOYMENT IN THE MINERAL INDUSTRY, STAGE III - SEMI-FABRICATION (total activity),[1] 1961-90

	Total Nonfuel Semi-Fabrication	Miscellaneous Petroleum and Coal Products	Lubricating Oil and Greases	Total Semi-Fabrication
SIC#		369	3612	
		(number)		
1961	77 063	581	331	77 975
1962	80 606	608	352	81 566
1963	82 420	635	354	83 409
1964	87 843	726	373	88 942
1965	93 912	531	408	94 851
1966	98 602	585	424	99 611
1967	96 033	546	407	96 986
1968	96 375	518	397	97 290
1969	99 438	532	438	100 408
1970	96 144	499	423	97 066
1971	95 831	561	450	96 842
1972	101 109	555	478	102 142
1973	105 884	757	487	107 128
1974	109 818	954	514	111 286
1975	104 296	984	656	105 936
1976	103 411	982	602	104 995
1977	101 257	716	669	102 642
1978	107 234	683	712	108 629
1979	111 231	461	695	112 387
1980	105 902	532	798	107 232
1981	103 192	584	729	104 505
1982	90 194	571	792	91 557
1983	86 814	503	857	88 174
1984	91 405	521	896	92 822
1985	94 515	513	900	95 928
1986	96 744	778	1 001	98 523
1987[r]	99 963	894	1 002	101 859
1988[e]	101 842	873	978	103 693
1989[p]	98 883	802	899	100 583
1990[f]	94 425	839	940	96 204

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Total activity includes sales and head offices.
[p] Preliminary; [f] Forecast; [r] Revised; [e] Estimate.
SIC: 1980 Standard Industrial Classification.

TABLE 42. CANADA, EMPLOYMENT IN THE MINERAL INDUSTRY, STAGE III - NONFUEL SEMI-FABRICATION (total activity),[1] 1961-90

	Steel Pipe and Tube	Iron Foundries	Aluminum Rolling, Casting, Extruding	Copper Rolling, Casting, Extruding	Other Rolling, Casting, Extruding	Wire and Wire Products	Clay and Clay Products	Cement	Concrete Products	Ready-Mix Concrete	Glass and Glass Products[2]	Abrasives	Lime	Other Non-metallic Products	Total Nonfuel Semi-Fabrication
SIC#	292	294	296	297	299	305	351	352	354	355	356	357	358	359	
								(number)							
1961	3 407	8 178	5 095	3 482	2 731	12 227	5 327	3 590	8 503	4 232	9 802	2 481	847	7 161	77 063
1962	3 676	8 546	5 118	3 492	2 770	13 045	5 468	3 679	9 156	4 886	10 042	2 577	949	7 202	80 606
1963	3 840	8 216	5 164	3 651	3 038	13 743	5 376	3 566	9 317	5 411	10 346	2 464	886	7 402	82 420
1964	4 437	9 620	4 834	3 849	3 382	14 850	5 582	3 592	10 225	6 171	10 362	2 580	815	7 544	87 843
1965	4 799	11 714	4 654	3 620	3 736	16 099	5 675	3 837	10 988	6 559	10 873	2 821	800	7 737	93 912
1966	4 795	13 027	4 943	4 199	4 103	16 391	5 876	4 053	11 090	7 349	11 248	3 044	785	7 699	98 602
1967	5 012	11 970	5 468	4 027	4 287	16 060	5 559	3 972	10 321	7 137	11 388	2 734	724	7 374	96 033
1968	5 441	11 131	5 491	3 947	4 585	16 082	5 515	3 747	10 166	7 440	11 992	2 617	662	7 559	96 375
1969	5 146	11 582	6 028	3 922	4 856	17 014	5 383	3 778	11 011	7 509	12 031	2 697	707	7 774	99 438
1970	5 314	10 663	6 297	3 744	4 060	16 598	4 938	3 887	9 562	7 340	11 654	2 559	660	8 868	96 144
1971	5 306	9 897	5 612	3 608	3 845	16 272	4 682	3 954	10 719	7 997	11 672	2 310	670	9 287	95 831
1972	6 268	9 948	6 200	3 740	4 215	17 651	4 695	4 732	10 817	8 240	12 045	2 367	651	9 540	101109
1973	5 288	10 965	6 206	3 736	4 863	18 877	5 001	4 871	10 790	9 233	12 840	2 555	724	9 935	105 884
1974	5 845	12 054	6 162	3 779	4 877	19 535	5 289	4 666	11 602	9 219	12 915	2 676	840	10 359	109 818
1975	5 785	11 480	5 672	3 240	4 573	17 614	5 042	4 577	11 201	9 541	11 779	2 318	790	10 684	104 296
1976	5 546	10 365	6 255	3 297	5 354	17 573	4 791	4 517	10 773	9 128	11 836	2 535	804	10 637	103 411
1977	5 634	10 459	6 884	3 183	4 703	17 886	4 553	4 265	10 001	8 521	11 204	2 557	828	10 579	101 257
1978	6 289	10 472	7 060	3 586	5 268	18 823	4 366	4 520	10 486	9 520	11 595	2 678	784	11 787	107 234
1979	6 480	10 520	7 698	3 728	6 292	19 765	4 947	4 828	9 766	9 332	11 835	2 660	925	12 455	111 231
1980	6 514	9 245	6 627	3 230	5 749	18 529	4 875	4 791	9 280	9 348	11 967	2 628	1 003	12 116	105 902
1981	7 531	8 358	6 512	3 031	5 182	17 309	4 145	4 726	9 121	10 053	12 003	2 571	968	11 682	103 192
1982	6 017	8 163	6 255	2 541	4 694	14 575	3 004	4 317	8 245	8 034	11 016	2 170	895	10 268	90 194
1983	4 521	7 364	6 415	2 744	4 827	13 493	3 008	4 057	7 286	8 390	11 896	1 852	862	10 099	86 814
1984	5 482	7 911	6 661	2 971	5 274	14 212	3 070	3 771	7 657	8 802	12 754	1 949	876	10 015	91 405
1985	5 978	7 750	6 196	3 012	5 620	15 354	2 727	3 533	8 336	9 210	12 872	1 895	783	11 249	94 515
1986	4 829	7 547	6 200	3 059	6 357	15 262	3 770	3 514	9 174	10 422	13 448	1 827	778	10 557	96 744
1987r	4 964	7 860	6 143	2 828	6 403	14 943	3 930	3 646	10 309	11 910	13 605	1 693	784	10 945	99 963
1988e	5 358	8 085	6 247	2 843	6 575	14 670	4 017	3 542	11 601	11 929	13 051	2 095	824	11 007	101 842
1989p	4 928	7 175	6 143	2 630	6 669	14 670	3 487	3 320	12 210	12 312	12 022	2 226	881	10 210	98 883
1990f	5 066	6 337	5 595	2 333	5 734	14 803	3 215	3 278	12 200	11 273	10 730	2 079	927	10 854	94 425

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Total activity includes sales and head offices. [2] Includes sealed window manufacturers until 1969; thereafter these are included in Stage IV - Ornamental Metal Products.
p Preliminary; f Forecast; r Revised; e Estimate.
SIC: 1980 Standard Industrial Classification.

TABLE 43. CANADA, EMPLOYMENT IN THE MINERAL INDUSTRY, STAGE IV - METALLIC MINERAL MANUFACTURING (total activity),[1] 1961-90

	Boilers	Structural Metal Products	Ornamental Metal Products	Stamped, Pressed and Coated Products	Hardware Tool and Cutlery	Heating Equipment	Machine Parts	Other Metal Fabricating	Total Mineral Manufacturing
SIC#	301	302	303	304	306	307	308	309	
					(number)				
1961	4 709	14 231	10 641	21 156	9 135	5 137	7 756	15 249	88 014
1962	4 886	14 802	11 640	23 606	10 223	5 349	8 603	16 283	95 392
1963	5 350	14 212	12 459	24 024	11 112	5 586	9 179	16 627	98 549
1964	5 429	14 602	12 808	25 192	13 110	5 673	10 137	18 088	105 039
1965	6 496	18 072	13 439	27 925	13 570	5 711	11 618	20 017	116 848
1966	7 239	21 038	13 488	29 577	14 326	5 464	13 235	21 431	125 798
1967	6 622	18 547	12 994	29 830	14 056	5 461	13 810	21 007	122 327
1968	7 962	17 150	12 664	29 560	14 166	4 930	13 501	20 825	120 758
1969	7 494	18 203	12 784	30 463	14 401	5 059	14 517	20 895	123 816
1970	7 661	19 104	12 417	29 709	15 241	4 670	14 221	20 543	123 566
1971	7 847	17 556	12 614	28 710	14 920	4 749	13 097	20 755	120 248
1972	8 136	17 113	13 611	27 939	16 386	4 238	11 731	21 504	120 658
1973	8 013	18 164	13 937	30 026	18 819	4 453	10 138	22 494	126 044
1974	8 681	20 020	14 470	31 276	20 234	4 930	10 936	23 663	134 210
1975	10 211	19 101	15 241	30 273	18 990	4 717	10 922	23 810	133 265
1976	10 704	18 056	15 541	31 487	19 316	4 977	10 764	23 704	134 549
1977	9 660	17 209	14 800	30 888	17 867	4 538	10 762	23 298	129 022
1978	9 124	16 759	16 753	34 181	18 856	5 086	12 029	24 904	137 692
1979	9 477	18 676	18 018	33 548	21 090	5 818	13 081	23 705	143 413
1980	10 374	17 700	17 890	32 266	20 830	5 993	13 449	24 217	142 719
1981	11 215	18 445	17 603	32 459	19 575	5 806	14 297	22 123	141 523
1982	10 965	17 021	15 228	29 865	17 342	5 317	13 083	18 167	126 988
1983	5 413	18 437	13 537	27 947	16 609	5 032	12 881	16 044	115 900
1984	4 548	17 162	13 538	27 758	17 308	4 220	14 200	16 256	114 990
1985	4 455	18 083	15 598	31 021	19 297	5 607	15 356	14 927	124 344
1986	4 990	19 213	17 462	31 584	21 164	5 779	17 259	15 170	132 621
1987r	4 816	18 615	19 770	35 329	22 129	6 252	18 398	16 358	141 667
1988e	5 022	20 110	21 656	36 611	20 556	6 429	16 520	17 302	144 204
1989p	5 237	21 605	24 220	34 435	17 710	6 670	16 616	17 657	144 150
1990f	5 349	20 778	27 073	31 705	17 043	6 302	16 728	17 795	142 773

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Total activity includes sales and head offices.
p Preliminary; f Forecast; r Revised; e Estimate.
SIC: 1980 Standard Industrial Classification.

TABLE 44. CANADA, EMPLOYMENT FOR SERVICES INCIDENTAL TO MINES, QUARRIES AND OIL WELLS, 1961-90

	Petroleum and Natural Gas Contract Drilling	Mining Diamond Drilling	Other Services Incidental to Mines, Quarries and Oil Wells	Total
	(number)			
1961	4 144	2 025	1 409	7 578
1962	3 800	1 926	1 720	7 446
1963	4 179	2 201	1 491	7 871
1964	4 158	2 401	2 077	8 636
1965	4 648	2 776	3 137	10 561
1966	4 428	2 887	4 317	11 632
1967	4 249	2 669	5 425	12 343
1968	4 434	2 985	6 350	13 769
1969	4 821	3 109	6 967	14 897
1970	4 267	3 207	7 894	15 368
1971	4 093	2 514	7 710	14 317
1972	4 817	2 083	6 139	13 039
1973	5 680	2 123	5 193	12 996
1974	5 054	2 317	5 017	12 388
1975	5 096	1 899	4 139	11 134
1976	5 486	1 548	5 043	12 077
1977	6 054	1 682	5 723	13 459
1978	7 419	1 681	7 492	16 592
1979	9 076	2 420	8 436	19 932
1980	11 097	2 959	9 327	23 383
1981	8 448	2 721	9 856	21 025
1982	6 882	1 880	7 752	16 514
1983	12 032	1 575	12 254	25 861
1984	9 250	1 684	15 433	26 367
1985	13 150	1 625	19 358	34 133
1986	9 800	2 198	18 958	30 956
1987[r]	8 883	3 353	23 267	35 503
1988[e]	9 408	3 201	23 208	35 818
1989[p]	7 108	1 903	21 233	30 245
1990[f]	7 257	1 903	18 957	28 117

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[p] Preliminary; [f] Forecast; [r] Revised; [e] Estimated.

TABLE 45. CANADA, EMPLOYMENT, SALARIES AND WAGES IN THE MINERAL INDUSTRY,[1] 1982–88

	Unit	1982	1983	1984	1985	1986	1987	1988
Metals								
Production and related workers	Number	44 261	37 270	39 181	36 618	34 941	34 329	36 140
Salaries and wages	$000	1 180 485	1 110 308	1 296 157	1 288 990	1 308 956	1 327 119	1 539 838
Annual average salary and wage	$	26 671	29 791	33 081	35 201	37 462	38 659	42 608
Administrative and office workers	Number	17 242	14 924	13 502	12 054	11 546	11 167	12 137
Salaries and wages	$000	585 249	533 517	518 644	487 398	489 402	489 609	561 205
Annual average salary and wage	$	33 943	35 749	38 412	40 435	42 387	43 844	46 239
Total metals								
Employees	Number	61 503	52 194	52 683	48 672	46 487	45 496	48 277
Salaries and wages	$000	1 765 734	1 643 825	1 814 801	1 776 388	1 798 358	1 816 728	2 101 043
Annual average salary and wage	$	28 710	31 495	34 448	36 497	38 685	39 932	43 521
Industrials[2]								
Production and related workers	Number	12 848	12 768	13 008	12 535	12 376	12 989	12 969
Salaries and wages	$000	309 736	329 201	356 828	354 460	361 039	401 626	429 111
Annual average salary and wage	$	24 108	25 783	27 431	28 278	29 173	30 920	33 087
Administrative and office workers	Number	4 323	3 805	4 250	4 380	4 887	4 930	4 627
Salaries and wages	$000	129 116	115 378	138 012	148 090	169 237	183 979	189 650
Annual average salary and wage	$	29 867	30 323	32 473	33 811	34 630	37 318	40 988
Total industrials								
Employees	Number	17 171	16 573	17 258	16 915	17 263	17 919	17 596
Salaries and wages	$000	438 852	444 579	494 840	502 550	530 276	585 605	618 761
Annual average salary and wage	$	25 558	26 825	28 673	29 710	30 717	32 681	35 165
Fuels								
Production and related workers	Number	17 069	16 591	17 461	18 155	16 958[r]	16 958[r]	17 601
Salaries and wages	$000	518 217	524 264	642 271	714 418	696 818[r]	711 429[r]	747 966
Annual average salary and wage	$	30 360	31 599	36 783	39 351	41 091[r]	41 952[r]	42 496
Administrative and office workers	Number	27 743	28 473	28 388	33 419	29 266[r]	27 290[r]	27 275
Salaries and wages	$000	925 201	1 075 245	1 154 137	1 419 903	1 392 666[r]	1 344 931[r]	1 428 335
Annual average salary and wage	$	33 349	37 764	40 656	42 488	47 586[r]	49 283[r]	52 368
Total fuels								
Employees	Number	44 812	45 064	45 849	51 574	46 224[r]	44 248[r]	44 876
Salaries and wages	$000	1 443 418	1 599 509	1 796 408	2 134 321	2 089 484[r]	2 056 360[r]	2 176 301
Annual average salary and wage	$	32 211	35 494	39 181	41 384	45 203[r]	46 474[r]	48 496
Total mineral industry								
Production and related workers	Number	74 178	66 629	69 650	67 308	64 275[r]	64 276[r]	66 710
Salaries and wages	$000	2 008 438	1 963 773	2 295 256	2 357 868	2 366 813[r]	2 440 174[r]	2 716 915
Annual average salary and wage	$	27 076	29 473	32 954	35 031	36 823[r]	37 964[r]	40 727
Administrative and office workers	Number	49 308	47 202	46 140	49 853	45 699[r]	43 387[r]	44 039
Salaries and wages	$000	1 639 566	1 724 140	1 810 793	2 055 391	2 051 305[r]	2 018 519[r]	2 179 189
Annual average salary and wage	$	33 252	36 527	39 246	41 229	44 887[r]	46 524[r]	49 483
Total mining industry								
Employees	Number	123 486	113 831	115 790	117 161	109 974[r]	107 663[r]	110 749
Salaries and wages	$000	3 648 004	3 687 913	4 106 049	4 413 259	4 418 118[r]	4 458 693[r]	4 896 105
Annual average salary and wage	$	29 542	32 398	35 461	37 668	40 174[r]	41 413[r]	44 209

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Cement manufacturing, lime manufacturing, clay and clay products (domestic clays) are included in the mineral manufacturing industry. [2] Includes structural materials.
[r] Revised.
Note: Totals may not add due to rounding.

TABLE 46. CANADA, EMPLOYMENT, SALARIES AND WAGES IN THE MINERAL MANUFACTURING INDUSTRIES, 1981-87

	Unit	1981	1982	1983	1984	1985	1986	1987
Primary metal industries								
Production and related workers	Number	105 518	92 621	87 769	92 336	92 695	90 035	..
Salaries and wages	$000	2 355 537	2 368 939	2 445 267	2 818 413	2 940 777	2 924 986	..
Annual average salary and wage	$	22 324	25 577	27 860	30 523	31 725	32 487	..
Administrative and office workers	Number	36 959	34 563	31 076	30 826	29 467	28 738	..
Salaries and wages	$000	1 039 467	1 104 327	1 055 120	1 131 842	1 159 060	1 182 287	..
Annual average salary and wage	$	28 125	31 951	33 953	36 717	39 334	41 140	..
Total primary metal industries[1]								
Employees	Number	142 477	127 184	118 845	123 162	122 162	118 773	119 372[r]
Salaries and wages	$000	3 395 004	3 473 266	3 500 387	3 950 387	4 099 837	4 107 273	4 244 950
Annual average salary and wage	$	23 828	27 309	29 453	32 074	33 561	34 581	35 561[r]
Nonmetallic mineral products industries								
Production and related workers	Number	40 145	33 997	34 097	36 155	38 763	42 011	45 158
Salaries and wages	$000	818 566	751 915	800 755	883 604	1 001 780	1 121 460	1 234 942
Annual average salary and wage	$	20 390	22 117	23 485	24 439	25 844	26 694	27 347
Administrative and office workers	Number	15 124	13 952	13 353	12 738	11 842	11 479	11 664
Salaries and wages	$000	369 889	383 405	391 901	394 620	397 131	406 427	433 927
Annual average salary and wage	$	24 457	27 480	29 349	30 980	33 536	35 406	37 202
Total nonmetallic mineral products								
Employees	Number	55 269	47 949	47 450	48 893	50 605	53 490	55 822
Salaries and wages	$000	1 188 455	1 135 320	1 192 656	1 278 224	1 398 911	1 527 887	1 668 869[r]
Annual average salary and wage	$	21 503	23 678	25 135	26 143	27 644	28 564	29 370[r]
Fabricated metal products industries								
Production and related workers	Number	107 269	94 779	87 661	88 787	100 650	109 634	..
Salaries and wages	$000	1 970 334	1 946 325	1 910 181	1 983 782	2 298 665	2 518 297	..
Annual average salary and wage	$	18 368	20 535	21 791	22 343	22 838	22 970	..
Administrative and officer workers	Number	34 254	30 372	28 239	26 203	23 694	22 987	..
Salaries and wages	$000	836 878	803 920	785 881	778 057	751 973	746 041	..
Annual average salary and wage	$	24 432	26 469	27 830	29 693	31 737	32 455	..
Total fabricated metal products industries								
Employees	Number	141 523	125 151	115 900	114 990	124 344	132 621	141 667[r]
Salaries and wages	$000	2 807 212	2 750 245	2 696 062	2 761 839	3 050 638	3 264 338	3 547 954
Annual average salary and wage	$	19 836	21 975	23 262	24 018	24 534	24 614	25 044[r]
Petroleum and coal products industries								
Production and related workers	Number	8 432	8 121	7 417	6 538	6 436	6 359	..
Salaries and wages	$000	249 199	266 022	264 104	262 827	265 859	265 156	..
Annual average salary and wage	$	29 554	32 757	35 608	40 200	41 308	41 698	..
Administrative and office workers	Number	14 182	13 380	11 500	10 726	10 303	8 707	..
Salaries and wages	$000	436 430	501 385	490 465	466 006	456 202	399 264	..
Annual average salary and wage	$	30 774	37 473	42 649	43 446	44 279	45 856	..
Total petroleum and coal products								
Employees	Number	22 614	21 501	18 917	17 264	16 739	15 066	15 148
Salaries and wages	$000	685 629	767 407	754 569	728 833	722 061	664 420	708 308
Annual average salary and wage	$	30 319	35 692	39 888	42 217	43 136	44 101	46 759
Total mineral manufacturing industries								
Production and related workers	Number	261 364	229 518	216 944	223 816	238 544	248 039	..
Salaries and wages	$000	5 393 636	5 333 201	5 420 307	5 948 626	6 507 081	6 829 899	..
Annual average salary and wage	$	20 636	23 237	24 985	26 578	27 278	27 536	..
Administrative and office workers	Number	100 519	92 267	84 168	80 493	75 306	71 911	..
Salaries and wages	$000	2 682 664	2 793 037	2 723 367	2 770 525	2 764 366	2 734 019	..
Annual average salary and wage	$	26 688	30 271	32 356	34 419	36 708	38 019	..
Total mineral manufacturing industries								
Employees	Number	361 883	321 785	301 112	304 309	313 850	319 950	333 009[r]
Salaries and wages	$000	8 076 300	8 126 238	8 143 674	8 719 151	9 271 447	9 563 918	10 170 081[r]
Annual average salary and wage	$	22 317	25 254	27 045	28 652	29 541	29 892	30 540[r]

Source: Statistics Canada.
[1] Wire and wire products have been included in the primary metal industries group.
[r] Revised; .. Not available.

TABLE 47. CANADA, NUMBER OF WAGE EARNERS EMPLOYED IN THE MINERAL INDUSTRY (SURFACE, UNDERGROUND AND MILL), 1982–88

	1982	1983	1984	1985	1986[1]	1987	1988
Metals							
Surface	12 133	9 970	9 724	10 093	9 674	9 557	9 637
Underground	18 673	15 861	16 668	14 798	13 982	13 747	14 968
Mill	13 455	11 439	12 789	11 727	11 285	11 025	11 535
Total	44 261	37 270	39 181	36 618	34 941	34 329	36 140
Industrials							
Surface	4 833	4 951	4 948	4 921	5 396	5 771	5 908
Underground	2 055	2 192	2 487	2 337	2 112	2 234	2 173
Mill	5 960	5 625	5 573	5 277	4 868	4 984	4 888
Total	12 848	12 768	13 008	12 535	12 376	12 989	12 969
Fuels							
Surface	13 283	12 190	14 392	15 101	..	..	..
Underground	3 226	2 896	1 818	1 626	..	..	..
Mill	560	1 505	1 251	1 428	..	..	..
Total	17 069	16 591	17 461	18 155	..	..	..
Total mineral industry							
Surface	30 429	27 111	29 064	30 115	15 070	15 328	15 545
Underground	23 954	20 949	20 973	18 761	16 094	15 981	17 141
Mill	19 975	18 569	19 613	18 432	16 153	16 009	16 423
Total	74 178	66 629	69 650	67 308	47 317	47 318	49 109

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Beginning in 1986, the count of employees for fuels broken down by surface, underground and mill workers is no longer available. For fuel totals for 1986, 1987 and 1988, refer to Table 45.
.. Not available.
Note: Totals may not add due to rounding.

TABLE 48. CANADA, MINE AND MILL WORKERS, BY SEX, EMPLOYED IN THE NONFUEL MINING INDUSTRY, 1988

	Mine Workers							
	Underground		Surface		Mill Workers		Total	
	Male	Female	Male	Female	Male	Female	Male	Female
Metallic minerals								
Nickel–copper–zinc[1]	6 224	17	4 052	102	3 090	105	13 366	224
Gold	5 238	23	1 687	73	2 706	86	9 631	182
Iron ore	96	1	1 120	12	3 280	122	4 496	135
Uranium	1 866	20	1 561	29	676	67	4 103	116
Silver–lead–zinc	1 355	10	558	31	1 083	23	2 996	64
Miscellaneous metal mines[2]	118	–	409	3	284	13	811	16
Total	14 897	71	9 387	250	11 119	416	35 403	737
Industrial minerals								
Potash	1 445	13	84	2	1 465	36	2 994	51
Stone	4	–	2 058	19	216	3	2 278	22
Asbestos	40	–	838	14	1 113	44	1 991	58
Sand and gravel	–	–	1 540	36	319	1	1 859	37
Miscellaneous nonmetals[3]	489	3	271	1	909	31	1 669	35
Peat	–	–	636	20	645	20	1 281	40
Gypsum	179	–	389	–	86	–	654	–
Total	2 157	16	5 816	92	4 753	135	12 726	243
Mining total[4]	17 054	87	15 203	342	15 872	551	48 129	980

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Includes copper–zinc and nickel–copper mines. [2] Includes molybdenum mines. [3] Includes salt mines. [4] Coal no longer included. Beginning in 1986, the count of employees for coal broken down by surface, underground and mill workers by sex is no longer available.
– Nil.

TABLE 49. CANADA, LABOUR COSTS FOR METAL MINES IN RELATION TO TONNES MINED, 1986–88

	Number of Wage Earners	Total Wages	Average Annual Wage	Tonnage of Ore Mined	Average Annual Tonnes Mined per Wage Earner	Wage Cost per Tonne Mined
		($000)	($)	(kilotonnes)		($)
1986						
Uranium	3 796	161 248	42 478	6 933	1 826	23.26
Gold	4 620	181 873	39 366	14 072	3 046	12.92
Silver–lead–zinc	1 801	68 971	328 296	12 084	6 710	5.71
Nickel–copper–zinc[1]	11 585	416 818	35 979	126 658	10 933	3.29
Miscellaneous metals[2]	546	19 674	36 033	8 360	15 311	2.35
Iron ore	1 308	51 760	39 572	88 231	67 455	0.59
Total	23 656	900 344	38 060	256 338	10 836	3.51
1987						
Uranium	3 591	152 184	42 379	6 383	1 778	23.84
Gold	5 381	218 960	40 691	15 326	2 848	14.29
Silver–lead–zinc	1 934	76 664	39 640	15 147	7 832	5.06
Nickel–copper–zinc[1]	10 703	397 886	37 175	130 452	12 188	3.05
Miscellaneous metals[2]	507	15 970	31 499	11 787	23 248	1.35
Iron ore	1 188	48 729	41 018	87 077	73 297	0.56
Total	23 304	910 393	39 066	266 172	11 422	3.42
1988						
Uranium	3 476	159 469	45 877	6 337	1 823	25.16
Gold	7 021	303 270	43 195	18 746	2 670	16.18
Silver–lead–zinc	1 954	83 297	42 629	12 758	6 529	6.53
Nickel–copper–zinc[1]	10 395	444 952	42 804	127 119	12 229	3.50
Miscellaneous metals[2]	530	17 595	33 198	47 747	27 824	1.19
Iron ore	1 229	56 953	46 341	102 392	83 313	0.56
Total	24 605	1 065 535	43 306	282 098	11 465	3.78

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Includes copper–zinc and nickel–copper mines. [2] Includes molybdenum mines.

TABLE 50. CANADA, PERSON-HOURS PAID FOR PRODUCTION AND RELATED WORKERS, AND TONNES OF ORE MINED AND ROCK QUARRIED IN METAL MINES AND OTHER MINERAL OPERATIONS, 1982–88

	Unit	1982	1983	1984	1985	1986	1987	1988
Metal mines[1]								
Ore mined	Mt	238.4	219.0	246.4	245.0	256.3	266.2	282.1
Person–hours paid[2]	million	80.4	71.8	78.2	77.1	73.6	74.9	79.1
Person–hours paid per tonne mined	number	0.34	0.33	0.32	0.31	0.29	0.28	0.28
Tonnes mined per person–hour paid	t	2.97	3.05	3.15	3.18	3.48	3.55	3.57
Other mineral operations[3]								
Ore mined and rock quarried	Mt	93.2	101.6	132.3	138.2	127.4	135.3	153.7
Person–hours paid[2]	million	34.8	32.2	34.0	31.3	28.9	29.9	30.4
Person–hours paid per tonne mined	number	0.37	0.32	0.26	0.23	0.23	0.22	0.20
Tonnes mined per person–hour paid	t	2.68	3.16	3.89	4.42	4.41	4.53	5.05

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Excludes placer mining. [2] Person–hours paid for production and related workers only. [3] Includes asbestos, potash, gypsum and coal.

TABLE 51. CANADA, AVERAGE WEEKLY WAGES AND HOURS WORKED (INCLUDING OVERTIME) FOR HOURLY-RATED EMPLOYEES IN MINING, MANUFACTURING AND CONSTRUCTION INDUSTRIES, 1984–89

	1984	1985	1986	1987	1988	1989
Mining						
Average hours per week	39.3	39.6	39.7	40.0	40.7	39.9
Average weekly wage ($)	664.56	697.90	711.05	726.40	771.17	821.59
Metals						
Average hours per week	38.8	39.1	39.6	39.6	39.9	39.7
Average weekly wage ($)	610.77	639.89	657.62	678.84	739.20r	793.06
Mineral fuels						
Average hours per week	40.6	40.8	40.9	41.6	42.1	41.5
Average weekly wage ($)	672.95	716.79	711.40	729.26	774.72r	831.14
Nonmetals						
Average hours per week	38.7	39.2	39.6	39.7	39.7	39.7
Average weekly wage ($)	536.20	554.88	581.84	595.98	623.08r	653.47
Manufacturing						
Average hours per week	38.5	38.8	38.8	38.8	38.8	38.6
Average weekly wage ($)	465.66	488.17	504.04	519.54	544.73r	572.93
Construction						
Average hours per week	37.4	37.8	37.9	38.4	38.5	38.2
Average weekly wage ($)	491.24	505.07	510.40	539.37	562.69	598.55

Source: Statistics Canada.
r Revised.

TABLE 52. CANADA, AVERAGE WEEKLY WAGES (INCLUDING OVERTIME) OF HOURLY-RATED EMPLOYEES IN THE MINING INDUSTRY, IN CURRENT AND 1986 DOLLARS,[1] 1984–89

	1984	1985	1986	1987	1988	1989
Current dollars						
All mining	664.56	697.90	711.05	726.40	771.17	821.59
Metals	610.77	639.89	657.62	678.84	739.20[r]	793.06
Mineral fuels	672.95	716.79	711.40	729.26	774.72[r]	831.14
Coal	653.42	697.30	718.82	729.54	766.60[r]	806.24
Industrial minerals	536.20	554.88	581.84	595.98	623.08[r]	653.47
1986 dollars (CPI)[1]						
All mining	719.22	726.98	711.05	695.79	710.10	720.69
Metals	661.01	666.55	657.62	650.23	680.66[r]	695.67
Mineral fuels	728.30	746.66	711.40	698.52	713.37[r]	729.07
Coal	707.16	726.35	718.82	698.79	705.89[r]	707.23
Industrial minerals	580.30	578.00	581.84	570.86	573.74[r]	573.22

Source: Statistics Canada.
[1] Consumer Price Index – all items.
[r] Revised.

TABLE 53. CANADA, INDUSTRIAL FATALITIES PER THOUSAND WORKERS BY INDUSTRY GROUPS,[1] 1987–89

	Fatalities[2]			Number of Workers			Rate per 1000 Workers		
	1987	1988	1989[p]	1987	1988	1989[p]	1987	1988	1989[p]
		(number)			(000)				
Agriculture	12	9	11	179	164	381	0.07	0.05	0.03
Forestry	61	62	57	62	65	66	0.98	0.95	0.86
Fishing[3]	24	12	8	15	18	30	1.60	0.67	0.27
Mining[4]	116[r]	85	58	181	185	165	0.64[r]	0.46	0.35
Manufacturing[5]	118[r]	124	71	2 017	2 097	2 069	0.06	0.06	0.03
Construction	120[r]	125	109	565	613	751	0.21	0.20	0.15
Transportation[6]	117[r]	108	101	848	860	947	0.14[r]	0.13	0.11
Trade	45[r]	42	35	1 928	1 997	2 231	0.02	0.02	0.02
Finance[7]	5	9	4	661	691	738	0.01	0.01	0.01
Service[8]	41[r]	48	44	3 501	3 631	4 212	0.01	0.01	0.01
Public administration[9]	38	40	30	814	820	790	0.05	0.05	0.04
Unknown	10	7	10	..	..	..	..	..	..
Total	707[r]	671	538	10 771	11 141	12 380	0.07[r]	0.06	0.04

Source: Labour Canada.

[1] Includes fatalities resulting from occupational chest illnesses such as silicosis, lung cancer, etc. [2] Excludes the province of Quebec for which data are unavailable. [3] Includes trapping and hunting. [4] Includes quarrying and oil wells. [5] Includes deaths of workers who were on pension for an earlier disabling injury. [6] Includes storage, communication, electric power and water utilities, and highway maintenance. [7] Includes insurance and real estate. [8] Includes community, business and personal services. [9] Includes defence.

[p] Preliminary; .. Not available; [r] Revised.

TABLE 54. CANADA, RATE OF INDUSTRIAL FATALITIES[1] PER THOUSAND WORKERS BY INDUSTRY GROUPS[2], 1983–89

	1983	1984	1985	1986	1987	1988	1989[p]
Agriculture	0.13	0.13	0.12	0.05	0.07	0.05	0.03
Forestry	0.97	0.88	1.08	0.90	0.98	0.95	0.86
Fishing[3]	1.07	1.93	2.17	1.00	1.60	0.67	0.27
Mining[4]	0.63	0.57	0.69	0.59	0.64[r]	0.46	0.35
Manufacturing[5]	0.08	0.07	0.07	0.06	0.06	0.06	0.03
Construction	0.25	0.31	0.28	0.27	0.21	0.20	0.15
Transportation[6]	0.17	0.15	0.16	0.14	0.14[r]	0.13	0.11
Trade	0.03	0.03	0.04	0.03	0.02	0.02	0.02
Finance[7]	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Service[8]	0.03	0.02	0.02	0.01	0.01	0.01	0.01
Public administration[9]	0.07	0.08	0.07	0.07	0.05	0.05	0.04
Total	0.08	0.08	0.09	0.07	0.07[r]	0.06	0.04

Source: Labour Canada.
[1] Excludes the Province of Quebec for which data is unavailable. [2] Includes fatalities resulting from occupational chest illnesses such as silicosis, lung cancer, etc. [3] Includes trapping and hunting. [4] Includes quarrying and oil wells. [5] Includes deaths of workers who were on pension for an earlier disabling injury. [6] Includes storage, communication, electric power and water utilities and highway maintenance. [7] Includes insurance and real estate. [8] Includes community, business and personal services. [9] Includes defence.
[p] Preliminary; [r] Revised.

TABLE 55. CANADA, INDUSTRIAL FATALITIES[1] BY OCCUPATIONAL INJURIES AND ILLNESSES,[2] 1987–89

	Occupational Injuries			Occupational Illnesses			Total		
	1987	1988	1989[p]	1987	1988	1989[p]	1987	1988	1989[p]
Agriculture	12	9	11	–	–	–	12	9	11
Forestry	61	61	56	–	1	1	61	62	57
Fishing[3]	24	12	8	–	–	–	24	12	8
Mining[4]	64[r]	46	35	52[r]	39	23	116[r]	85	58
Manufacturing[5]	73[r]	91	58	45[r]	33	13	118[r]	124	71
Construction	101[r]	96	86	19	29	23	120[r]	125	109
Transportation[6]	112[r]	102	94	5[r]	6	7	117[r]	108	101
Trade	42[r]	36	31	3	6	4	45[r]	42	35
Finance[7]	5	7	4	–	2	–	5	9	4
Service[8]	39[r]	46	41	2[r]	2	3	41[r]	48	44
Public administration[9]	31	35	26	7	5	4	38	40	30
Unknown	7[r]	5	5	3[r]	2	5	10	7	10
Total	571[r]	546	455	136[r]	125	83	707[r]	671	538

Source: Labour Canada.
[1] Excludes the Province of Quebec for which data is unavailable. [2] Includes fatalities resulting from occupational chest illnesses such as silicosis, lung cancer, etc. [3] Includes trapping and hunting. [4] Includes quarrying and oil wells. [5] Includes deaths of workers who were on pension for an earlier disabling injury. [6] Includes storage, communication, electric power and water utilities, and highway maintenance. [7] Includes insurance and real estate. [8] Includes community, business and personal services. [9] Includes defence.
[p] Preliminary; [r] Revised; – Nil.

TABLE 56. CANADA, NUMBER OF STRIKES AND LOCKOUTS BY INDUSTRIES, 1987–89

	1987			1988			1989p		
	Strikes and Lockouts	Workers Involved	Duration in Person–Days	Strikes and Lockouts	Workers Involved	Duration in Person–Days	Strikes and Lockouts	Workers Involved	Duration in Person–Days
Agriculture	1	18	3 830r	1	18	4 610	1	107	2 030
Forestry	5	881r	2 430r	4	963	19 520	1	368	53 000
Fishing and trapping	–	–	–	–	–	–	3	3 897	35 650
Mines	14	8 539r	156 540r	13	4 229	134 410	17	7 129	189 600
Manufacturing	304r	82 562r	1 717 402r	258	51 070	1 320 851	248	41 587	1 179 520
Construction	20r	8 345r	53 150r	21	34 156	632 030	35	34 353	137 040
Transportation and utilities	66r	124 982r	687 110r	47	38 338	1 996 840	66	26 522	407 970
Trade	96r	9 071r	337 240r	80	4 178	175 780	71	4 352	211 600
Finance, insurance and real estate	12r	557r	36 920r	9	462	23 780	13	465	4 410
Service	119r	58 060	487 815r	93	38 362	425 128	134	285 985	1 197 530
Public administration	31r	289 095r	328 030r	22	35 039	169 620	34	49 879	246 330
Various industries	–	–	–	–	–	–	–	–	–
All industries	668r	582 110	3 810 467	548	206 815	4 902 569	623	454 644	3 664 680

Source: Labour Canada.
p Preliminary; r Revised; – Nil.

TABLE 57. CANADA, NUMBER OF STRIKES AND LOCKOUTS BY MINING AND MINERAL MANUFACTURING INDUSTRIES, 1987–89

	1987			1988			1989p		
	Strikes and Lockouts	Workers Involved	Duration in Person–Days	Strikes and Lockouts	Workers Involved	Duration in Person–Days	Strikes and Lockouts	Workers Involved	Duration in Person–Days
Mines	14	8 539r	156 540r	13	4 229	134 410	17	7 129	189 600
Metals	10	7 188r	149 270r	8	3 488	93 430	7	2 978	113 510
Mineral fuels	2	1 060	1 000	–	–	–	4	3 261	36 320
Nonmetals	1	272	6 210	3	691	40 460	5	855	38 960
Quarries	1	19	60	2	50	520	1	35	810
Mineral manufacturing	40r	11 832r	441 140r	28	8 481	211 200	31	3 119	150 400
Primary metals	21	8 759r	363 490r	15	6 178	157 990	4	955	93 880
Nonmetallic mineral products	19r	3 073r	77 650r	13	2 303	53 210	24	1 730	52 320
Petroleum and coal products	–	–	–	–	–	–	3	434	4 200

Source: Labour Canada.
p Preliminary; r Revised; – Nil.

TABLE 58. CANADA, MINING WAGES AND SALARIES BY CLASS, 1987 AND 1988

	1987					1988				
	Metals	Nonmetals	Mineral Fuels	Quarries and Sand Pits	Total	Metals	Nonmetals	Mineral Fuels	Quarries and Sand Pits	Total
			($000)					($000)		
Newfoundland	87 291	14 227	–	1 007	102 525	116 080	14 791	–	1 291	132 162
Prince Edward Island	–	–	–	–	–	–	–	–	–	–
Nova Scotia	x	x	76 944	6 222	112 057	10 522	22 615	82 194	6 414	121 745
New Brunswick	x	x	6 415	3 621	107 175	62 211	x	6 869	x	112 568
Quebec	372 606	99 953	–	49 922	522 481	421 748	104 512	–	57 800	584 060
Ontario	750 059	67 317	16 790[r]	94 175	928 341[r]	870 317	68 050	8 069	105 544	1 051 980
Manitoba	118 925	4 998	2 989[r]	5 553	132 465[r]	157 651	4 521	3 201	6 208	171 581
Saskatchewan	x	131 784	x[r]	x	238 523[r]	54 718	136 404	x	x	251 265
Alberta	x	x	x[r]	x	1 608 209[r]	630	x	x	8 858	1 730 929
British Columbia	242 686	16 820	269 607[r]	16 018	545 131[r]	278 737	18 410	275 371	12 440	584 959
Yukon and Northwest Territories	120 763	–	22 248[r]	–	143 011[r]	128 430	–	21 276	–	149 706
Offshore	–	–	18 775[r]	–	18 775[r]	–	–	5 149	–	5 149
Total	1 816 727	401 732	2 056 360[r]	183 874	4 458 693[r]	2 101 043	415 695	2 176 301	203 066	4 896 105
Services incidental to mining[1]					1 158 621					1 227 695
Grand total					5 617 314[r]					6 123 800

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Includes establishments primarily engaged in providing contract drilling and other services to petroleum and natural gas industries.
x Confidential; – Nil; [r] Revised.

TABLE 59. CANADA, SOURCE OF ORES HOISTED OR REMOVED FROM SELECTED TYPES OF MINES, 1986-88

Mines	1986			1987			1988		
	Underground	Open-Pit	Total	Underground	Open-Pit	Total	Underground	Open-Pit	Total
					(kilotonnes)				
Nickel-copper-zinc	27 486	98 812	126 298	28 040	102 412	130 452	26 177	100 942	127 119
Iron ore	1 660	86 571	88 231	1 434	85 644	87 077	1 346	101 045	102 392
Coal	3 562	69 174	72 736	4 206	73 245	77 452	5 286	83 970	89 256
Potash	33 563	–	33 563	34 875	–	34 875	38 965	. .	38 965
Gold	10 208	3 864	14 072	11 593	3 733	15 326	13 768	4 977	18 746
Silver-lead-zinc	7 118	4 965	12 083	7 321	7 826	15 147	8 297	4 461	12 758
Asbestos	1 212	10 596	11 808	1 089	12 437	13 526	288	15 085	15 373
Gypsum	1 324	7 851	9 175	1 435	8 004	9 439	1 399	7 441	8 840
Rock salt	8 460	–	8 460	7 091	–	7 091	7 960	–	7 960
Miscellaneous metals	1 127	7 234	8 361	909	10 878	11 787	1 006	13 741	14 747
Uranium	6 313	620	6 933	5 716	667	6 383	5 791	546	6 337
Miscellaneous nonmetals	409	2 988	3 397	192	3 372	3 564	233	1 504	1 737
Total	102 442	292 675	395 117	103 902	308 217	412 119	110 518	333 711	444 228
Percentage	25.9	74.1	100.0	25.2	74.8	100.0	24.9	75.1	100.0

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available.
Note: Totals may not add due to rounding.

TABLE 60. CANADA, SOURCE OF MATERIAL HOISTED OR REMOVED FROM SELECTED TYPES OF MINES, 1988

	Underground		Open-Pit			
	Ore	Waste	Ore	Waste	Over-burden	Tailings
			(kilotonnes)			
Nickel-copper-zinc	26 177	4 157	100 942	104 688	1 466	121 544
Iron ore	1 346	5	101 045	27 047	7 783	57 682
Coal	5 286	. .	83 970	. .	. .	. .
Potash	38 965	13	. .	. .	. .	25 341
Gold	13 768	3 185	4 977	18 920	537	17 831
Silver-lead-zinc	8 297	1 503	4 461	497	–	11 359
Asbestos	288	–	15 085	40 182	2 988	7 646
Gypsum	1 399	78	7 441	2 218	3 313	557
Rock salt	7 960	649	–	–	–	802
Miscellaneous metals	1 006	25	13 741	7 741	–	11 713
Uranium	5 791	285	546	7 549	426	6 505
Miscellaneous nonmetals	233	68	1 504	667	291	540
Total	110 518	9 967	333 711	209 508	16 804	261 521

Sources: Energy, Mines and Resources Canada; Statistics Canada.
– Nil; . . Not available.
Note: Totals may not add due to rounding.

TABLE 61. CANADA, ORE MINED AND ROCK QUARRIED IN THE MINING INDUSTRY, 1982-88

	1982	1983	1984	1985	1986	1987	1988
				(kilotonnes)			
Metals							
Nickel-copper-zinc	117 833	116 532	124 682	117 169	126 298	130 452	127 119
Iron	81 963	74 597	89 210	94 587	88 231	87 077	102 392
Gold	8 368	9 553	11 225	11 997	14 072	15 326	18 746
Silver-lead-zinc	14 113	9 157	10 084	9 970	12 083	15 147	12 758
Miscellaneous metals	8 477	2 133	3 627	4 067	8 361	11 787	14 747
Uranium	7 608	7 073	7 608	7 182	6 933	6 383	6 337
Total	238 362	219 045	246 436	244 972	255 978	266 172	282 098
Nonmetals							
Potash	16 946	24 222	36 542	34 843	33 563	34 875	38 965
Asbestos	17 493	15 035	15 726	17 118	11 808	13 526	15 373
Gypsum	5 830	7 540	8 869	9 608	9 175	9 439	8 840
Rock salt	5 723	5 996	6 706	7 101	8 460	7 091	7 960
Miscellaneous nonmetals	1 995	2 922	3 825	3 036	3 397	3 564	1 737
Total	47 987	55 715	71 668	71 706	66 403	68 496	72 875
Structural materials							
Stone, all kinds quarried[1]	59 181	67 651	81 754	86 632	112 693	128 969	135 010
Stone used to make cement	10 593	10 154	10 101	8 467	11 535	12 543[r]	12 539
Stone used to make lime	3 411	3 446	4 260	5 137	3 556	3 134[r]	2 346
Total	73 185	81 251	96 115	100 236	127 784	144 646	149 895
Fuels							
Coal	52 979	54 817	71 207	76 667	72 736	77 452	89 256
Total ore mined and rock quarried	412 513	410 828	485 426	493 581	522 901	556 765	594 123

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Excludes stone used to manufacture cement and lime in Canada.

[r] Revised.

Note: Totals may not add due to rounding.

TABLE 62. CANADA, EXPLORATION AND CAPITAL EXPENDITURES IN THE MINING INDUSTRY[1] BY PROVINCES AND TERRITORIES, 1988–90

		Capital											
		Construction						Repair					
		On-Property Exploration	On-Property Development	Structures	Sub-Total	Machinery and Equipment	Total Capital	Construction	Machinery and Equipment	Total Repair	Total Capital and Repair	General Exploration plus Minesite	Total, all Expenditures
		($ million)											
Newfoundland	1988	x	35.8	x	102.4	18.4	120.8	x	x	153.0	273.8	41.1[a]	314.9[r]
	1989[p]	–	43.0	10.2	53.2	38.2	91.4	x	x	155.6	247.0	33.7[b]	280.7[r]
	1990[i]	–	39.3[r]	12.1[r]	51.4[r]	48.1[r]	99.5	x	x	151.3	250.8	32.6[b]	283.4[r]
Prince Edward Island	1988	–	–	–	–	–	–	–	–	–	–	. .	–
	1989[p]	–	–	–	–	–	–	–	–	–	–	. .	–
	1990[i]	–	–	–	–	–	–	–	–	–	–	. .	–
Nova Scotia	1988	1.2	16.7	8.3	26.2	46.6	72.8	2.5	37.2	39.7	112.5	49.0[a]	161.5[r]
	1989[p]	x	21.8	x	26.0	33.8	59.8	1.2	37.1	38.3	98.1	29.8[b]	127.9[r]
	1990[i]	x	36.1[r]	x	47.4[r]	94.1[r]	141.5[r]	2.0	38.1	40.1	181.6[r]	12.8[b]	194.4[r]
New Brunswick	1988	0.8	32.7	14.3	47.8	41.6	89.4	8.0	76.7	84.7	174.1	. .	174.1[r]
	1989[p]	x	26.9	x	41.0	72.9	113.9	9.4	88.6	98.0	211.9	18.5[b]	230.4[r]
	1990[i]	2.2[r]	33.8[r]	19.8[r]	55.8[r]	59.9[r]	115.7[r]	10.3	87.0	97.3	213.0[r]	16.7[b]	229.7[r]
Quebec	1988	33.6	207.8	110.3	351.7	109.1	460.8	17.7	219.7	237.4	698.2	357.9[a]	1 056.1[r]
	1989[p]	49.9	251.9	53.0	354.8	140.4	495.2	25.8	259.6	285.4	780.6	203.2[b]	983.8[r]
	1990[i]	16.8[r]	196.6[r]	22.8[r]	236.2[r]	115.0[r]	351.2[r]	27.0	265.2	292.2	643.4[r]	174.0[b]	817.4[r]
Ontario	1988	67.0	361.2	192.2	620.4	339.1	959.5	75.4	433.4	508.8	1 468.3	395.0[a]	1 863.3[b]
	1989[p]	37.8	281.8	80.5	400.1	280.0	680.1	54.4	447.6	502.0	1 182.1	237.0[b]	1 419.1[r]
	1990[i]	44.2[r]	293.5[r]	76.8[r]	414.5[r]	257.1[r]	671.6[r]	56.2	453.9	510.1	1 181.7[r]	199.7[b]	1 381.4[r]
Manitoba	1988	9.4	33.6	69.2	112.2	45.1	157.3	8.1	56.1	64.2	221.5	39.5[a]	261.0[r]
	1989[p]	x	49.4	x	88.6	37.9	126.5	1.8	57.1	58.9	185.4	35.7[b]	221.1[r]
	1990[i]	5.0[r]	x	x	108.3[r]	34.4[r]	142.7[r]	1.9	50.8	52.7	195.4[r]	35.6[b]	231.0[r]
Saskatchewan	1988	13.5	114.4	26.0	153.9	65.9	219.8	8.4	138.2	146.6	366.4	. .	366.4[r]
	1989[p]	13.8	58.1	32.5	104.4	70.8	175.2	14.1	136.9	151.0	326.2	70.1[b]	396.3[r]
	1990[i]	26.3[r]	81.6[r]	22.4[r]	130.3[r]	59.1[r]	189.4[r]	14.0	139.9	153.9	343.3[r]	72.8[b]	416.1[r]
Alberta	1988	1.0	14.2	10.1	25.3	33.9	59.2	1.1	104.0	105.1	164.3	. .	164.3[r]
	1989[p]	x	15.8	x	17.9	26.1	44.0	0.5	115.8	116.3	160.3	6.9[b]	167.2[r]
	1990[i]	x	19.4[r]	x	23.5[r]	32.1[r]	55.6[r]	1.1	120.7	121.8	177.4[r]	7.7[b]	185.1[r]
British Columbia	1988	12.0	330.9	147.6	490.5	101.8	592.3	29.7	406.8	436.5	1 028.8	229.8[a]	1 258.6[r]
	1989[p]	30.1	287.2	114.5	431.8	139.3	571.1	22.5	428.8	451.3	1 022.4	218.3[b]	1 240.7[r]
	1990[i]	13.8[r]	258.0[r]	33.9[r]	305.7[r]	159.7[r]	465.4[r]	22.5	449.1	471.6	937.0[r]	165.9[b]	1 102.9[r]

TABLE 62 (cont'd)

		Capital						Repair					
		Construction											
		On-Property Exploration	On-Property Development	Structures	Sub-Total	Machinery and Equipment	Total Capital	Construction	Machinery and Equipment	Total Repair	Total Capital and Repair	General Exploration plus Minesite	Total, all Expenditures
		($ million)											
Yukon	1988	x	24.2	x	35.4	3.8	39.2	x	x	3.2	42.4	..	42.4[r]
	1989[p]	x	13.6	x	18.7	4.9	23.6	x	x	21.6	45.2	48.0[b]	93.2[r]
	1990[i]	x	x	x	26.7[r]	7.1[r]	33.8[r]	x	x	31.2	65.0[r]	43.3[b]	108.3[r]
Northwest Territories	1988	1.4	38.3	36.1	75.8	20.6	96.4	3.9	42.1	46.0	142.4	..	142.4[r]
	1989[p]	1.8	40.3	86.5	128.6	83.8	212.4	1.7	32.0	33.7	246.1	25.5[b]	271.6[r]
	1990[i]	x[r]	54.4[r]	x	81.0[r]	24.3[r]	105.3[r]	1.2	31.8	33.0	138.3[r]	22.2[b]	160.5[r]
Canada	1988	143.4	1 229.7	668.3	2 041.4	825.8	2 867.2	161.6	1 663.3	1 824.9	4 692.1	1 350.0[e]	6 042.1[r]
	1989[p]	146.3	1 089.7	429.1	1 665.1	928.1	2 593.2	140.6	1 771.4	1 912.0	4 505.2	926.8	5 432.0[r]
	1990[i]	114.3[r]	1 137.4[r]	229.0[r]	1 480.7[r]	890.9[r]	2 371.6[r]	145.1	1 810.0	1 955.1	4 326.7[r]	783.4	5 110.1[r]

Sources: Statistics Canada; Energy, Mines and Resources Canada.
1 Excludes crude oil and natural gas industries.
[a] Provincial Government Departments produced these figures. [b] Produced through new federal-provincial survey of mining and exploration companies beginning 1988. [e] Estimated by EMR.
[p] Preliminary; [i] Intentions; .. Not available; – Nil; x Confidential, included in total; [r] Revised.
Note: Totals may not add due to rounding.

TABLE 63. CANADA, EXPLORATION AND CAPITAL EXPENDITURES IN THE MINING INDUSTRY[1] BY TYPE OF MINING, 1988–90

		Capital						Repair			
		Construction									
		On-Property Exploration	On-Property Development	Structures	Sub-Total	Machinery and Equipment	Total Capital	Construction	Machinery and Equipment	Total Repair	Total Capital and Repair
		($ million)									
Metal mines											
Copper-gold-silver	1988	27.4	130.3	129.0	286.7	84.9	371.6	18.1	260.8	278.9	650.5
	1989p	22.6	91.1	85.4	199.1	109.4	308.5	19.9	279.3	299.2	607.7
	1990i	15.1r	138.5r	16.0r	169.6r	105.1r	274.7r	22.3	283.4	305.7	580.4r
Gold	1988	86.0	416.8	362.5	865.3	291.7	1 157.0	48.0	177.2	225.2	1 382.2
	1989p	78.0	328.9	226.7	633.6	218.3	851.9	28.4	208.2	236.6	1 088.5
	1990i	40.1r	263.9r	97.5r	401.5r	107.4r	508.9r	29.5	214.1	243.6	752.5r
Iron	1988	x	66.0	x	70.2	13.2	83.4	8.8	234.6	243.4	326.8
	1989p	x	x	x	74.6	48.7	123.3	12.8	232.0	244.8	368.1
	1990i	x	x	x	93.9r	88.3r	182.2r	12.8	213.7	226.5	408.7r
Silver-lead-zinc	1988	7.7	80.8	25.9	114.4	40.4	154.8	11.2	80.9	92.1	246.9
	1989p	7.9	89.2	17.9	115.0	70.8	185.8	10.9	107.8	118.7	304.5
	1990i	7.6r	66.1r	19.9r	93.6r	46.3r	139.9r	11.1	115.7	126.8	266.7r
Uranium	1988	x	93.1	x	112.7	26.7	139.4	8.1	129.5	137.6	277.0
	1989p	x	x	x	72.6	28.9	101.5	9.5	119.5	129.0	230.5
	1990i	x	x	x	100.2r	24.0r	124.2r	8.9	125.7	134.6	258.8r
Other metal mining[2]	1988	12.5	104.2	42.6	159.3	105.3	264.6	28.9	145.6	174.5	439.1
	1989p	19.4	143.2	40.1	202.7	143.1	345.8	30.3	153.7	184.0	529.8
	1990i	25.1r	153.2r	39.2r	217.5r	162.5r	380.0r	32.5	164.7	197.2	577.2r
Total metal mining	1988	139.3	891.2	578.1	1 608.6	562.3	2 170.9	123.2	1 028.6	1 151.8	3 322.7
	1989p	132.3	780.6	384.5	1 297.4	619.2	1 916.6	111.9	1 100.6	1 212.5	3 129.1
	1990i	100.8r	779.2r	196.2r	1 076.2r	533.5r	1 609.7r	117.1	1 117.5	1 234.6	2 844.3r
Nonmetal mines											
Asbestos	1988	x	55.2	x	56.0	3.1	59.1	2.1	40.6	42.7	101.8
	1989p	x	51.4	x	52.6	1.3	53.9	5.5	53.1	58.6	112.5
	1990i	x	45.4r	x	47.0r	7.2r	54.2r	4.6	46.2	50.8	105.0r

TABLE 63. (cont'd)

		Capital						Repair			
		Construction									
		On-Property Exploration	On-Property Development	Structures	Sub-Total	Machinery and Equipment	Total Capital	Construction	Machinery and Equipment	Total Repair	Total Capital and Repair
		($ million)									
Coal	1988	x	189.1	x	214.9	115.6	330.5	21.1	353.1	374.2	704.7
	1989[p]	x	183.7	x	200.0	115.6	315.6	8.3	368.3	376.6	692.2
	1990[i]	2.6[r]	234.0[r]	16.9[r]	253.5[r]	172.1[r]	425.6[r]	7.7	396.6	404.3	829.9[r]
Other nonmetal mining[3]	1988	2.4	94.1	65.3	161.8	144.9	306.7	15.3	241.0	256.3	563.0
	1989[p]	11.0	74.0	30.2	115.2	192.0	307.2	15.0	249.4	264.4	571.6
	1990[i]	x	78.8[r]	x	104.0[r]	178.1[r]	282.1[r]	15.6	249.7	265.3	547.4[r]
Total nonmetal mining	1988	4.1	338.5	90.3	432.9	263.5	696.4	38.5	634.7	673.2	1 369.6
	1989[p]	14.1	309.1	44.6	367.8	308.9	676.7	28.7	670.9	699.6	1 376.3
	1990[i]	13.6[r]	358.2[r]	32.8[r]	404.6[r]	357.4[r]	762.0[r]	28.0	692.5	720.5	1 482.5[r]
Metal and nonmetal exploration companies	1988	..	..	..	..	..	..	..	..	..	..
	1989[p]	..	..	..	..	..	..	..	..	..	..
	1990[i]	..	..	..	..	..	..	..	..	..	..
Total mining	1988	143.4	1 229.7	668.3	2 041.4	825.8	2 867.2	161.6	1 663.3	1 824.9	4 692.1
	1989[p]	146.3	1 089.7	429.1	1 665.1	928.1	2 593.2	140.6	1 771.4	1 912.0	4 505.2
	1990[i]	114.3[r]	1 137.4[r]	229.0[r]	1 480.7[r]	890.9[r]	2 371.6[r]	145.1	1 810.0	1 955.1	4 326.7[r]

Sources: Statistics Canada; Energy, Mines and Resources Canada.

[1] Excludes expenditures in the petroleum and natural gas industries. [2] Includes nickel-copper mines, silver-cobalt mines and other metal mines. [3] Includes gypsum mines, salt mines, potash mines, quarries, sand and gravel pits and other nonmetal mines.

[p] Preliminary; [i] Intentions; .. Not available; x Confidential, included in total; [r] Revised.

Note: Totals may not add due to rounding.

TABLE 64. CANADA, DIAMOND DRILLING IN THE MINING INDUSTRY BY MINING COMPANIES WITH OWN EQUIPMENT AND BY DRILLING CONTRACTORS, 1986-88

		1986			1987			1988		
		Exploration	Other	Total	Exploration	Other	Total	Exploration	Other	Total
		(metres)								
Metal mines										
Gold	Own equipment	50 003	161 919	211 922	36 101	49 276	85 377	39 604	23 941	63 545
	Contractors	553 141	9 833	562 974	565 311	–	565 311	672 825	–	672 825
	Total	603 144	171 752	774 896	601 412	49 276	650 688	712 429	23 941	736 370
Iron mines	Own equipment	15 000	199 336	214 336	15 000	226 782	241 782	10 038	365 123	375 161
	Contractors	3 900	–	3 900	6 771	–	6 771	–	–	–
	Total	18 900	199 336	218 236	21 771	226 782	248 553	10 038	365 123	375 161
Nickel-copper-zinc	Own equipment	185 156	11 568	196 724	154 123	–	154 123	127 441	–	127 441
	Contractors	237 601	–	237 601	349 386	–	349 386	233 841	9 000	242 841
	Total	422 757	11 568	434 325	503 509	–	503 509	361 282	9 000	370 082
Silver-lead-zinc	Own equipment	59 334	6 000	65 334	54 667	–	54 667	60 858	–	60 858
	Contractors	98 422	–	98 422	70 624	–	70 624	72 280	–	72 280
	Total	157 756	6 000	163 756	125 291	–	125 291	133 138	–	133 138
Uranium	Own equipment	37 661	–	37 661	30 619	49 485	80 104	34 175	–	34 175
	Contractors	233	–	233	11 718	–	11 718	10 250	–	10 250
	Total	37 894	–	37 894	42 337	49 485	91 822	44 425	–	44 425
Miscellaneous metal mining	Own equipment	–	–	–	–	–	–	–	–	–
	Contractors	22 512	–	22 512	18 636	–	18 636	13 878	–	13 878
	Total	22 512	–	22 512	18 636	–	18 636	13 878	–	13 878
Total metal mining	Own equipment	347 154	378 823	725 977	290 510	325 543	616 053	272 116	389 064	661 180
	Contractors	915 809	9 833	925 642	1 022 446	–	1 022 446	1 003 074	9 000	1 012 074
	Total	1 262 963	388 656	1 651 619	1 312 956	325 543	1 638 499	1 275 190	398 064	1 673 254
Nonmetal mines										
Gypsum	Own equipment	–	–	–	–	–	–	–	–	–
	Contractors	4 632	9 144	13 776	–	2 438	2 438	4 145	3 444	7 589
	Total	4 632	9 144	13 776	–	2 438	2 438	4 145	3 444	7 589
Other nonmetal mines	Own equipment	1 710	–	1 710	–	–	–	–	–	–
	Contractors	1 430	4	1434	2 154	–	2 154	2 300	–	2 300
	Total	3 140	4	3 144	2 154	–	2 154	2 300	–	2 300
Asbestos	Own equipment	–	–	–	–	–	–	–	–	–
	Contractors	2 851	–	2 851	1 864	–	1 864	2 289	–	2 289
	Total	2 851	–	2 851	1 864	–	1 864	2 289	–	2 289
Potash	Own equipment	–	–	–	18 100	–	18 100	–	–	–
	Contractors	–	–	–	3 437	–	3 437	–	–	–
	Total	–	–	–	21 537	–	21 537	–	–	–
Total nonmetal mining	Own equipment	1 710	–	1 710	18 100	–	18 100	–	–	–
	Contractors	8 913	9 148	18 061	7 455	2 438	9 893	8 734	3 444	12 178
	Total	10 623	9 148	19 771	25 555	2 438	27 993	8 734	3 444	12 178
Total mining industry	Own equipment	348 864	378 823	727 687	308 610	325 543	634 153	272 116	389 064	661 180
	Contractors	924 722	18 981	943 703	1 029 901	2 438	1 032 339	1 011 808	12 444	1 024 252
	Total	1 273 586	397 804	1 671 390	1 338 511	327 981	1 666 492	1 283 924	401 508	1 685 432

Sources: Energy, Mines and Resources Canada; Statistics Canada, Catalogue Nos. 26-223 and 26-224.
– Nil.
Note: Totals may not add due to rounding.

TABLE 65. CANADA, ORE MINED AND ROCK QUARRIED IN THE MINING INDUSTRY, 1959-88

	Metals	Industrial[1]	Coal	Total
		(million tonnes)		
1959	89.9	82.2		172.1
1960	92.1	88.7		180.8
1961	90.1	96.7		186.8
1962	103.6	103.8		207.4
1963	112.7	120.4		233.1
1964	128.0	134.1		162.1
1965	151.0	146.5		297.5
1966	147.6	171.8		319.4
1967	169.1	177.5		346.6
1968	186.9	172.7		359.6
1969	172.0	178.8		350.8
1970	213.0	179.1		392.1
1971	211.5	185.8		397.3
1972	206.0	189.7		395.7
1973	274.9	162.6		437.4
1974	278.7	178.8		457.5
1975	264.2	158.7		422.9
1976	296.5	167.1		463.6
1977	299.5	205.2	33.8	538.5
1978	248.1	205.5	36.3	489.9
1979	274.8	200.1	39.8	514.6
1980	290.1	193.5	43.9	527.5
1981	301.5	172.5	48.2	522.2
1982	238.4	121.2	53.0	412.5
1983	219.0	137.0	54.8	410.8
1984	246.4	167.8	71.2	485.4
1985	245.0	171.9	76.7	493.6
1986	256.0	194.2	72.7	522.9
1987	266.2	213.1	77.5	556.8
1988	282.1	222.8	89.3	594.1

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Includes nonmetallic mineral mining and all stone quarried, including stone used to make cement and lime. From 1979 onwards, coverage includes miscellaneous nonmetal mines previously excluded.
Note: Totals may not add due to rounding.

TABLE 66. CANADA, TOTAL DIAMOND DRILLING, METAL DEPOSITS, 1959-88

	Gold Deposits	Copper-Zinc and Nickel-Copper Deposits	Silver-Lead-Zinc Deposits	Other Metal-Bearing Deposits[1]	Total Metal Deposits
			(metres)		
1959	558 160	1 110 664	282 088	383 471	2 334 383
1960	628 016	1 267 792	226 027	315 067	2 436 902
1961	595 180	1 128 091	255 101	221 079	2 199 451
1962	902 288	1 025 048	350 180	358 679	2 636 195
1963	529 958	977 257	288 204	148 703	1 944 122
1964	458 933	709 588	401 099	104 738	1 674 358
1965	440 020	779 536	331 294	275 917	1 826 767
1966	442 447	729 148	292 223	164 253	1 628 071
1967	391 347	947 955	230 182	120 350	1 689 834
1968	375 263	935 716	198 038	56 780	1 565 797
1969	274 410	923 452	197 670	109 592	1 505 124
1970	214 717	1 132 915	375 019	99 373	1 822 024
1971	193 291	1 089 103	308 798	83 851	1 675 043
1972	229 771	967 640	240 195	50 225	1 487 831
1973	243 708	713 134	185 946	57 730	1 200 518
1974	250 248	798 564	197 322	83 484	1 329 618
1975	216 158	532 991	184 203	97 971	1 031 323
1976	156 030	507 620	166 366	97 735	927 751
1977	175 643	515 780	213 279	124 329	1 029 031
1978	209 335	346 722	490 489	135 197	1 181 743
1979	198 955	437 562	131 032	150 018	917 567
1980	187 635	566 610	259 877	173 945	1 188 067
1981	306 197	675 712	478 754	170 369	1 631 032
1982	288 421	386 940	424 218	164 742	1 264 321
1983	352 218	512 745	269 659	97 661	1 232 283
1984	406 060	830 536	273 238	281 661	1 791 495
1985	429 565	475 582	152 692	286 764	1 344 603
1986	774 896	434 325	163 756	278 642	1 651 619
1987	650 688	503 509	125 291	359 011	1 638 499
1988	736 370	370 282	133 138	433 464	1 673 254

Sources: Energy, Mines and Resources Canada; Statistics Canada, Catalogue No. 26-223.
[1] Includes iron, titanium, uranium, molybdenum and other metal deposits.

TABLE 67. CANADA, EXPLORATION DIAMOND DRILLING, METAL DEPOSITS, 1959-88

	Mining Companies with Own Personnel and Equipment	Diamond Drilling Contractors	Total
		(metres)	
1959	239 786	1 367 061	1 606 847
1960	268 381	1 409 416	1 677 797
1961	302 696	1 337 173	1 639 869
1962	167 214	1 748 023	1 915 237
1963	361 180	1 169 292	1 530 472
1964	143 013	1 072 985	1 215 998
1965	209 002	1 176 996	1 385 998
1966	163 379	1 044 860	1 208 239
1967	93 164	1 123 137	1 216 301
1968	159 341	990 690	1 150 031
1969	135 311	1 072 328	1 207 639
1970	62 147	1 228 061	1 290 208
1971	86 838	1 053 330	1 140 168
1972	251 651	839 753	1 091 404
1973	321 333	742 899	1 064 232
1974	357 823	892 557	1 250 380
1975	346 770	618 161	964 931
1976	335 919	532 036	867 955
1977	327 241	638 327	965 568
1978	237 250	534 557	771 807
1979	311 221	571 721	882 942
1980	347 829	747 566	1 095 395
1981	460 687	917 566	1 378 253
1982	289 901	713 413	1 003 314
1983	324 383	707 343	1 031 726
1984	357 680	936 459	1 294 139
1985	382 490	725 310	1 107 800
1986	347 154	915 809	1 262 963
1987	290 510	1 022 446	1 312 956
1988	272 116	1 003 074	1 275 190

Sources: Energy, Mines and Resources Canada; Statistics Canada, Catalogue No. 26-223.

TABLE 68. CANADA, DIAMOND DRILLING, OTHER THAN FOR EXPLORATION, METAL DEPOSITS, 1959-88

	Mining Companies with Own Personnel and Equipment	Diamond Drilling Contractors	Total
		(metres)	
1959	488 783	238 753	727 536
1960	450 246	308 860	759 106
1961	384 432	175 149	559 581
1962	528 700	192 259	720 959
1963	388 228	25 422	413 650
1964	385 765	72 594	458 359
1965	393 947	46 822	440 769
1966	227 968	191 863	419 831
1967	186 463	287 071	473 534
1968	122 851	292 914	415 765
1969	87 552	209 933	297 485
1970	290 363	241 453	531 816
1971	295 966	238 910	534 876
1972	304 523	91 903	396 426
1973	77 162	59 124	136 286
1974	54 353	24 885	79 238
1975	31 917	34 475	66 392
1976	31 413	28 383	59 796
1977	24 303	39 160	63 463
1978	351 344	58 592	409 936
1979	4 090	30 535	34 625
1980	20 545	72 127	92 672
1981	200 898	51 881	252 779
1982	188 674	72 333	261 007
1983	81 138	119 419	200 557
1984	492 939	4 417	497 356
1985	230 501	6 302	236 803
1986	378 823	9 833	388 656
1987	325 543	–	325 543
1988	389 064	9 000	398 064

Sources: Energy, Mines and Resources Canada; Statistics Canada, Catalogue No. 26-223.
– Nil.
Note: Nonproducing companies excluded since 1964.

TABLE 69. CANADA, CRUDE MINERALS TRANSPORTED BY CANADIAN RAILWAYS, 1986–88

	1986	1987	1988
		(kilotonnes)	
Metallic minerals			
Iron ores and concentrates	36 688	36 093	39 835
Nickel–copper ores and concentrates	4 084	3 797	3 742
Alumina and bauxite	3 503	3 363	3 224
Zinc ores and concentrates	993	1 380	1 554
Copper ores and concentrates	1 357	1 356	1 185
Lead ores and concentrates	912	514	590
Metallic ores and concentrates, n.e.s.	10	4	63
Nickel ores and concentrates	–	–	–
Total metallic minerals	47 547	46 509	50 193
Nonmetallic minerals			
Potash (KCl)	10 266	11 577	12 337
Sulphur, n.e.s.	5 831	5 731	6 559
Gypsum	5 512	5 636	5 418
Limestone, n.e.s.	2 997	3 301	3 008
Phosphate rock	1 612	1 162	1 236
Clay	790	750	1 025
Sulphur, liquid	839	970	1 002
Sand, industrial	888	948	985
Salt, rock	799	687	688
Sodium carbonate	560	663	659
Limestone, industrial	455	386	396
Nepheline syenite	242	252	302
Sodium sulphate	385	319	297
Nonmetallic minerals, n.e.s.	177	142	170
Salt, n.e.s.	101	146	161
Limestone, agricultural	128	93	122
Stone, n.e.s.	57	196	107
Silica	14	21	23
Abrasives, natural	17	21	21
Sand, n.e.s.	227	47	17
Barite	14	12	9
Asbestos	31	11	5
Peat and other mosses	10	2	1
Total nonmetallic minerals	31 951	33 072	34 550
Mineral fuels			
Coal, bituminous	40 386	39 051	47 117
Coal, lignite	1 236	2 549	2 976
Natural gas and other crude bituminous substances	31	43	34
Coal, n.e.s.	63	949	24
Oil, crude	8	7	12
Total mineral fuels	41 724	42 599	50 163
Total crude minerals	121 223	122 180	134 906
Total revenue freight[1] moved by Canadian railways	249 786	261 406	269 354
Crude minerals as a percentage of total revenue freight	48.5	46.7	50.1

Source: Statistics Canada.
[1] Revenue freight refers to a local or interline shipment from which earnings accrue to a carrier.
n.e.s. Not elsewhere specified; – Nil.

TABLE 70. CANADA, FABRICATED MINERAL PRODUCTS TRANSPORTED BY CANADIAN RAILWAYS, 1986–88

	1986	1987	1988
		(kilotonnes)	
Metallic minerals			
Ferrous mineral products			
Iron and steel scrap	1 926	1 982	2 068
Sheets and strips, steel	829	1 140	1 191
Ingots, blooms, billets, slabs of iron and steel	804	659	674
Bars and rods, steel	683	648	593
Structural shapes and sheet piling, iron and steel	523	451	476
Plates, steel	350	311	311
Pipes and tubes, iron and steel	190	177	275
Rails and railway track material	62	70	91
Castings and forgings, iron and steel	94	67	83
Pig iron	59	68	36
Ferroalloys	48	37	27
Other primary iron and steel	33	23	9
Wire, iron or steel	10	5	4
Total ferrous mineral products	5 611	5 639	5 838
Nonferrous mineral products			
Aluminum and aluminum alloy fabricated material, n.e.s.	1 041	888	760
Zinc and alloys	483	433	517
Copper and alloys, n.e.s.	401	408	391
Aluminum paste, powder, pigs, ingots, shot	457	315	352
Other nonferrous base metals and alloys	205	123	167
Lead and alloys	143	116	163
Nonferrous metal scrap	86	104	94
Slag, dross, etc.	55	60	49
Copper matte and precipitates	4	1	–
Total nonferrous mineral products	2 875	2 449	2 493
Total metallic mineral products	8 486	8 088	8 332
Nonmetallic mineral products			
Fertilizers and fertilizer materials, n.e.s.	2 143	2 470	2 424
Portland cement, standard	1 665	1 873	1 813
Sulphuric acid	1 490	1 471	1 806
Gypsum basic products, n.e.s.	357	426	282
Cement and concrete basic products, n.e.s.	258	208	223
Nonmetallic mineral basic products, n.e.s.	197	210	210
Lime, hydrated and quick	104	177	185
Natural stone basic products, chiefly structural	172	185	166
Dolomite and magnesite, calcined	76	48	50
Glass basic products	40	43	45
Bricks and tiles, clay	18	104	30
Fire brick and similar shapes	23	23	24
Asbestos and asbestos–cement basic products	5	17	22
Plaster	5	6	9
Refractories, n.e.s.	10	9	6
Total nonmetallic mineral products	6 563	7 268	7 295
Mineral fuel products			
Refined and manufactured gases, fuel type	2 333	2 355	2 671
Diesel fuel	1 430	1 269	1 531
Gasoline	949	897	675
Fuel oil, n.e.s.	725	677	654
Coke, n.e.s.	732	633	623
Other petroleum and coal products	685	606	517
Petroleum coke	408	341	341
Lubricating oils and greases	312	308	304
Asphalts and road oils	347	284	248
Total mineral fuel products	7 922	7 371	7 566
Total fabricated mineral products	22 971	22 727	23 193
Total revenue freight[1] moved by Canadian railways	249 786	261 406	269 354
Fabricated mineral products as a percentage of total revenue freight	9.2	8.7	8.6

Source: Statistics Canada.
[1] Revenue freight refers to a local or interline shipment from which earnings accrue to a carrier.
n.e.s. Not elsewhere specified; – Nil.

TABLE 71. CANADA, CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS TRANSPORTED BY CANADIAN RAILWAYS, 1959–88

	Total Revenue Freight[1]	Total Crude Minerals	Total Fabricated Mineral Products	Total Crude and Fabricated Minerals	Crude and Fabricated Minerals as Percent of Revenue Freight
	(million tonnes)				
1959	150.6	68.2	15.3	78.1	51.9
1960	142.8	57.1	14.5	71.6	50.1
1961	138.9	54.1	13.6	67.7	48.7
1962	146.0	60.3	13.8	74.1	50.8
1963	154.6	62.9	15.5	78.4	50.6
1964	180.0	74.6	15.9	90.5	50.3
1965	186.2	80.9	17.3	98.2	52.7
1966	194.5	80.6	17.8	94.8	50.6
1967	190.0	81.2	17.7	98.9	52.1
1968	195.4	86.7	18.8	105.5	54.0
1969	189.0	81.9	27.6	109.5	57.9
1970	211.6	97.5	28.4	125.9	59.5
1971	214.5	95.6	27.4	123.0	57.3
1972	215.8	89.4	27.6	117.0	54.2
1973	241.2	113.1	29.1	142.2	59.0
1974	246.3	115.3	30.9	146.2	59.4
1975	226.0	110.6	26.6	137.2	60.7
1976	238.5	116.6	25.5	142.1	59.6
1977	247.2	121.1	25.7	146.8	59.4
1978	238.8	107.7	26.2	133.9	56.1
1979	257.9	127.2	26.6	153.8	59.6
1980	254.4	124.8	24.6	149.4	58.7
1981	246.6	120.7	26.4	147.1	59.7
1982	212.5	95.7	21.0	116.7	54.9
1983	222.8	95.3	22.7	118.0	53.0
1984	254.6	121.1	25.1	146.2	57.4
1985	250.6	125.2	24.3	149.5	59.7
1986	249.8	121.2	23.0	144.2	57.7
1987	261.4	122.2	22.7	144.9	55.4
1988	269.4	134.9	23.2	158.1	58.7

Source: Statistics Canada.
[1] Revenue freight refers to a local or interline shipment from which earnings accrue to a carrier.

TABLE 72. CANADA, CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS TRANSPORTED THROUGH THE ST. LAWRENCE SEAWAY,[1] 1987–89

	Montreal–Lake Ontario Section			Welland Canal Section		
	1987	1988	1989	1987	1988	1989
	(tonnes)					
Crude minerals						
Iron ore	9 557 376	10 810 682	11 185 264	6 180 641	7 083 883	7 293 840
Coal	233 756	712 945	776 999	5 644 283	7 029 061	6 321 198
Salt	928 559	1 027 602	1 377 273	1 766 446	1 672 709	2 176 005
Stone, ground or crushed	231 637	432 370	448 117	889 303	992 668	1 187 148
Other crude minerals	1 176 688	1 000 802	965 083	731 820	601 526	920 752
Sand and gravel	–	–	–	89 372	226 492	241 749
Clay and bentonite	164 766	240 823	215 214	164 766	240 823	215 214
Aluminum ores and concentrates	169 584	230 356	236 629	136 984	218 960	203 711
Potash	55 098	294 948	291 373	83 312	372 971	105 371
Stone, rough	21	41	530	–	15 021	113
Phosphate rock	47 223	2 833	6 120	–	–	–
Total crude minerals	12 564 708	14 753 402	15 502 602	15 686 927	18 454 114	18 665 101
Fabricated mineral products						
Iron and steel, manufactured	2 633 980	2 724 806	3 353 717	2 197 601	2 327 939	2 782 889
Coke	654 432	1 466 718	1 272 068	822 061	1 638 341	1 412 270
Fuel oil	481 049	879 438	529 627	569 051	669 756	637 605
Cement	242 758	32 101	27 463	549 874	488 672	367 748
Scrap iron and steel	344 352	369 397	320 630	372 318	364 658	313 738
Iron and steel, bars, rods, slabs	972 396	1 581 257	825 931	469 961	697 850	304 885
Gasoline	167 472	248 120	485 319	97 982	126 537	275 681
Other petroleum products	181 447	141 952	124 006	136 429	141 004	155 894
Pig iron	124 355	93 248	70 938	104 815	82 921	65 164
Tar, pitch and creosote	22 946	27 104	29 432	49 030	62 830	32 035
Lubricating oils and greases	59 826	28 128	42 923	27 119	18 544	22 531
Iron and steel, nails, wire	8 027	10 670	6 468	6 951	8 396	4 995
Total fabricated minerals	5 893 040	7 603 029	7 088 522	5 403 192	6 627 448	6 375 435
Total crude and fabricated minerals	18 457 748	22 356 431	22 591 124	21 090 119	25 081 562	25 040 536
Total, all products[2]	39 968 615	40 557 669	37 070 370	42 724 755	43 536 317	39 909 450
Crude and fabricated minerals as a percentage of all products	46.2	55.1	60.9	49.4	57.6	62.7

Source: St. Lawrence Seaway Traffic Report.
[1] Total cargo transported regardless of travel direction. [2] Includes crude minerals and fabricated mineral products along with all other cargo transported.
– Nil.

TABLE 73. CANADA, CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS TRANSPORTED THROUGH THE ST. LAWRENCE SEAWAY,[1] 1960–89

	Montreal–Lake Ontario Section				Welland Canal Section			
	Total All Products[2]	Total Crude Minerals	Total Fabricated Mineral Products	Crude and Fabricated Minerals as Percent of All Products	Total All Products[2]	Total Crude Minerals	Total Fabricated Mineral Products	Crude and Fabricated Minerals as Percent of All Products
	(kilotonnes)				(kilotonnes)			
1960	18 460	5 760	2 904	46.9	26 563	12 679	2 606	57.5
1961	21 212	6 706	2 358	42.7	28 490	12 599	2 378	52.6
1962	23 271	7 531	2 522	43.2	32 215	15 625	2 342	55.8
1963	28 198	9 507	2 804	43.7	37 490	18 094	2 524	55.0
1964	35 701	13 127	3 558	46.7	46 644	23 489	3 095	57.0
1965	39 352	13 788	6 024	50.3	48 477	23 555	4 933	58.8
1966	44 538	16 376	6 340	51.0	53 648	25 712	5 329	57.9
1967	39 918	17 800	6 430	60.7	47 945	26 010	5 459	65.6
1968	43 496	19 312	8 425	63.8	52 712	29 075	7 587	69.6
1969	37 256	12 682	8 263	56.2	48 601	25 090	6 715	65.4
1970	46 445	15 554	8 932	52.7	57 121	27 233	7 156	60.2
1971	48 069	14 204	9 263	48.8	57 205	23 903	7 914	55.6
1972	48 607	13 425	9 837	47.9	58 146	24 808	7 701	55.9
1973	52 285	17 111	9 639	51.2	60 958	26 907	7 718	56.8
1974	40 049	16 137	7 018	57.8	47 500	23 952	5 437	61.9
1975	43 554	15 698	6 071	50.0	53 387	26 100	5 129	58.5
1976	49 348	20 884	7 181	56.9	58 368	29 914	6 323	62.1
1977	57 456	23 008	9 918	57.3	65 079	30 459	8 933	60.5
1978	51 658	15 057	8 558	45.7	59 576	22 700	7 759	51.1
1979	50 187	16 408	8 104	48.8	60 023	24 851	7 940	54.6
1980	42 142	12 248	6 009	43.3	54 074	20 487	5 405	47.9
1981	45 876	15 453	5 711	46.1	53 389	22 132	5 529	51.8
1982	38 841	9 146	4 997	36.4	44 474	15 057	4 333	43.6
1983	45 061	12 443	5 422	39.6	50 145	17 412	5 618	45.9
1984	47 505	14 009	6 980	44.2	53 917	20 312	7 052	50.8
1985	37 322	11 689	6 152	47.8	41 852	16 203	6 127	53.4
1986	37 582	11 387	6 429	47.4	41 613	15 774	6 020	52.4
1987	39 969	12 565	5 893	46.2	42 725	15 687	5 403	49.4
1988	40 558	14 753	7 603	55.1	43 536	18 454	6 627	57.6
1989	37 070	15 503	7 089	60.9	39 909	18 665	6 375	62.7

Source: St. Lawrence Seaway Traffic Report.
[1] Total cargo transported regardless of travel direction. [2] Includes crude minerals and fabricated mineral products along with all other cargo transported.

TABLE 74. CANADA, CRUDE MINERALS LOADED AND UNLOADED IN COASTWISE SHIPPING, 1989

	Loaded				Unloaded			
	Atlantic	Great Lakes	Pacific	Total	Atlantic	Great Lakes	Pacific	Total
	(tonnes)							
Metallic minerals								
Iron ore and concentrates	7 087 573	238 546	8 119	7 334 238	1 252 204	6 073 914	8 119	7 334 237
Titanium ore	2 041 074	–	–	2 041 074	2 041 074	–	–	2 041 074
Other metal ores, concentrates and scrap	29 556	72 409	181	102 146	323	101 642	181	102 146
Zinc bearing ore and concentrates	–	–	12 156	12 156	–	–	12 156	12 156
Lead in ores and concentrates	–	–	–	–	–	–	–	–
Total metallic minerals	9 158 203	310 955	20 456	9 489 614	3 293 601	6 175 556	20 456	9 489 613
Nonmetallic minerals								
Limestone	29 767	3 582 253	780 305	4 392 325	99 276	3 512 744	780 305	4 392 325
Salt	671 541	1 571 450	27 215	2 270 206	1 369 714	873 277	27 215	2 270 206
Sand and gravel	188 780	206 528	1 125 606	1 520 914	188 780	206 528	1 125 606	1 520 914
Gypsum	825 700	11 720	84 755	922 175	631 431	205 989	84 755	922 175
Stone, crude, n.e.s.	22 555	317 433	–	339 988	23 220	316 768	–	339 988
Other crude nonmetallic minerals, n.e.s.	5 860	306 879	–	312 739	219 523	93 216	–	312 739
Potash	–	122 210	–	122 210	32 134	90 076	–	122 210
Quartz–silica	21 772	–	454	22 226	–	21 772	454	22 226
Sulphur, crude and refined	7 499	–	–	7 499	7 499	–	–	7 499
Total nonmetallic minerals	1 773 474	6 118 473	2 018 335	9 910 282	2 571 577	5 320 370	2 018 335	9 910 282
Mineral fuels								
Coal and peat for fuel	424 541	3 049 346	59 507	3 533 394	424 541	3 049 346	59 507	3 533 394
Petroleum, crude	29 558	–	–	29 558	29 558	–	–	29 558
Total mineral fuels	454 099	3 049 346	59 507	3 562 952	454 099	3 049 346	59 507	3 562 952
Total crude minerals	11 385 776	9 478 774	2 098 298	22 962 848	6 319 277	14 545 272	2 098 298	22 962 847
Total all commodities[1]	20 947 863	19 467 524	20 706 163	61 121 550	21 471 952	18 927 680	20 721 919	61 121 551
Crude minerals as a percentage of all commodities	54.4	48.7	10.1	37.6	29.4	76.8	10.1	37.6

Source: Statistics Canada.
[1] Includes metallic minerals, nonmetallic minerals and mineral fuels, along with all other cargo loaded and unloaded in coastwise shipping.
– Nil; n.e.s. Not elsewhere specified.
Note: Totals may not add due to rounding.

TABLE 75. CANADA, FABRICATED MINERALS LOADED AND UNLOADED IN COASTWISE SHIPPING, 1989

	Loaded				Unloaded			
	Atlantic	Great Lakes	Pacific	Total	Atlantic	Great Lakes	Pacific	Total
	(tonnes)							
Metallic mineral products								
Ferrous mineral products								
Structural shapes, iron and steel	1 685	125 207	30 345	157 237	45	126 846	30 345	157 236
Plates and sheets, steel	508	17 459	–	17 967	508	17 459	–	17 967
Primary iron, steel	14 701	–	–	14 701	5 393	9 308	–	14 701
Castings and forgings, steel	–	–	9 925	9 925	–	–	9 925	9 925
Wire, iron and steel	595	–	–	595	595	–	–	595
Pipes and tubes, iron and steel	400	–	–	400	400	–	–	400
Rails and railway track material	271	–	–	271	271	–	–	271
Bars and rods, steel	–	–	–	–	–	–	–	–
Aluminum and aluminum products	128 775	–	–	128 775	128 775	–	–	128 775
Total metallic mineral products	146 935	142 666	40 270	329 871	135 987	153 613	40 270	329 870
Nonmetallic mineral products								
Cement	9 980	864 367	89 744	964 091	14 090	860 257	89 744	964 091
Cement basic products	4 097	49 369	43 817	97 283	53 164	302	43 817	97 283
Other nonmetallic mineral products	27 143	–	–	27 143	27 143	–	–	27 143
Sulphuric acid	12 626	–	6 046	18 672	12 626	–	6 046	18 672
Fertilizers and fertilizer material, n.e.s.	8 912	–	–	8 912	8 912	–	–	8 912
Bricks, tiles and pipes, clay	2 345	88	–	2 433	2 345	88	–	2 433
Glass basic products	–	–	191	191	–	–	191	191
Total nonmetallic mineral products	65 103	913 824	139 798	1 118 725	118 280	860 647	139 798	1 118 725
Mineral fuel products								
Fuel oil	4 235 884	1 079 470	954 815	6 270 169	4 555 103	762 774	952 291	6 270 168
Gasoline	2 599 063	420 707	529 942	3 549 712	2 577 292	442 698	529 723	3 549 713
Asphalts and road oils	240 827	86 344	–	327 171	198 291	128 880	–	327 171
Petroleum coke	55 301	90 630	–	145 931	134 830	11 101	–	145 931
Other petroleum and coal products	49 910	26 224	–	76 134	63 889	12 246	–	76 135
Lubricating oils and greases	274	7 114	–	7 388	274	7 114	–	7 388
Total mineral fuel products	7 181 259	1 710 489	1 484 757	10 376 505	7 529 679	1 364 813	1 482 014	10 376 506
Total fabricated mineral products	7 393 297	2 766 979	1 664 825	11 825 101	7 783 946	2 379 073	1 662 082	11 825 101
Total all commodities[1]	20 947 863	19 467 524	20 706 163	61 121 550	21 471 952	18 927 680	20 721 919	61 121 551
Fabricated mineral products as a percentage of all commodities	35.3	14.2	8.0	19.3	36.3	12.6	8.0	19.3

Source: Statistics Canada.
1 Includes metallic mineral products, nonmetallic mineral products and mineral fuel products, along with all other cargo loaded and unloaded in coastwise shipping.
– Nil; n.e.s. Not elsewhere specified.
Note: Totals may not add due to rounding.

TABLE 76. CANADA, CRUDE AND FABRICATED MINERALS LOADED AT CANADIAN PORTS IN COASTWISE SHIPPING, 1960–89

	Total All Commodities[1]	Total Crude Minerals	Total Fabricated Minerals	Crude and Fabricated Minerals as Percent of All Products
	(kilotonnes)			
1960	37 058	8 786	8 229	45.9
1961	41 861	9 527	8 857	43.9
1962	39 763	8 361	9 768	45.6
1963	40 328	7 998	9 942	44.5
1964	47 171	8 522	11 194	41.8
1965	48 200	9 183	11 766	43.5
1966	55 122	10 155	12 653	41.4
1967	49 799	11 509	12 207	47.6
1968	50 921	13 698	13 245	52.9
1969	51 890	12 746	14 181	51.9
1970	57 301	14 415	14 818	51.0
1971	55 128	14 783	15 374	54.7
1972	55 326	14 197	15 290	53.3
1973	55 314	16 573	15 615	58.2
1974	53 633	11 723	16 575	52.8
1975	54 373	15 687	17 510	61.1
1976	53 882	15 924	16 208	59.6
1977	58 309	18 131	17 435	61.0
1978	60 668	18 318	16 619	57.6
1979	79 950	22 130	17 486	49.6
1980	82 761	22 947	17 134	48.4
1981	71 271	17 849	16 669	48.4
1982	65 881	16 473	13 214	45.1
1983	67 598	21 248	12 025	49.2
1984	68 698	22 798	11 909	50.5
1985	61 717	19 867	10 291	48.9
1986	60 506	19 901	10 264	49.9
1987	67 572	20 969	11 118	47.5
1988	69 974	23 325	11 676	50.0
1989	61 122	22 963	11 825	56.9

Source: Statistics Canada.
[1] Includes metallic mineral products, nonmetallic mineral products and mineral fuel products, along with all other cargo loaded and unloaded in coastwise shipping.

TABLE 77. CANADA, CRUDE MINERALS LOADED AND UNLOADED AT CANADIAN PORTS IN INTERNATIONAL SHIPPING TRADE, 1987–89

	1987		1988		1989	
	Loaded	Unloaded	Loaded	Unloaded	Loaded	Unloaded
Metallic minerals						
Iron ore and concentrates	31 002 238	6 716 664	32 879 255	6 419 164	31 921 550	6 993 891
Other nonferrous ores, concentrates and metal scrap, n.e.s.	1 342 230	252 384	1 798 622	279 629	1 858 624	412 828
Copper ores and concentrates	1 601 356	155 112	1 271 805	158 305	1 249 357	172 477
Zinc ores and concentrates	994 894	629	1 276 705	605	822 867	262
Lead ores and concentrates	132 778	2 158	90 179	7 587	91 967	6 266
Alumina, bauxite ore	27 726	3 599 494	22 707	4 486 281	21 561	4 660 980
Titanium ore	(2)	(2)	(2)	(2)	(2)	(2)
Manganese ore	(2)	(2)	(2)	(2)	(2)	(2)
Nickel ore and concentrates	(1)	(1)	(1)	(1)	(1)	(1)
Total metallic minerals	35 101 222	10 726 441	37 339 273	11 351 571	35 965 926	12 246 704
Nonmetallic minerals						
Potash (KCl)	6 426 820	283 583	7 654 867	250 170	6 084 022	184 452
Gypsum	5 433 907	189 915	5 963 134	285 164	5 711 513	301 545
Sulphur	5 920 979	–	6 437 171	–	4 448 002	55 027
Crude nonmetallic minerals, n.e.s.	1 915 122	1 317 368	1 741 111	1 506 828	2 367 239	2 521 906
Salt	2 067 309	906 523	2 725 945	1 085 842	1 983 508	1 510 057
Limestone	1 421 705	1 188 278	1 667 478	1 003 680	1 149 695	684 279
Clay materials, n.e.s.	571 612	249 559	825 121	444 385	609 265	705 067
Asbestos	505 591	1 845	578 507	294	552 073	18 740
Sand and gravel	408 707	1 395 557	347 789	1 273 376	466 352	1 361 671
Phosphate rock	3 328	1 661 378	–	1 797 371	2 722	1 647 574
Bentonite	(4)	(4)	(4)	(4)	–	(4)
China clay	(4)	(4)	(4)	(4)	(4)	(4)
Dolomite	(3)	(3)	(3)	(3)	(3)	(3)
Stone, crude, n.e.s.	(3)	(3)	(3)	(3)	(3)	(3)
Stone, crushed	(3)	(3)	(3)	(3)	(3)	(3)
Fluorspar	(3)	(3)	(3)	(3)	(3)	(3)
Barite	(3)	(3)	(3)	(3)	(3)	(3)
Total nonmetallic minerals	24 675 080	7 194 006	27 941 123	7 647 110	23 374 391	8 990 318
Mineral fuels						
Coal, bituminous	25 324 002	14 334 318	31 604 994	17 777 159	29 940 842	15 180 835
Petroleum, crude	980 908	14 810 357	2 033 662	17 646 741	1 434 497	18 242 493
Fuels, n.e.s.	3 734	–	14 658	3	91 153	–
Total mineral fuels	26 308 644	29 144 675	33 653 314	35 423 903	31 466 492	33 423 328
Total crude minerals	86 084 946	47 065 122	98 933 710	54 422 584	90 806 809	54 660 350
Total all commodities[5]	158 993 861	68 025 360	171 064 410	78 911 838	156 568 302	79 670 214
Crude minerals as a percentage of all commodities	54.1	69.2	57.8	69.0	58.0	68.6

Source: Statistics Canada.
(1) Included with "Copper ores and concentrates." (2) Included with "Other nonferrous ores, concentrates and metal scrap, n.e.s." (3) Included with "Crude nonmetallic minerals, n.e.s." (4) Included with "Clay materials, n.e.s." [5] Includes metallic minerals, nonmetallic minerals and mineral fuels, along with all other cargo loaded and unloaded at Canadian ports.
– Nil; n.e.s. Not elsewhere specified.

TABLE 78. CANADA, FABRICATED MINERAL PRODUCTS LOADED AND UNLOADED AT CANADIAN PORTS IN INTERNATIONAL SHIPPING TRADE,[1] 1987–89

	1987		1988		1989	
	Loaded	Unloaded	Loaded	Unloaded	Loaded	Unloaded
Metallic products						
Iron and steel, other	1 238 605	2 373 878	1 005 743	3 333 003	1 898 150	1 982 130
Nonferrous metals, n.e.s.	536 826	243 882	696 619	326 824	762 061	204 929
Total metals	1 775 431	2 617 760	1 702 362	3 659 827	2 660 211	2 187 059
Nonmetallic products						
Cement	1 875 476	515 100	1 579 898	778 713	1 494 839	625 672
Nonmetallic mineral basic products	289 902	389 752	112 017	468 563	270 415	492 025
Total nonmetals	2 165 378	904 852	1 691 915	1 247 276	1 765 254	1 117 697
Mineral fuel products						
Fuel oil	3 512 047	4 104 047	5 861 422	5 249 818	5 193 961	6 172 370
Gasoline	1 489 372	1 108 892	2 329 522	905 923	1 944 466	1 348 571
Coke	1 180 208	1 231 270	353 210	1 739 797	541 905	1 295 009
Petroleum and coal products, n.e.s.	365 073	783 366	288 917	694 674	1 518 112	1 069 244
Total fuels	6 546 700	7 227 575	8 833 071	8 590 212	9 198 444	9 885 194
Total fabricated mineral products	10 487 509	10 750 187	12 227 348	13 497 315	13 623 909	13 189 950
Total all commodities[2]	158 993 861	68 025 360	171 064 410	78 911 838	156 568 302	79 670 214
Fabricated mineral products as a percentage of all commodities	6.6	15.8	7.1	17.1	8.7	16.6

Source: Statistics Canada.
[1] More detailed breakdown not presently available. [2] Includes metallic products, nonmetallic products and mineral fuel products, along with all other cargo loaded and unloaded at Canadian ports.
n.e.s. Not elsewhere specified.

TABLE 79. CANADA, CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS LOADED AT CANADIAN PORTS IN INTERNATIONAL SHIPPING TRADE, 1960–89

	Total All Commodities[1]	Total Crude Minerals	Total Fabricated Minerals	Crude and Fabricated Minerals as Percent of All Products
		(kilotonnes)		
1960	45 872	24 671	2 039	58.2
1961	48 771	23 241	2 133	52.0
1962	54 676	30 446	2 296	59.9
1963	62 031	32 214	2 503	56.0
1964	75 760	42 087	2 602	59.0
1965	74 521	41 338	2 746	59.2
1966	76 192	41 374	3 350	58.7
1967	72 598	42 704	3 701	63.9
1968	78 663	48 680	2 960	65.6
1969	70 432	42 442	3 456	65.2
1970	95 807	55 849	4 965	63.5
1971	95 887	53 245	5 022	60.8
1972	98 988	51 912	9 091	61.6
1973	112 434	64 195	10 103	66.1
1974	106 110	64 093	9 041	68.9
1975	102 444	61 970	7 495	67.8
1976	114 815	71 527	6 108	67.6
1977	119 770	70 257	5 979	63.7
1978	116 522	62 291	7 556	59.9
1979	134 639	79 685	8 901	65.8
1980	138 161	67 898	11 770	57.7
1981	145 445	83 007	9 022	63.3
1982	125 282	65 594	7 115	58.0
1983	129 490	67 152	6 197	56.6
1984	145 322	82 752	7 986	62.4
1985	143 421	83 878	10 814	66.0
1986	144 561	84 720	8 303	64.3
1987	158 994	86 085	10 488	60.7
1988	171 064	98 934	12 227	65.0
1989	156 568	90 807	13 624	66.7

Source: Statistics Canada.
[1] Includes metallic products, nonmetallic products and mineral fuel products, along with all other cargo loaded and unloaded at Canadian ports.

TABLE 80. CANADA, FINANCIAL STATISTICS OF CORPORATIONS IN THE MINING INDUSTRY[1] BY DEGREE OF NON-RESIDENT OWNERSHIP, 1986

	Corporations[2]		Assets[3]		Equity[4]		Sales[5]		Profits[6]		Taxable Income[7]	
	(number)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)
Metal mines												
Reporting corporations												
Canadian	172	81.1	23 195	80.9	11 019	82.2	6 546	68.9	308	56.5	151	59.2
Foreign	40	18.9	5 493	19.1	2 380	17.8	2 958	31.1	237	43.5	104	40.8
Total	212	100.0	28 688	100.0	13 399	100.0	9 504	100.0	545	100.0	255	100.0
Mineral fuels												
Reporting corporations												
Canadian	2 412	91.5	46 669	63.5	17 057	57.3	9 893	50.2	-3 310	158.7	566	29.6
Foreign	225	8.5	26 850	36.5	12 732	42.7	9 829	49.8	1 224	-58.7	1 347	70.4
Total	2 637	100.0	73 519	100.0	29 789	100.0	19 722	100.0	-2 086	100.0	1 913	100.0
Other mining (including mining services)												
Reporting corporations												
Canadian	5 225	96.9	8 596	74.1	3 836	73.4	4 141	75.6	-482	97.6	185	59.7
Foreign	167	3.1	3 006	25.9	1 391	26.6	1 340	24.4	-12	2.4	125	40.3
Total	5 392	100.0	11 602	100.0	5 227	100.0	5 481	100.0	-494	100.0	310	100.0
Total mining												
Reporting corporations												
Canadian	7 809	94.8	78 460	68.9	31 912	65.9	20 580	59.3	-3 484	171.2	902	36.4
Foreign	432	5.2	35 349	31.1	16 503	34.1	14 127	40.7	1 449	-71.2	1 576	63.6
Total	8 241	100.0	113 809	100.0	48 415	100.0	34 707	100.0	-2 035	100.0	2 478	100.0

1 Cement, lime and clay products (domestic clay) are included in mineral manufacturing industries. 2 Corporations reporting under the Corporations and Labour Unions Returns Act. A corporation is considered to be foreign controlled if 50% or more of its voting rights are known to be held outside Canada, and/or by one or more Canadian corporations which are, in turn, foreign controlled. Each corporation is classified according to the percentage of its voting rights which are owned by non-residents, either directly or through other Canadian corporations, and the whole of the corporation is assigned to this particular degree of foreign ownership. 3 Included are cash, marketable securities, accounts receivable, inventories, fixed assets, investments in affiliated corporations and other assets. The amounts tabulated are those shown on the balance sheets of corporations after deducting allowances for doubtful accounts, amortization, depletion and depreciation. 4 Equity represents the shareholders' interest in the net assets of the corporation and includes the total amount of all issued and paid-up share capital, earnings retained in the business and other surplus accounts such as contributed and capital surplus. 5 For nonfinancial corporations, sales are gross revenues from nonfinancial operations. For financial corporations, sales include income from financial as well as nonfinancial sources. 6 The net earnings from operations, investment income and net capital gains. Profits are tabulated after deducting allowances for amortization, depletion and depreciation, but before income tax provisions or declaration of dividends. 7 Taxable income figures are as reported by corporations prior to assessment by the Department of National Revenue. They include earnings in the reference year after the deduction of applicable losses of other years.

Note: Totals may not add due to rounding.

TABLE 80a. CANADA, FINANCIAL STATISTICS OF CORPORATIONS IN THE MINING INDUSTRY[1] BY DEGREE OF NON-RESIDENT OWNERSHIP, 1987p

	Corporations[2]		Assets[3]		Equity[4]		Sales[5]		Profits[6]		Taxable Income[7]	
	(number)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)
Metal mines												
Reporting corporations												
Canadian	170	81.0	26 044	82.1	14 413	83.2	8 133	71.3	1 353	71.2	316	80.0
Foreign	40	19.0	5 687	17.9	2 904	16.8	3 266	28.7	546	28.8	79	20.0
Total	210	100.0	31 731	100.0	17 317	100.0	11 399	100.0	1 899	100.0	395	100.0
Mineral fuels												
Reporting corporations												
Canadian	2 406	92.2	49 011	62.9	18 853	57.1	11 015	50.2	1 232	32.8	768	32.9
Foreign	204	7.8	28 936	37.1	14 151	42.9	10 935	49.8	2 522	67.2	1 564	67.1
Total	2 610	100.0	77 947	100.0	33 004	100.0	21 950	100.0	3 754	100.0	2 332	100.0
Other mining (including mining services)												
Reporting corporations												
Canadian	5 288	97.4	9 751	78.3	4 708	78.9	3 755	76.5	-53	66.2	175	57.8
Foreign	143	2.6	2 696	21.7	1 262	21.1	1 153	23.5	-27	33.8	128	42.2
Total	5 431	100.0	12 447	100.0	5 970	100.0	4 908	100.0	-80	100.0	303	100.0
Total mining												
Reporting corporations												
Canadian	7 864	95.3	84 806	69.4	37 974	67.5	22 903	59.9	2 532	45.4	1 259	41.6
Foreign	387	4.7	37 319	30.6	18 317	32.5	15 354	40.1	3 041	54.6	1 771	58.4
Total	8 251	100.0	122 125	100.0	56 291	100.0	38 257	100.0	5 573	100.0	3 030	100.0

[1] Cement, lime and clay products (domestic clay) are included in mineral manufacturing industries. [2] Corporations reporting under the Corporations and Labour Unions Returns Act. A corporation is considered to be foreign controlled if 50% or more of its voting rights are known to be held outside Canada, and/or by one or more Canadian corporations which are, in turn, foreign controlled. Each corporation is classified according to the percentage of its voting rights which are owned by non-residents, either directly or through other Canadian corporations, and the whole of the corporation is assigned to this particular degree of foreign ownership. [3] Included are cash, marketable securities, accounts receivable, inventories, fixed assets, investments in affiliated corporations and other assets. The amounts tabulated are those shown on the balance sheets of corporations after deducting allowances for doubtful accounts, amortization, depletion and depreciation. [4] Equity represents the shareholders' interest in the net assets of the corporation and includes the total amount of all issued and paid-up share capital, earnings retained in the business and other surplus accounts such as contributed and capital surplus. [5] For nonfinancial corporations, sales are gross revenues from nonfinancial operations. For financial corporations, sales include income from financial as well as nonfinancial sources. [6] The net earnings from operations, investment income and net capital gains. Profits are tabulated after deducting allowances for amortization, depletion and depreciation, but before income tax provisions or declaration of dividends. [7] Taxable income figures are as reported by corporations prior to assessment by the Department of National Revenue. They include earnings in the reference year after the deduction of applicable losses of other years.

p Preliminary.

Note: Totals may not add due to rounding.

TABLE 81. CANADA, FINANCIAL STATISTICS OF CORPORATIONS IN THE MINERAL MANUFACTURING INDUSTRIES[1] BY DEGREE OF NON-RESIDENT OWNERSHIP, 1986

	Corporations[2]		Assets[3]		Equity[4]		Sales[5]		Profits[6]		Taxable Income[7]	
	(number)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)
Primary metal products												
Reporting corporations												
Canadian	411	91.5	14 614	79.8	6 707	85.7	11 839	81.8	578	79.8	256	64.5
Foreign	38	8.5	3 696	20.2	1 118	14.3	2 628	18.2	146	20.2	141	35.5
Total	449	100.0	18 310	100.0	7 825	100.0	14 467	100.0	724	100.0	397	100.0
Nonmetallic mineral products												
Reporting corporations												
Canadian	1 554	95.0	2 541	30.6	997	28.3	3 317	46.5	279	51.5	254	40.4
Foreign	81	5.0	5 759	69.4	2 522	71.7	3 821	53.5	263	48.5	374	59.6
Total	1 635	100.0	8 300	100.0	3 519	100.0	7 138	100.0	542	100.0	628	100.0
Metal fabricating products												
Reporting corporations												
Canadian	6 370	96.4	9 425	74.1	3 708	68.6	12 653	73.4	728	70.5	545	66.8
Foreign	235	3.6	3 298	25.9	1 697	31.4	4 591	26.6	304	29.5	271	33.2
Total	6 605	100.0	12 723	100.0	5 405	100.0	17 244	100.0	1 032	100.0	816	100.0
Petroleum and coal products												
Reporting corporations												
Canadian	113	83.1	18 226	47.2	8 810	41.2	9 559	33.0	2 481	64.9	215	27.5
Foreign	23	16.9	20 408	52.8	12 563	58.8	19 368	67.0	1 343	35.1	568	72.5
Total	136	100.0	38 634	100.0	21 373	100.0	28 927	100.0	3 824	100.0	783	100.0
Total mineral manufacturing industries												
Reporting corporations												
Canadian	8 448	95.7	44 806	57.5	20 222	53.0	37 368	55.1	4 066	66.4	1 270	48.4
Foreign	377	4.3	33 161	42.5	17 900	47.0	30 408	44.9	2 056	33.6	1 354	51.6
Total	8 825	100.0	77 967	100.0	38 122	100.0	67 776	100.0	6 122	100.0	2 624	100.0

[1] Includes cement, lime and clay products (domestic clay). [2] Corporations reporting under the Corporations and Labour Unions Returns Act. A corporation is considered to be foreign controlled if 50% or more of its voting rights are known to be held outside Canada, and/or by one or more Canadian corporations which are, in turn, foreign controlled. Each corporation is classified according to the percentage of its voting rights which are owned by non-residents, either directly or through other Canadian corporations, and the whole of the corporation is assigned to this particular degree of foreign ownership. [3] Included are cash, marketable securities, accounts receivable, inventories, fixed assets, investments in affiliated corporations and other assets. The amounts tabulated are those shown on the balance sheets of corporations after deducting allowances for doubtful accounts, amortization, depletion and depreciation. [4] Equity represents the shareholders' interest in the net assets of the corporation and includes the total amount of all issued and paid-up share capital, earnings retained in the business and other surplus accounts such as contributed and capital surplus. [5] For nonfinancial corporations, sales are gross revenues from nonfinancial operations. For financial corporations, sales include income from financial as well as nonfinancial sources. [6] The net earnings from operations, investment income and net capital gains. Profits are tabulated after deducting allowances for amortization, depletion and depreciation, but before income tax provisions or declaration of dividends. [7] Taxable income figures are as reported by corporations prior to assessment by the Department of National Revenue. They include earnings in the reference year after the deduction of applicable losses of other years.
Note: Totals may not add due to rounding.

TABLE 81a. CANADA, FINANCIAL STATISTICS OF CORPORATIONS IN THE MINERAL MANUFACTURING INDUSTRIES[1] BY DEGREE OF NON-RESIDENT OWNERSHIP, 1987[p]

	Corporations[2]		Assets[3]		Equity[4]		Sales[5]		Profits[6]		Taxable Income[7]	
	(number)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)
Primary metal products												
Reporting corporations												
Canadian	428	92.6	15 838	81.0	7 747	84.3	13 010	82.2	1 015	73.7	414	84.7
Foreign	34	7.4	3 720	19.0	1 447	15.7	2 814	17.8	363	26.3	75	15.3
Total	462	100.0	19 558	100.0	9 194	100.0	15 824	100.0	1 378	100.0	489	100.0
Nonmetallic mineral products												
Reporting corporations												
Canadian	1 542	94.9	2 867	33.1	1 178	30.3	3 800	45.1	353	40.7	284	39.0
Foreign	83	5.1	5 795	66.9	2 712	69.7	4 633	54.9	515	59.3	444	61.0
Total	1 625	100.0	8 662	100.0	3 890	100.0	8 433	100.0	868	100.0	728	100.0
Metal fabricating products												
Reporting corporations												
Canadian	6 427	96.7	10 092	74.7	3 813	69.2	13 911	74.2	1 063	74.7	618	65.2
Foreign	221	3.3	3 418	25.3	1 695	30.8	4 842	25.8	360	25.3	330	34.8
Total	6 648	100.0	13 510	100.0	5 508	100.0	18 753	100.0	1 423	100.0	948	100.0
Petroleum and coal products												
Reporting corporations												
Canadian	108	80.6	11 198	32.3	6 495	31.5	7 627	25.9	622	26.0	237	19.3
Foreign	26	19.4	23 494	67.7	14 094	68.5	21 768	74.1	1 770	74.0	993	80.7
Total	134	100.0	34 692	100.0	20 589	100.0	29 395	100.0	2 392	100.0	1 230	100.0
Total mineral manufacturing industries												
Reporting corporations												
Canadian	8 505	95.9	39 995	52.3	19 233	49.1	38 348	53.0	3 053	50.4	1 553	45.7
Foreign	364	4.1	36 427	47.7	19 948	50.9	34 057	47.0	3 008	49.6	1 842	54.3
Total	8 869	100.0	76 422	100.0	39 181	100.0	72 405	100.0	6 061	100.0	3 395	100.0

[1] Includes cement, lime and clay products (domestic clay). [2] Corporations reporting under the Corporations and Labour Unions Returns Act. A corporation is considered to be foreign controlled if 50% or more of its voting rights are known to be held outside Canada, and/or by one or more Canadian corporations which are, in turn, foreign controlled. Each corporation is classified according to the percentage of its voting rights which are owned by non-residents, either directly or through other Canadian corporations, and the whole of the corporation is assigned to this particular degree of foreign ownership. [3] Included are cash, marketable securities, accounts receivable, inventories, fixed assets, investments in affiliated corporations and other assets. The amounts tabulated are those shown on the balance sheets of corporations after deducting allowances for doubtful accounts, amortization, depletion and depreciation. [4] Equity represents the shareholders' interest in the net assets of the corporation and includes the total amount of all issued and paid-up share capital, earnings retained in the business and other surplus accounts such as contributed and capital surplus. [5] For nonfinancial corporations, sales are gross revenues from nonfinancial operations. For financial corporations, sales include income from financial as well as nonfinancial sources. [6] The net earnings from operations, investment income and net capital gains. Profits are tabulated after deducting allowances for amortization, depletion and depreciation, but before income tax provisions or declaration of dividends. [7] Taxable income figures are as reported by corporations prior to assessment by the Department of National Revenue. They include earnings in the reference year after the deduction of applicable losses of other years.

[p] Preliminary.

Note: Totals may not add due to rounding.

TABLE 82. CANADA, FINANCIAL STATISTICS OF CORPORATIONS IN NON-FINANCIAL INDUSTRIES BY MAJOR INDUSTRY GROUP AND BY CONTROL, 1986 AND 1987

	Agriculture, Forestry, Fishing and Trapping		Mines, Quarries and Oil Wells		Manufacturing		Construction		Transportation, Communication and Other Utilities		Trade		Services		Total	
	1986	1987p	1986	1987p	1986	1987p	1986	1987p	1986	1987p	1986	1987p	1986	1987p	1986	1987p
	(number)															
Corporations[1]																
Canadian control	24 145	24 791	7 809	7 864	41 987	42 493	62 898	66 060	26 657	27 445	141 000	141 733	130 870	134 725	435 366	445 111
Foreign control	84	84	432	387	1 906	1 831	157	159	247	245	1 731	1 665	632	637	5 189	5 008
Total	24 229	24 875	8 241	8 251	43 893	44 324	63 055	66 219	26 904	27 690	142 731	143 398	131 502	135 362	440 555	450 119
	($ million)															
Assets[2]																
Canadian control	13 187	13 865	78 460	84 806	130 810	136 199	23 110	27 085	185 499	192 870	102 264	108 263	48 185	54 286	581 515	617 374
Foreign control	405	385	35 348	37 319	102 063	114 134	1 619	1 637	5 947	6 410	28 122	33 253	7 034	8 075	180 538	201 213
Total	13 592	14 250	113 808	122 125	232 873	250 333	24 729	28 722	191 446	199 280	130 386	141 516	55 219	62 361	762 053	818 587
Equity[3]																
Canadian control	4 722	5 041	31 912	37 973	53 696	57 109	5 830	7 077	50 345	54 266	30 886	31 528	12 197	15 160	189 588	208 154
Foreign control	221	210	16 503	18 317	51 897	56 836	598	583	2 273	2 449	11 350	12 943	2 513	2 931	85 355	94 269
Total	4 943	5 251	48 415	56 290	105 593	113 945	6 428	7 660	52 618	56 715	42 236	44 471	14 710	18 091	274 943	302 423
Sales[4]																
Canadian control	10 190	11 062	20 580	22 903	151 308	161 814	45 318	53 279	81 210	82 775	252 376	274 960	54 509	60 267	615 491	667 060
Foreign control	248	245	14 127	15 354	146 216	153 169	2 950	3 015	4 739	4 720	61 722	69 060	6 708	6 588	236 710	252 151
Total	10 438	11 307	34 707	38 257	297 524	314 983	48 268	56 294	85 949	87 495	314 098	344 020	61 217	66 855	852 201	919 211
Profits[5]																
Canadian control	564	849	-3 484	2 532	9 842	11 046	1 567	2 335	5 737	7 482	8 277	8 492	3 478	4 929	25 981	37 665
Foreign control	31	24	1 449	3 041	9 454	11 059	86	39	615	720	2 396	2 151	519	464	14 550	17 498
Total	595	873	-2 035	5 573	19 296	22 105	1 653	2 374	6 352	8 202	10 673	10 643	3 997	5 393	40 531	55 163

[1] Corporations reporting under the Corporations and Labour Unions Returns Act. A corporation is considered to be foreign controlled if 50% or more of its voting rights are known to be held outside Canada, and/or by one or more Canadian corporations which are, in turn, foreign controlled. Each corporation is classified according to the percentage of its voting rights which are owned by non-residents, either directly or through other Canadian corporations, and the whole of the corporation is assigned to this particular degree of foreign ownership. [2] Included are cash, marketable securities, accounts receivable, inventories, fixed assets, investments in affiliated corporations and other assets. The amounts tabulated are those shown on the balance sheets of corporations after deducting allowances for doubtful accounts, amortization, depletion and depreciation. [3] Equity represents the shareholders' interest in the net assets of the corporation and includes the total amount of all issued and paid-up share capital, earnings retained in the business and other surplus accounts such as contributed and capital surplus. [4] For nonfinancial corporations, sales are gross revenues from nonfinancial operations. For financial corporations, sales include income from financial as well as nonfinancial sources. [5] The net earnings from operations, investment income and net capital gains. Profits are tabulated after deducting allowances for amortization, depletion and depreciation, but before income tax provisions or declarations of dividends.

p Preliminary.

Note: Totals may not add due to rounding.

TABLE 83. CANADA, CAPITAL AND REPAIR EXPENDITURES BY SELECTED INDUSTRIAL SECTOR, 1988-90

		Capital Expenditures			Repair Expenditures			Capital and Repair Expenditures		
		Construction	Machinery and Equipment	Total	Construction	Machinery and Equipment	Total	Construction	Machinery and Equipment	Total
						($ million)				
Agriculture	1988	1 128.5	2 032.5	3 161.0	448.3	1 329.3	1 777.6	1 576.8	3 361.8	4 938.6
	1989[p]	1 163.2	2 120.9	3 284.1	498.7	1 444.9	1 943.6	1 661.9	3 565.8	5 227.7
	1990[I]	1 140.5[r]	2 081.0[r]	3 221.5[r]	519.6	1 507.0	2 026.6	1 660.1[r]	3 588.0[r]	5 248.1[r]
Construction	1988	354.6	1 505.3	1 859.9	65.0	1 803.6	1 148.6	419.6	2 588.9	3 008.5
	1989[p]	400.5	1 699.7	2 100.2	69.5	1 157.8	1 227.3	470.0	2 857.5	3 327.5
	1990[I]	434.1[r]	1 843.4[r]	2 277.5[r]	74.1	1 234.1	1 308.2	508.2[r]	3 077.5[r]	3 585.7[r]
Forestry	1988	137.6	133.3	270.9	64.5	266.6	331.1	202.1	399.9	602.0
	1989[p]	122.6	150.3	272.9	92.3	247.0	339.3	214.9	397.3	612.2
	1990[I]	153.0[r]	145.7[r]	298.7[r]	96.9	250.7	347.6	249.9[r]	396.4[r]	646.3[r]
Housing	1988	34 916.9	–	34 916.9	4 019.0	–	4 019.0	38 935.9	–	38 935.9
	1989[p]	38 681.8	–	38 681.8	4 440.0	–	4 440.0	43 121.8	–	43 121.8
	1990[I]	37 413.2[r]	–	37 413.2[r]	4 905.5	–	4 905.5	42 318.7[r]	–	42 318.7[r]
Manufacturing	1988	3 233.9	14 427.9	17 661.8	1 024.7	6 973.6	7 998.3	4 258.6	21 401.5	25 660.1
	1989[p]	3 754.5	16 547.3	20 301.8	1 054.8	7 107.1	8 161.9	4 809.3	23 654.4	28 463.7
	1990[I]	4 020.7[r]	17 519.8[r]	21 540.5[r]	1 101.4	7 299.7	8 401.1	5 122.1[r]	24 819.5[r]	29 941.6[r]
Mining[1]	1988	7 176.3	1 574.1	8 750.4	403.3	2 429.7	2 833.0	7 579.6	4 003.8	11 583.4
	1989[p]	6 071.1	1 235.8	7 306.9	376.5	2 562.6	2 939.1	6 447.6	3 798.4	10 246.0
	1990[I]	6 452.7[r]	1 315.8[r]	7 768.5[r]	466.3	2 592.8	3 059.1	6 919.0[r]	3 908.6[r]	10 827.6[r]
Trade	1988	940.1	2 205.1	3 145.2	330.8	520.4	851.2	1 270.9	2 725.5	3 996.4
	1989[p]	1 144.4	2 185.4	3 329.8	379.4	478.1	857.5	1 523.8	2 663.5	4 187.3
	1990[I]	1 365.2[r]	2 493.5[r]	3 858.7[r]	396.7	500.6	897.3	1 761.9[r]	2 994.1[r]	4 756.0[r]
Utilities	1988	7 757.0	9 793.3	17 550.3	2 149.0	5 945.6	8 094.6	9 906.0	15 738.9	25 644.9
	1989[p]	9 650.8	10 595.4	20 246.2	2 300.0	5 825.8	8 125.8	11 950.8	16 421.2	28 372.0
	1990[I]	11 901.5[r]	12 414.4[r]	24 315.9[r]	2 419.6	6 025.1	8 444.7	14 321.1[r]	18 439.5[r]	32 760.6[r]
Other[2]	1988	21 706.7	13 911.4	35 618.1	5 013.5	2 066.4	7 079.9	26 720.2	15 977.8	42 698.0
	1989[p]	24 538.5	14 285.0	38 832.5	5 325.2	2 213.5	7 538.7	29 863.7	16 498.5	46 362.2
	1990[I]	26 436.4[r]	15 799.6[r]	42 236.0[r]	5 451.7	2 311.3	7 763.0	31 888.1[r]	18 110.9[r]	49 999.0[r]
Total	1988	77 351.6	45 582.9	122 934.5	13 518.1	20 615.2	34 133.3	90 869.7	66 198.1	157 067.8
	1989[p]	85 527.4	48 819.8	134 347.2	14 536.4	21 036.8	35 573.2	100 063.8	69 856.6	169 920.4
	1990[I]	89 317.3[r]	53 613.2[r]	142 930.5[r]	15 431.8	21 721.3	37 153.1	104 749.1[r]	75 334.5[r]	180 083.6[r]
Mining as a percentage of total	1988	9.3	3.5	7.1	3.0	11.8	8.3	8.3	6.0	7.4
	1989[p]	7.1	2.5	5.4	2.6	12.2	8.3	6.4	5.4	6.0
	1990[I]	7.2[r]	2.5[r]	5.4	3.0	11.9	8.2	6.6[r]	5.2[r]	6.0

Source: Statistics Canada.
[1] Includes mines, quarries and oil wells. [2] Includes finance, real estate, insurance, commercial services, institutions and government departments.
[p] Preliminary; [I] Intentions; – Nil; [r] Revised.
Note: Totals may not add due to rounding.

TABLE 84. CANADA, CAPITAL AND REPAIR EXPENDITURES IN MINING[1] BY GEOGRAPHICAL REGION, 1988-90

		Capital Expenditures			Repair Expenditures			Capital and Repair Expenditures		
		Construction	Machinery and Equipment	Total	Construction	Machinery and Equipment	Total	Construction	Machinery and Equipment	Total
						($ million)				
Atlantic Region	1988	392.7	113.9	506.6	17.0	260.6	277.6	409.7	374.5	784.2
	1989[p]	226.5	144.8	371.3	19.5	272.1	291.6	246.0	416.9	662.9
	1990[i]	317.8[r]	206.4[r]	524.2[r]	21.0	267.8	288.8	338.8[r]	474.2[r]	813.0[r]
Quebec	1988	351.8	108.9	460.7	17.6	219.7	237.3	369.4	328.6	698.0
	1989[p]	355.0	140.3	495.3	25.7	259.6	285.3	380.7	399.9	780.6
	1990[i]	236.4[r]	115.0[r]	351.4[r]	27.1	265.3	292.4	263.5[r]	380.3[r]	643.8[r]
Ontario	1988	653.2	341.6	994.8	77.4	435.7	513.1	730.6	777.3	1 507.9
	1989[p]	412.9	287.3	700.2	55.1	448.3	503.4	468.0	735.6	1 203.6
	1990[i]	438.0[r]	277.2[r]	715.2[r]	56.9	454.6	511.5	494.9[r]	731.8[r]	1 226.7[r]
Prairie Region	1988	4 661.4	877.6	5 539.0	240.4	1 028.8	1 269.2	4 901.8	1 906.4	6 808.2
	1989[p]	3 887.6	420.9	4 308.5	217.7	1 077.3	1 295.0	4 105.3	1 498.2	5 603.5
	1990[i]	4 425.5[r]	494.9[r]	4 920.4[r]	297.2	1 070.7	1 367.9	4 722.7[r]	1 565.6[r]	6 288.3[r]
British Columbia	1988	772.0	105.2	877.2	46.5	439.1	485.6	818.5	544.3	1 362.8
	1989[p]	802.3	151.8	954.1	56.7	451.6	508.3	859.0	603.4	1 462.4
	1990[i]	783.8[r]	177.9[r]	961.7[r]	62.8	471.2	534.0	846.6[r]	649.1[r]	1 495.7[r]
Yukon and Northwest Territories	1988	345.2	26.9	372.1	4.4	45.8	50.2	349.6	72.7	422.3
	1989[p]	386.8	90.7	477.5	1.8	53.7	55.5	388.6	144.4	533.0
	1990[i]	251.2[r]	44.4[r]	295.6[r]	1.3	63.2	64.5	252.5[r]	107.6[r]	360.1[r]
Total	1988	7 176.3	1 574.1	8 750.4	403.3	2 429.7	2 833.0	7 579.6	4 003.8	11 583.4
	1989[p]	6 071.1	1 235.8	7 306.9	376.5	2 562.6	2 939.1	6 447.6	3 798.4	10 246.0
	1990[i]	6 452.7[r]	1 315.8[r]	7 768.5[r]	466.3	2 592.8	3 059.1	6 919.0[r]	3 908.6[r]	10 827.6[r]

Source: Statistics Canada.
[1] Includes mines, quarries and oil wells.
[p] Preliminary; [i] Intentions; [r] Revised.
Note: Totals may not add due to rounding.

TABLE 85. CANADA, CAPITAL AND REPAIR EXPENDITURES IN MINING[1] AND MINERAL MANUFACTURING INDUSTRIES,[2] 1988-90

	1988			1989p			1990I		
	Capital	Repair	Total	Capital	Repair	Total	Capital	Repair	Total
					($ million)				
Mining industry									
Metal mines									
Copper-gold-silver	371.4	278.8	650.2	308.5	299.2	607.7	274.6r	305.8	580.4r
Gold	1 157.0	225.1	1 382.1	851.8	236.5	1 088.3	508.7r	243.7	752.4r
Iron	83.5	243.5	327.0	123.2	244.6	367.8	182.4r	226.6	409.0r
Silver-lead-zinc	154.9	91.8	246.7	185.8	118.8	304.6	139.8r	126.9	266.7r
Other metal mines	408.7	317.6	726.3	447.2	312.8	760.0	504.1r	331.7	835.8r
Total metal mines	2 175.5	1 156.8	3 332.3	1 916.5	1 211.9	3 128.4	1 609.6r	1 234.7	2 844.3r
Nonmetal mines									
Asbestos	59.1	42.7	101.8	53.9	58.6	112.5	54.2r	50.8	105.0r
Other nonmetal mines[3]	637.2	630.2	1 267.4	622.6	640.6	1 263.2	707.7r	669.6	1 377.3r
Total nonmetal mines	696.3	672.9	1 369.2	676.5	699.2	1 375.7	761.9r	720.4	1 482.3r
Mineral fuels									
Petroleum and gas[4]	5 878.6	1 003.3	6 881.9	4 713.9	1 028.0	5 741.9	5 397.0r	1 104.0	6 501.0r
Total mining industries	8 750.4	2 833.0	11 583.4	7 306.9	2 939.1	10 246.0	7 768.5r	3 059.1	10 827.6r
Mineral manufacturing									
Primary metal industries									
Aluminum rolling, casting and extruding	89.4	61.3	150.7	95.1	66.6	161.7	110.8e	70.5	181.3e
Copper and copper alloy, rolling, casting and extruding	7.5	18.1	25.6	7.4	10.2	17.6	4.8e	10.2	15.0e
Iron and steel mills	534.0	986.1	1 520.1	563.1	1 009.8	1 572.9	1 064.9e	1 043.5	2 108.4e
Iron foundries	36.5	63.4	99.9	50.0	74.5	124.5	31.8e	72.3	104.1e
Metal rolling, casting and extruding	20.3	17.3	37.6	26.9	18.5	45.4	19.3e	19.8	39.1e
Smelting and refining	813.2	530.9	1 344.1	1 368.7	545.9	1 914.6	2 125.8e	580.2	2 706.0e
Steel pipe and tube mills	29.2	73.7	102.9	48.5	66.1	114.6	82.2e	63.9	146.1e
Total primary metal industries	1 530.1	1 750.8	3 280.9	2 159.7	1 791.6	3 951.3	3 439.6e	1 860.4	5 300.0r
Nonmetallic mineral products									
Abrasives	7.6	12.8	20.4	x	x	17.7	x	x	..r
Cement	86.5	104.0	190.5	127.3	106.4	233.7	172.8e	107.8	280.6e
Clay products	24.0	10.2	34.2	8.2	15.3	23.5	14.0e	15.8	29.8e
Concrete products	51.7	35.8	87.5	57.8	31.6	89.4	75.7e	34.3	110.0e
Glass and glass products	71.8	29.8	101.6	105.7	27.4	133.1	172.8e	31.0	203.8e
Lime	13.1	10.1	23.2	8.9	4.9	13.8	8.7e	4.9	13.6e
Ready-mix concrete	92.2	66.7	158.9	69.3	63.8	133.1	59.7e	63.1	122.8e
Stone products	1.5	1.1	2.6	x	x	5.9	x	x	..r
Other nonmetallic mineral products	92.2	67.4	159.6	111.9	60.7	172.6	92.6e	59.7	152.3e
Total nonmetallic mineral products	440.6	337.9	778.5	498.3	324.5	822.8	604.3r	330.7	935.0r
Metal-fabricating industries									
Boiler and plate works	12.4	13.4	25.8	13.4	9.9	23.3	16.4e	10.2	26.6e
Fabricated structural metal	25.1	13.0	38.1	13.0	10.0	23.0	13.9e	10.3	24.2e
Hardware, tool and cutlery	66.2	29.7	95.9	70.0	27.1	97.1	65.9e	24.8	90.7e
Heating equipment	6.6	4.0	10.6	10.6	3.2	13.8	11.9e	3.5	15.4e
Machine ships	32.2	8.0	40.2	19.0	8.6	27.6	25.0e	8.2	33.2e
Metal stamping, pressing and coating	158.3	65.7	224.0	109.9	68.5	178.4	110.0e	66.6	176.6e
Miscellaneous metal fabricating	81.0	31.1	112.1	65.2	30.6	95.8	67.4e	30.5	97.9e
Ornamental and architectural metal	26.9	10.2	37.1	26.0	10.4	36.4	25.1e	10.3	35.4e
Wire and wire products	58.7	49.8	108.5	49.7	46.0	95.7	54.7e	49.2	103.9e
Total metal-fabricating industries	467.4	224.9	692.3	376.8	214.3	591.1	390.4r	213.6	604.0r

TABLE 85. (cont'd)

	1988			1989p			1990i		
	Capital	Repair	Total	Capital	Repair	Total	Capital	Repair	Total
					($ million)				
Petroleum and coal products									
Petroleum and coal products	14.2	17.9	32.1	9.7	21.1	30.8	6.9e	20.5	27.4e
Petroleum refineries	684.7	353.4	1 038.1	860.2	381.1	1 241.3	1 282.4e	404.6	1 687.0e
Total petroleum and coal products	698.9	371.3	1 070.2	869.9	402.2	1 272.1	1 289.3e	425.1	1 714.4r
Total mineral manufacturing industries	3 137.0	2 684.9	5 821.9	3 904.7	2 732.6	6 637.3	5 723.6r	2 829.8	8 553.4r
Total mining and mineral manufacturing industries	11 887.4	5 517.9	17 405.3	11 211.6	5 671.7	16 883.3	13 492.1r	5 888.9	19 381.0r

Source: Statistics Canada.
[1] Does not include cement, lime and clay products (domestic clay) manufacturing, smelting and refining. [2] All years have been revised to include the metal-fabricating industries. [3] Includes coal mines, gypsum, salt, potash and miscellaneous nonmetal mines and quarrying. [4] The total of capital expenditures shown under "petroleum and gas" is equal to the total capital expenditure under the columns entitled "petroleum and natural gas extraction," "natural gas processing plants" and "oil and gas drilling contractors" of Table 32.
p Preliminary; i Intentions; x Confidential; r Revised; e Estimated; .. Not available.
Note: Totals may not add due to rounding.

TABLE 86. CANADA, CAPITAL AND REPAIR EXPENDITURES IN THE MINING INDUSTRY,[1] 1984-90

	1984	1985	1986	1987	1988	1989p	1990i
				($ million)			
Metal mines							
Capital							
Construction	942.2	1 053.5	979.7	1 328.2	1 609.0	1 297.3	1 076.2r
Machinery	372.7	322.4	319.4	372.9	566.5	619.2	533.4r
Total	1 314.9	1 375.9	1 299.1	1 701.1	2 175.5	1 916.5	1 609.6r
Repair							
Construction	99.6	104.5	99.6	109.8	123.2	111.7	117.2
Machinery	861.1	846.4	811.3	880.8	1 033.6	1 100.2	1 117.5
Total	960.7	950.9	910.9	990.6	1 156.8	1 211.9	1 234.7
Total capital and repair	2 275.6	2 326.8	2 210.0	2 691.7	3 332.3	3 128.4	2 844.3r
Nonmetal mines[2]							
Capital							
Construction	658.6	573.6	502.4	421.7	432.9	367.6	404.4r
Machinery	571.7	350.1	256.6	251.6	263.4	308.9	357.5r
Total	1 230.3	923.7	759.0	673.3	696.3	676.5	761.9r
Repair							
Construction	47.2	39.3	31.2	23.2	38.3	28.5	27.9
Machinery	454.8	529.5	565.4	608.8	634.6	670.7	692.5
Total	502.0	568.8	596.6	632.0	672.9	699.2	720.4
Total capital and repair	1 732.3	1 492.5	1 355.6	1 305.3	1 369.2	1 375.7	1 482.3r
Mineral fuels							
Capital							
Construction	6 643.5	7 645.9	5 142.4	4 096.0	5 134.4	4 406.2	4 972.1r
Machinery	686.7	959.7	496.4	505.8	744.2	307.7	424.9r
Total	7 330.2	8 605.6	5 638.8	4 601.8	5 878.6	4 713.9	5 397.0r
Repair							
Construction	283.4	374.3	316.5	307.0	241.8	236.3	321.2
Machinery	709.5	761.3	705.5	673.9	761.5	791.7	782.8
Total	992.9	1 135.6	1 022.0	980.9	1 003.3	1 028.0	1 104.0
Total capital and repair	8 323.1	9 741.2	6 660.8	5 582.7	6 881.9	5 741.9	6 501.0r
Total mining							
Capital							
Construction	8 244.3	9 273.0	6 624.5	5 845.9	7 176.3	6 071.1	6 452.7r
Machinery	1 631.1	1 632.2	1 072.4	1 130.3	1 574.1	1 235.8	1 315.8r
Total	9 875.4	10 905.2	7 696.9	6 976.2	8 750.4	7 306.9	7 768.5r
Repair							
Construction	430.2	518.1	447.3	440.0	403.3	376.5	466.3
Machinery	2 025.4	2 137.2	2 082.2	2 163.5	2 429.7	2 562.6	2 592.8
Total	2 455.6	2 655.3	2 529.5	2 603.5	2 833.0	2 939.1	3 059.1
Total capital and repair	12 331.0	13 560.5	10 226.4	9 579.7	11 583.4	10 246.0	10 827.6r

Source: Statistics Canada.
[1] Does not include cement, lime and clay products (domestic clays) manufacturing, smelting and refining. [2] Includes coal mines, asbestos, gypsum, salt, potash, miscellaneous nonmetals, quarrying and sand pits.
p Preliminary; i Intentions; r Revised.
Note: Totals may not add due to rounding.

TABLE 87. CANADA, CAPITAL AND REPAIR EXPENDITURES IN THE MINERAL MANUFACTURING INDUSTRIES,[1] 1984-90

	1984	1985	1986	1987	1988	1989p	1990i
				($ millions)			
Primary metal industries[2]							
Capital							
Construction	318.6	593.8	400.2	265.7	287.3	576.9	599.3r
Machinery	712.6	1 019.0	1 333.6	1 223.2	1 242.8	1 582.8	2 840.3r
Total	1 031.2	1 612.8	1 733.8	1 488.9	1 530.1	2 159.7	3 439.6r
Repair							
Construction	119.6	125.2	126.9	119.0	134.0	144.9	150.4
Machinery	1 215.7	1 231.1	1 279.0	1 409.4	1 616.8	1 646.7	1 710.0
Total	1 335.3	1 356.3	1 405.9	1 528.4	1 750.8	1 791.6	1 860.4
Total capital and repair	2 366.5	2 969.1	3 139.7	3 017.3	3 280.9	3 951.3	5 300.0r
Nonmetallic mineral products[3]							
Capital							
Construction	26.6	39.2	36.0	73.5	88.1	118.3	83.4r
Machinery	151.0	193.2	295.1	282.6	352.5	380.0	520.9r
Total	177.6	232.4	331.1	356.1	440.6	498.3	604.3r
Repair							
Construction	26.3	21.2	24.7	23.3	24.0	17.7	20.9
Machinery	236.5	270.6	285.7	277.5	313.9	306.8	309.8
Total	262.8	291.8	310.4	300.8	337.9	324.5	330.7
Total capital and repair	440.4	524.2	641.5	656.9	778.5	822.8	935.0r
Metal-fabricating industries							
Capital							
Construction	79.1	133.6	194.7	107.1	112.2	62.3	67.0r
Machinery	309.4	438.7	525.4	356.3	355.2	314.5	323.4r
Total	388.5	572.3	720.1	463.4	467.4	376.8	390.4r
Repair							
Construction	26.8	23.7	22.7	24.2	27.8	26.8	24.9
Machinery	158.0	167.7	209.1	194.7	197.1	187.5	188.7
Total	184.8	191.4	231.8	218.9	224.9	214.3	213.6
Total capital and repair	573.3	763.7	951.9	682.3	692.3	591.1	604.0r
Petroleum and coal products							
Capital							
Construction	321.4	248.3	272.3	464.9	437.9	562.1	890.6r
Machinery	111.0	87.4	125.9	205.0	261.0	307.8	398.7r
Total	432.4	335.7	398.2	669.9	698.9	869.9	1 289.3r
Repair							
Construction	230.3	213.0	212.0	252.8	255.6	276.1	293.0
Machinery	79.3	74.9	91.9	112.8	115.7	126.1	132.1
Total	309.6	287.9	303.9	365.6	371.3	402.2	425.1
Total capital and repair	742.0	623.6	702.1	1 035.5	1 070.2	1 272.1	1 714.4r
Total mineral manufacturing industries							
Capital							
Construction	745.7	1 014.9	903.2	911.2	925.5	1 319.6	1 640.3r
Machinery	1 284.0	1 738.3	2 280.0	2 067.1	2 211.5	2 585.1	4 083.3r
Total	2 029.7	2 753.2	3 183.2	2 978.3	3 137.0	3 904.7	5 723.6r
Repair							
Construction	403.0	383.1	386.3	419.3	441.4	465.5	489.2
Machinery	1 689.5	1 744.3	1 865.7	1 994.4	2 243.5	2 267.1	2 340.6
Total	2 092.5	2 127.4	2 252.0	2 413.7	2 684.9	2 732.6	2 829.8
Total capital and repair	4 122.2	4 880.6	5 435.2	5 392.0	5 821.9	6 637.3	8 553.4r

Source: Statistics Canada.
[1] All years have been revised to include the metal-fabricating industries. [2] Includes smelting and refining. [3] Includes cement, lime and clay products manufacturing.
p Preliminary; i Intentions; r Revised.
Note: Totals may not add due to rounding.

TABLE 88. CANADA, CAPITAL EXPENDITURES IN THE PETROLEUM, NATURAL GAS AND ALLIED INDUSTRIES,[1] 1981-90

	Petroleum and Natural Gas Extraction	Transportation (Pipelines)	Marketing (Chiefly Outlets of Oil Companies)	Natural Gas Distribution	Petroleum and Coal Products Industries	Natural Gas Processing Plants	Oil and Gas Drilling Contractors	Total Capital Expenditures
				($ million)				
1981	6 444.9	1 745.7	264.1	408.7	844.9	311.6	274.9	10 294.8
1982	6 743.4	1 994.3	320.5	517.6	1 224.5	522.8	173.5	11 496.6
1983	6 563.5	660.5	374.5	516.8	840.8	195.8	155.4	9 307.3
1984	6 946.4	795.4	422.9	604.1	432.4	340.0	43.8	9 585.0
1985	8 187.6	664.2	356.8	603.5	335.7	337.7	80.1	10 565.6
1986	5 401.1	586.9	344.9	573.9	398.2	207.8	29.9	7 542.7
1987	4 414.6	503.0	412.4	571.8	669.9	174.1	13.1	6 758.9
1988	5 589.9	828.9	478.4	602.8	698.9	271.8	16.9	8 487.6
1989[p]	4 349.1	1 539.7	489.3	587.8	869.9	351.2	13.8	8 200.8
1990[i]	4 997.3[r]	2 001.4[r]	518.8[r]	687.2[r]	1 289.7[r]	388.3[r]	11.4	9 894.2[r]

Source: Statistics Canada.
[1] The petroleum and natural gas industries in this table include all companies engaged in whole or in part in oil and gas activities.
[p] Preliminary; [i] Intentions; [r] Revised.
Note: Totals may not add due to rounding.

TABLE 89. CANADA, TOTAL INTRAMURAL RESEARCH AND DEVELOPMENT EXPENDITURES FOR MINING-RELATED INDUSTRIES IN CURRENT AND CONSTANT (1986) DOLLARS, 1984-90

	1984	1985	1986	1987	1988	1989p	1990f
				($ million)			
Current dollars							
Mining industry	115	119	90	76	83	88	91
Mines	48	51	52	46r	47	51	58
Oil and gas wells	67	69	38	30r	33	32	33
Mineral manufacturing	356	342	279	275r	331	335	332
Ferrous primary metals	26	26	27	31r	32	33	37
Nonferrous primary metals	95	92	88	111	130	141	149
Nonmetallic mineral products	17	19	16	15	20	22	23
Petroleum products	218	205	148	118	149	139	123
Metal fabricating	24	30	34	35r	38	49	52
Constant dollars							
Mining industry	121	123	90	73	73	72	76
Mines	50	52	52	44r	43	44	49
Oil and gas wells	70	71	38	29r	30	28	28
Mineral manufacturing	374	350	279	262r	301	291	279
Ferrous primary metals	27	27	27	30r	29	29	31
Nonferrous primary metals	100	94	88	106	118	122	125
Nonmetallic mineral products	18	19	16	14	18	19	19
Petroleum products	229	210	148	113	136	121	103
Metal fabricating	25	31	34	33r	35	43	44

Source: Statistics Canada.
p Preliminary; f Forecast; r Revised.
Note: Totals may not add due to rounding.

TABLE 90. CANADA, CAPITAL AND CURRENT INTRAMURAL RESEARCH AND DEVELOPMENT EXPENDITURES FOR MINING-RELATED INDUSTRIES, IN CURRENT DOLLARS, 1984–90

	1984	1985	1986	1987	1988	1989p	1990f
				($ million)			
Capital expenditures							
Mining industry	21	27	11	7	6	11	11
Mines	5	4	8	4	3	8	7
Oil and gas wells	16	23	3	3	3	3	4
Mineral manufacturing	97	82	30	34	53	58	40
Ferrous primary metals	1	3	3	4	3	4	7
Nonferrous primary metals	9	5	7	15	15	11	12
Nonmetallic mineral products	6	6	3	2	2	3	3
Petroleum products	81	68	17	13	33	40	18
Metal fabricating	3	2	4	4	4	4	5
Current expenditures							
Mining industry	94	92	79	69r	77	77	80
Mines	43	47	44	42r	44	43	51
Oil and gas wells	51	46	35	27r	30	29	29
Mineral manufacturing	259	260	249	241r	278	277	292
Ferrous primary metals	25	23	24	27r	29	29	30
Nonferrous primary metals	86	87	81	96	115	130	137
Nonmetallic mineral products	11	13	13	13	18	19	20
Petroleum products	137	137	131	105	116	99	105
Metal fabricating	21	28	30	31r	34	45	47
Total expenditures							
Mining industry	115	119	90	76	83	88	91
Mines	48	51	52	46r	47	51	58
Oil and gas wells	67	69	38	30r	33	32	33
Mineral manufacturing	356	342	279	275r	331	335	332
Ferrous primary metals	26	26	27	31r	32	33	37
Nonferrous primary metals	95	92	88	111	130	141	149
Nonmetallic mineral products	17	19	16	15	20	22	23
Petroleum products	218	205	148	118	149	139	123
Metal fabricating	24	30	34	35r	38	49	52

Source: Statistics Canada.
p Preliminary; f Forecast; r Revised.
Note: Capital expenditures are expenditures on construction, acquisition or preparation of land, buildings, machinery and equipment. All other expenditures are current expenditures. Totals may not add due to rounding.