MINERAL REPORT 32

CANADIAN MINERALS YEARBOOK, 1982

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Foreword

This issue of the Canadian Minerals Yearbook is a comprehensive report of developments in the mineral industry during 1982. In order to provide information as early as possible to all interested persons, the 44 chapters dealing with individual commodities and all other chapters were issued previously as Annual Mineral Reviews, 1982. The General Review deals with the main events and trends in the Canadian economy during the year, as well as overall developments in the mineral industry. The Company index lists the accurate full names of all companies mentioned in the text and the page number of each mention, thus providing a complete cross-reference to the activities of companies engaged in the Canadian mineral industry. Map 900A, Principal Mineral Areas of Canada is available upon request at the following address:

Publication Distribution Office
Mineral Policy Sector
Energy, Mines and Resources Canada
580 Booth Street
Ottawa, Ontario
K1A OE4

The Canadian Minerals Yearbook has been published under that title, or other titles, since 1886 and is the permanent official record of the mineral industry in Canada. Those wishing to refer to previous Yearbooks or reports should consult departmental catalogues, available in most libraries.

The basic statistics on Canadian production, trade and consumption were collected by the Information Systems Division, Mineral Policy Sector, Energy, Mines and Resources Canada, and by Statistics Canada, unless otherwise stated. Company data were obtained by the authors directly from company officials through surveys or correspondence, or from corporate annual reports. Market quotations are mainly from standard marketing reports.

Energy, Mines and Resources Canada is grateful to all those who contributed information necessary to compile this report.

September 14, 1984

Editor: G.E. Thompson
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Graphics and Cover: N. Sabolotny

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Front Cover:
Geologist examines ore at a drilling face at Husky Mine, United Keno Hill.
(George Hunter photo)

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Conversion Factors

Imperial units to Metric (SI) Units

Ounces to grams	x	28.349 523
Troy ounces to grams	x	31.103 476 8
to kilograms	x	.031 103 476
Pounds to kilograms	x	.453 592 37
Short tons to tonnes	x	.907 184 74
Gallons to litres	x	4.546 09
Barrels to cubic metres	x	.158 987 220
Cubic feet to cubic metres	x	.028 346 85

Source: Canadian Metric Practice Guide

General Review

INFORMATION SYSTEMS DIVISION

The sharp decline in economic activity throughout the industrialized world in 1982 had severe repercussions for all sectors of the Canadian economy. In an attempt to stem the high inflation levels of the late 1970s an almost universal tight monetary policy was put in place. The inflation rate in Canada was higher in the past decade than in any previous 10-year period including those spanning the two world wars. In the last three years it was above 10 per cent compared with an equally high 9 per cent in the United States. The adoption of monetary policies aimed at slowing money growth in order to reduce these inflation levels was in recognition of the necessity to improve the Canadian cost and price performance with respect to major trade competitors. Canada, as one of the most open industrialized economies in the world must be internationally competitive in order to maintain, let alone improve its standard of living.

The resultant performance of the overall economy in Canada was the weakest on record since the Great Depression. Record high volatile interest rates choked off consumer demand and business investment and thus economic growth. Gross National Product (GNP), a measure of the total value of goods and services produced in Canada dropped for five consecutive quarters from mid-1981. An overall annualized rate of decline of 4.4 per cent was recorded in 1982 compared with an increase of 3.2 per cent in 1981. This combined with an annualized rate of decline of 4.6 per cent in Gross Domestic Product (a measure that reflects the change in physical volume of output), the sharpest decline since 1954, emphasized the seriousness and durability of the recession. The decline was widespread across industries and regions. Primary resource industries, construction and manufacturing were hit the hardest. Employment declined throughout the year with a loss of some 508,000 jobs. The unemployment rate reached a post-war record of 12.7 per cent. At the same time, productivity (measured in terms of real GNP per person employed) showed a sharp decline from an increase in 1981 of 0.5 per cent to a decrease of 1.6 per cent in 1982.

One favourable development in the midst of such gloom was the easing of inflation during the year. Measured by the Consumer Price Index, inflation fell from 11.4 per cent in January to 10.8 per cent in July and 9.8 per cent at the end of the year. The average for the year was 10.8 per cent down from 12.5 per cent in 1981. Another bright spot was the record merchandise trade surplus of $18.3 billion, up from $7.4 billion in 1981. The surplus on the current account measured $2.7 billion, the first year since 1973 that a surplus was recorded. The Canadian dollar lost ground in terms of the U.S. dollar, slipping from 83.5 cents to 81.1 cents (US) during the year but remained stable relative to other world currencies.

The combination of record high interest rates, high unemployment levels, improving but still high inflation rates and declining productivity produced a dismal economic climate. However, the rest of the industrialized world experienced a severe slow down in economic activity as well. Total production of goods and services declined by 1.8 per cent in the United States in 1982, 1.2 per cent in Germany and 0.1 per cent in Italy. In the United Kingdom real growth was 0.5 per cent while Japan reached a level of 2.7 per cent, considerably lower than previous years. All faced record unemployment levels and high though moderating inflation levels. As a result, the level of demand and hence world trade dropped considerably. Given Canada's dependence on world trade for economic prosperity, the sharp downturn in domestic activity was not unexpected.

Performace of the Mineral Industry

Over the 1971-1981 period growth in the Canadian economy as measured by Gross Domestic Product in constant 1971 prices (real output), increased at an average annual rate of 3.8 per cent. This is

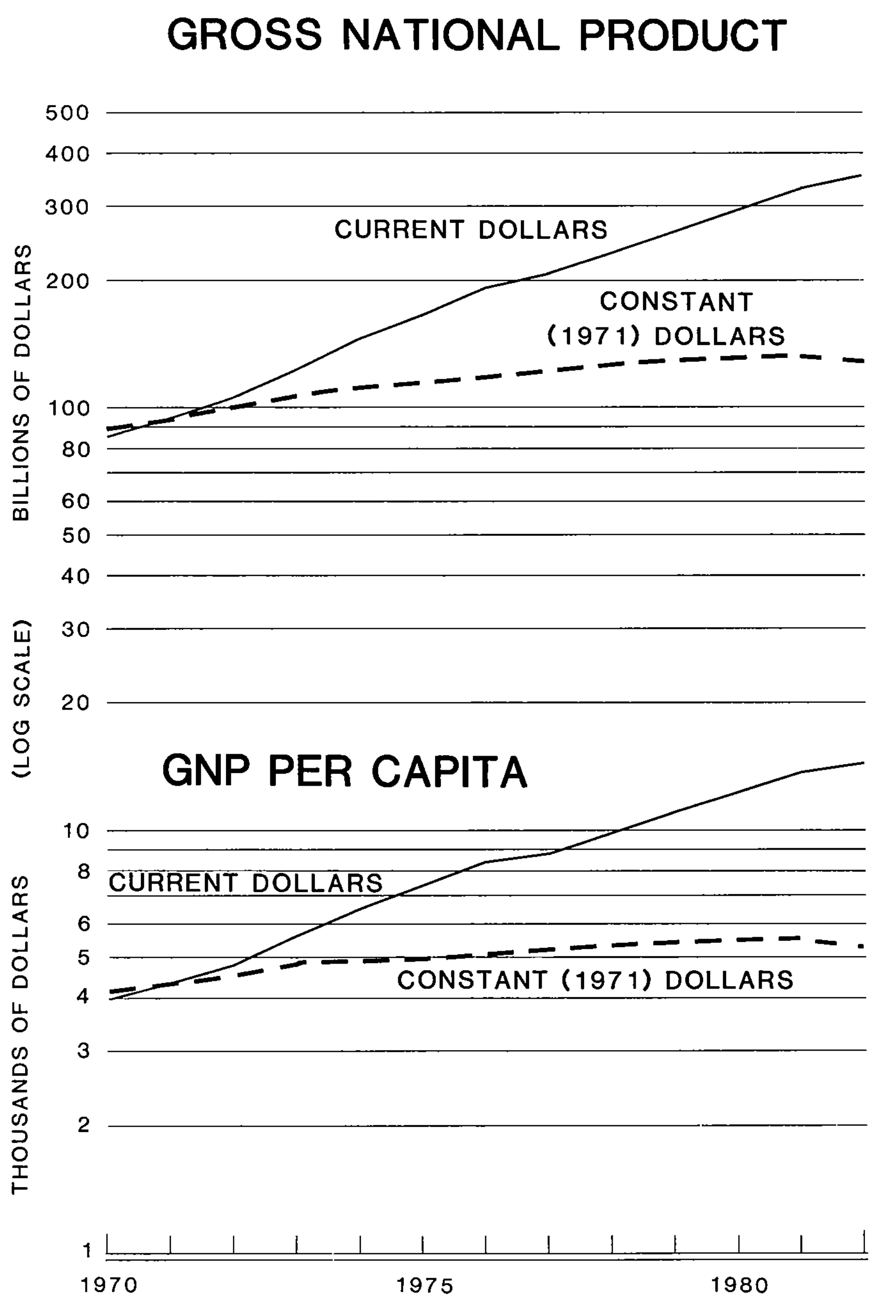

GROSS NATIONAL PRODUCT
500
400
300
200
100
80
60
50
40
30
20
10
8
6
5
4
3
2
1
BILLIONS OF DOLLARS
(LOG SCALE)
THOUSANDS OF DOLLARS
CURRENT DOLLARS
CONSTANT (1971) DOLLARS
GNP PER CAPITA
CURRENT DOLLARS
CONSTANT (1971) DOLLARS
1970
1975
1980

Figure 1

CANADA
POPULATION AND LABOUR FORCE

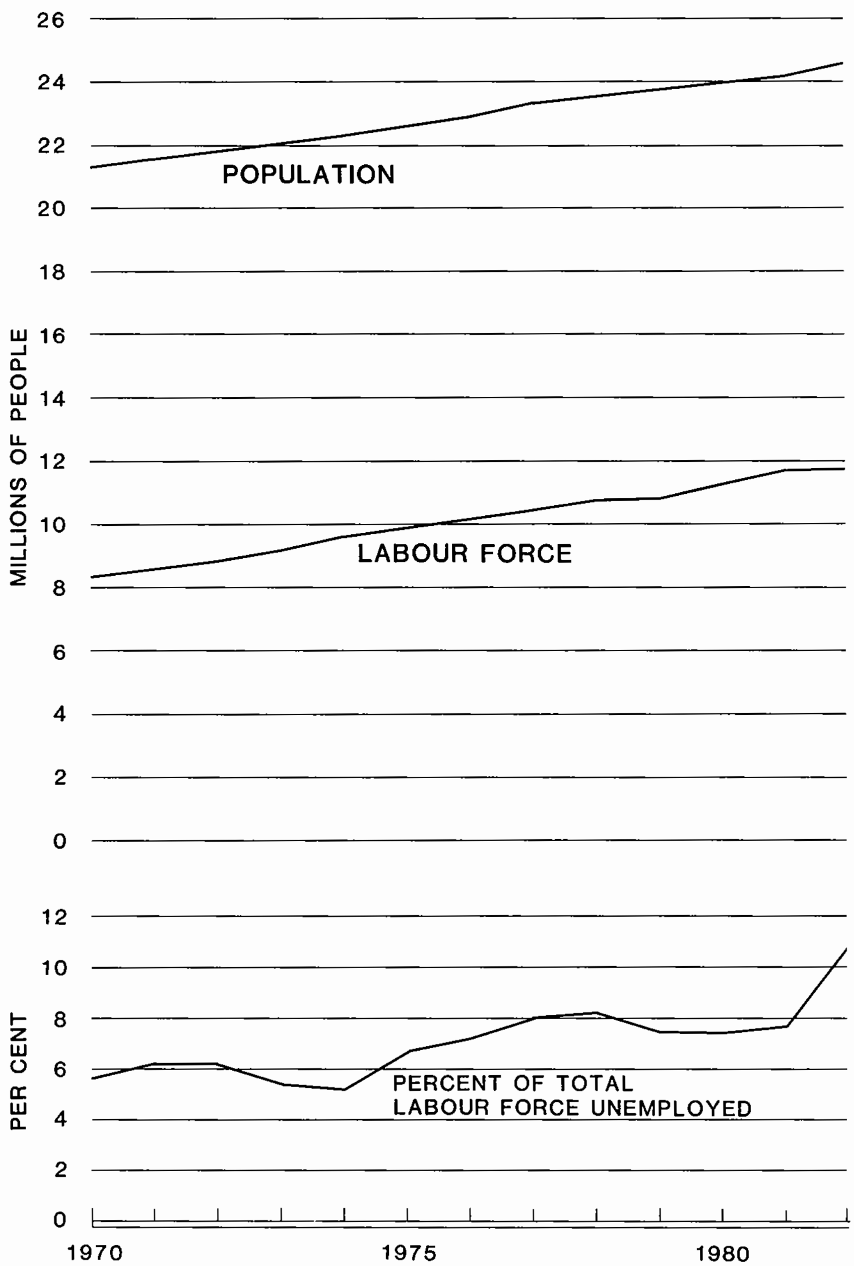


Figure 2

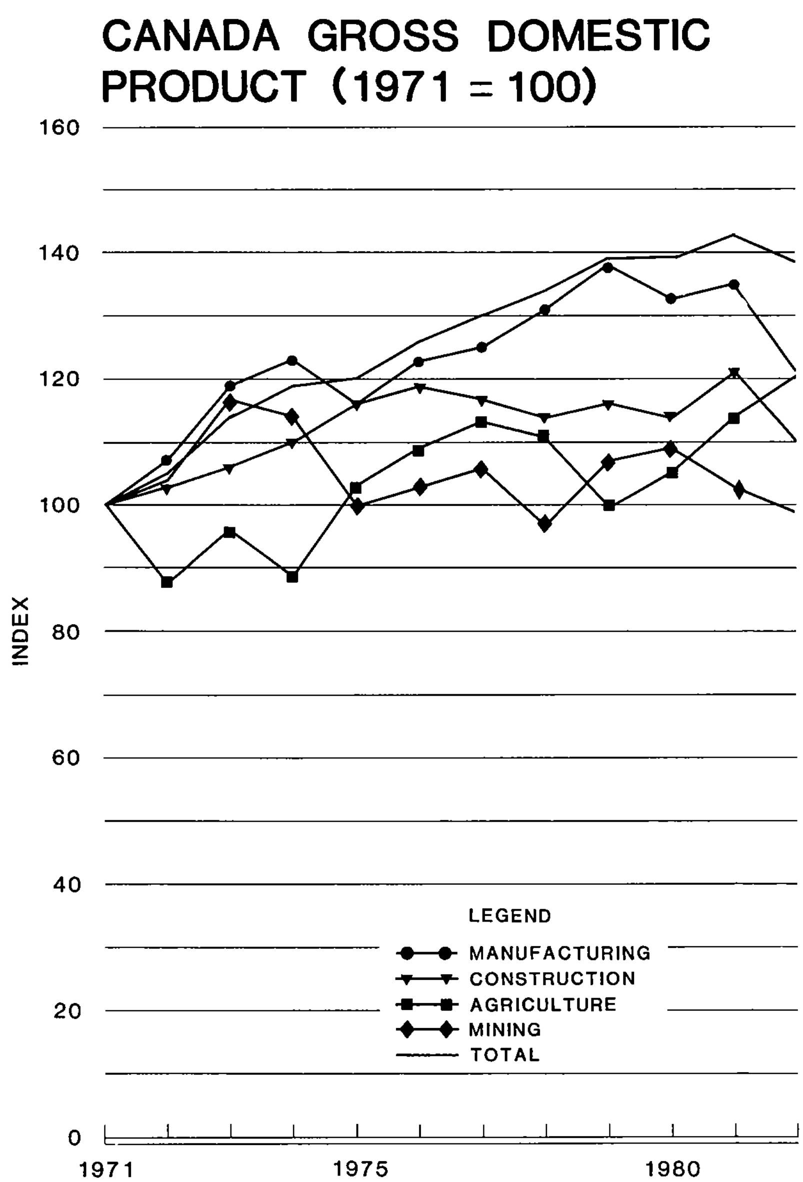

CANADA GROSS DOMESTIC PRODUCT (1971 = 100)
160
140
120
100
80
60
40
20
0
INDEX
1971
1975
1980
LEGEND
MANUFACTURING
CONSTRUCTION
AGRICULTURE
MINING
TOTAL

Figure 3

significantly less than the average rate of 5.5 per cent for the 1961-1971 period. At the same time (1971-1982), Industrial Production including mining, manufacturing and utilities had an average annual growth of only 1.9 per cent. The mining industry, including metallics, nonmetallics and fuels showed a negative growth rate of 0.8 per cent over the period. The index of real output for mines, quarries and oil wells measured 91.8 in 1982, down from 104.6 in 1981 and 110.1 in 1980. Metal mines and nonmetal mines were particularly weak in 1982, falling 24 per cent and 22 per cent respectively from the previous year. However, an increase in export volumes of crude oil helped sustain output levels for mineral fuels and the index for 1982 at 113.1 was almost unchanged from 1981.

The value of total Canadian mineral production in 1982 also reflected the industry decline. Value of output reached $33.1 billion, up 2.5 per cent from 1981, but that increase came in the fuel sector only. The metal sector showed a decrease in value of 18.8 per cent from $8.7 billion in 1981 to $7.0 billion in 1982. Nonmetals dropped from $2.7 billion to $2.1 billion. The improvement was shown by the fuel sector which increased 17 per cent from $19.0 billion in 1981 to $22.2 billion in 1982.

The ten leading minerals represented 79.3 per cent of the total value of output in 1982. They included petroleum (35.1 per cent), natural gas (21.4 per cent), coal (3.9 per cent), iron ore (3.7 per cent), copper (3.6 per cent), zinc (3.42 per cent) gold (2.8 per cent), uranium (2.5 per cent), nickel (1.8 per cent) and silver (1.1 per cent).

The combination of weak demand and falling prices caused a dismal performance for nearly all metals with the exception of gold.

Canadian mine production of recoverable copper was 606 202 t in 1982, down 12 per cent from 1981 and the value of production dropped to $1.2 billion from $1.5 billion in 1981. Prices averaged 88.24 cents (Cdn) per pound in 1982, well below production costs for many producers. Planned expansions or development of new orebodies were deferred indefinitely as world oversupply provided continued downward pressure on prices. A number of mines closed permanently during the year while those still in production operated at reduced rates.

The nickel industry faced similar problems of world oversupply and depressed prices. North American producers placed restrictions on output but countries such as the Soviet Union, Cuba, Colombia and Yugoslavia continued to increase deliveries as well as install new capacity. Production was cut in Canada to about 40 per cent of capacity and volume of output dropped to 88 745 t valued at $581 million compared with 160 247 t at $1.238 billion in 1981.

The zinc industry fared somewhat better with a 13 per cent increase in volume of mine output and a corresponding 2 per cent increase in value in 1982. However, prices were down in response to lower demand and production and consumption of refined metal decreased over the year. One bright spot was the start-up of production of Cominco Ltd.'s Polaris Mine, on Little Cornwallis Island, some 130 kilometres south of the magnetic North Pole. At full capacity the Polaris mine will produce 130 000 tpy of zinc and 30 000 tpy of lead in concentrates annually.

Lead production increased slightly from 268 556 t in 1981 to 290 092 t in 1982 but the value of that output dropped by 20 per cent. With its major uses geared to the automobile and construction industries, lower demand and reduced prices were inevitable. After averaging 44.52 cents Canadian per pound in 1981, the price dropped steadily during 1982 reaching 27.0 cents in November, the lowest nominal price in six years.

The only encouraging growth in metals appeared in the gold mining sector where prices above the $US 400 per ounce mark encouraged exploration. Volume of production increased to 62 456 000 g valued at $929 million compared with 52 034 000 g at $922 million the previous year. New mining operations, under development since the gold price surge of 1979-1980 made their first contribution to production and a major new gold discovery at Hemlo, Ontario will result in several new mines in the near future.

The iron ore industry faced stiff competition from developing countries that were forced to keep producing to service foreign debts, thereby aggravating an existing world glut of iron ore. Domestic output of iron ore decreased to 33 million t in 1982 from 50 million t in 1981. At the same time the Canadian steel industry operated at an average rate of 55.5 per cent

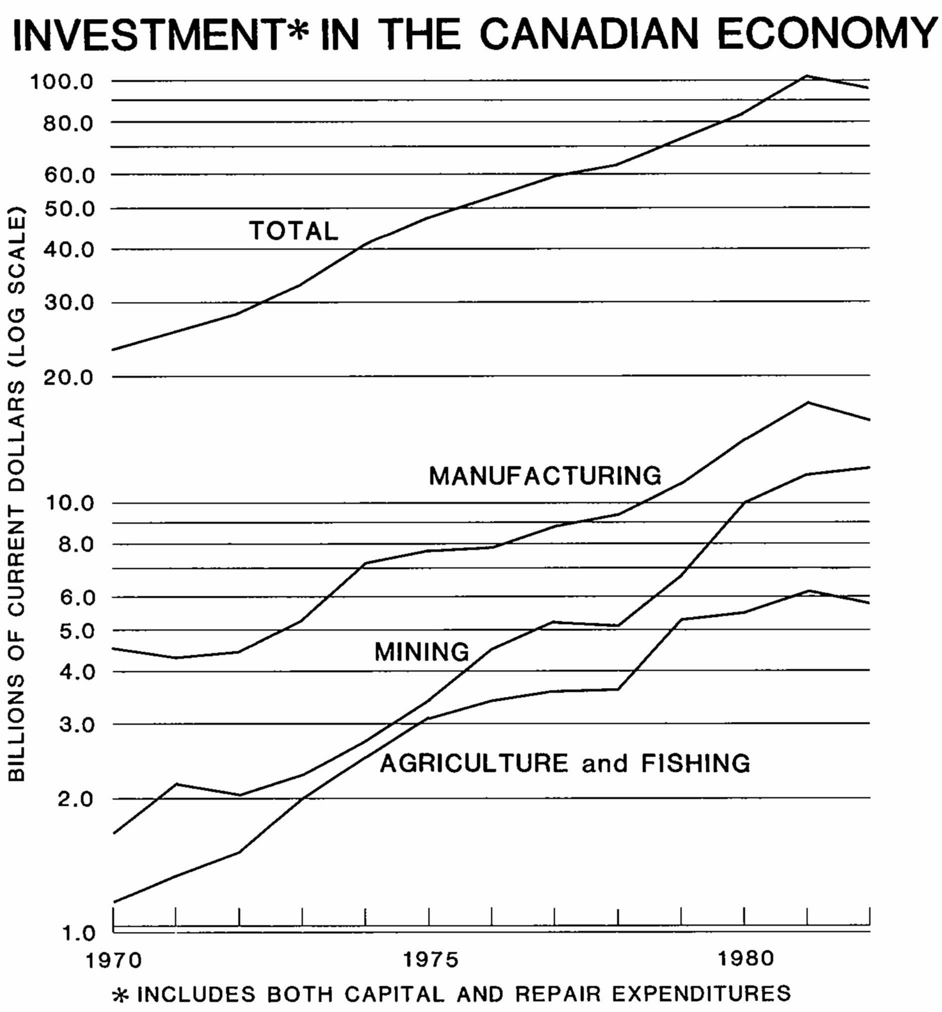

INVESTMENT* IN THE CANADIAN ECONOMY
100.0
80.0
60.0
50.0
40.0
30.0
20.0
10.0
8.0
6.0
5.0
4.0
3.0
2.0
1.0
BILLIONS OF CURRENT DOLLARS (LOG SCALE)
TOTAL
MANUFACTURING
MINING
AGRICULTURE and FISHING
1970
1975
1980
* INCLUDES BOTH CAPITAL AND REPAIR EXPENDITURES

Figure 4

CANADA
VALUE OF MINERAL PRODUCTION

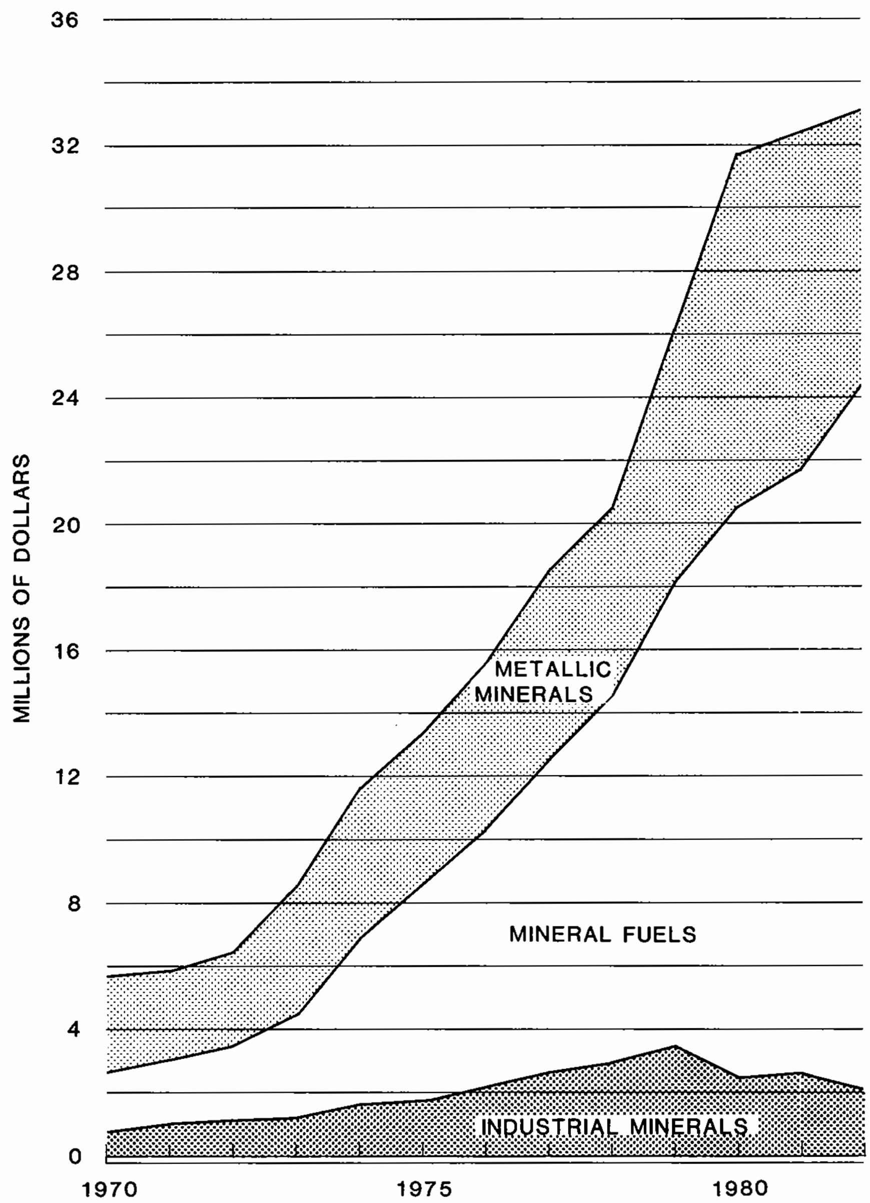


Figure 5

CANADA, MINERAL PRODUCTION, 1982

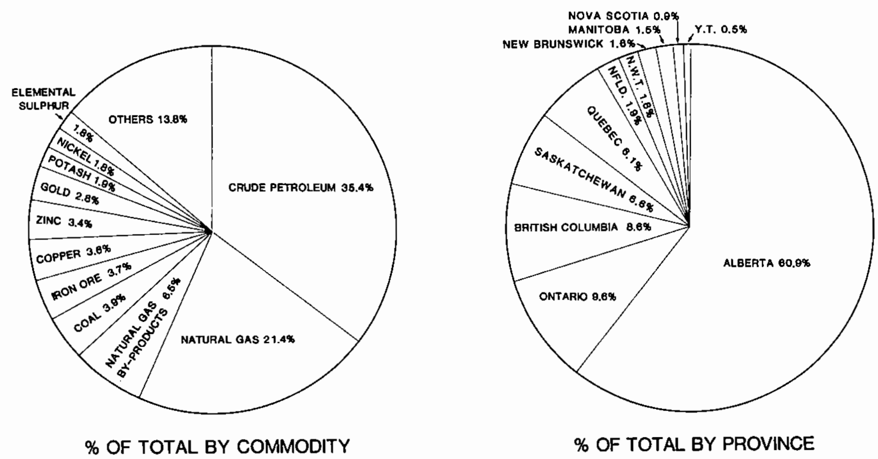


Figure 6

of capacity during 1982, producing 11.8 million t of crude steel, a decrease of 20 per cent from 1981 quantities. The situation was worse in the United States where steelmaking capacity was cut by almost 3 million t with a utilization rate of 42 per cent for the year. Reduced demand for imports of iron ore from Canada culminated in the planned permanent closure of the Iron Ore Company of Canada's operations at Schefferville, Quebec in June 1983.

Molybdenum producers were one of the victims of an ailing steel industry as severely reduced demand for the commodity with more than a year's supply already available worldwide saw prices plummet. Production in Canada continued to hold pace with last year at 15 232 t compared to 12 850 t but markets were difficult to find.

The uranium industry, also a victim of oversupply and general economic conditions was plagued by lower sales and weak prices leading to the closure by Eldorado Nuclear Limited of its Beaverlodge operation in Saskatchewan. However, the Elliot Lake region of Ontario, the largest producing area in Canada, managed to operate profitably on contracts negotiated prior to the recession. Production levels reached 8 178 t, up 9 per cent compared with last year.

The grim story continued across the industrial minerals sector. The overall value of output declined 16.7 per cent and production levels for asbestos, gypsum, clay and most construction materials were below the levels of 1981.

The mining industry overall experienced a cost/price squeeze causing corporate

CANADA, CRUDE AND FABRICATED MINERAL EXPORTS BY DESTINATION

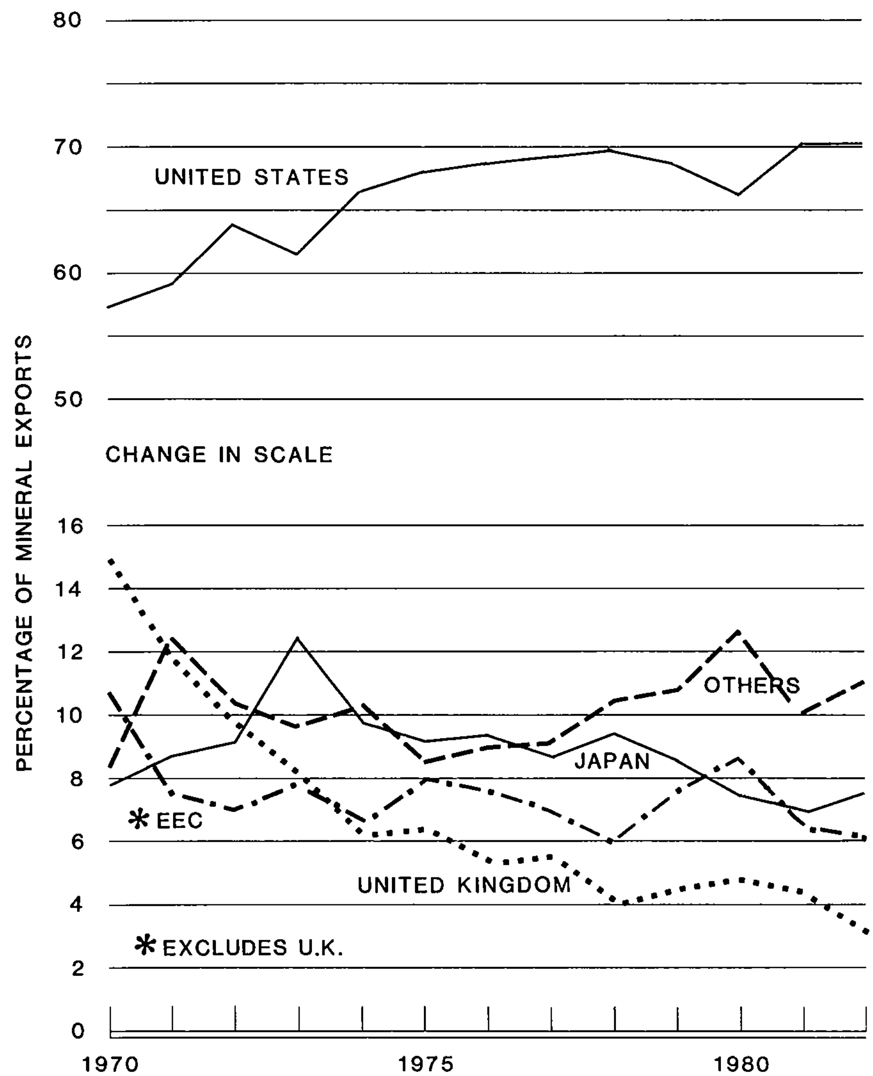


Figure 7

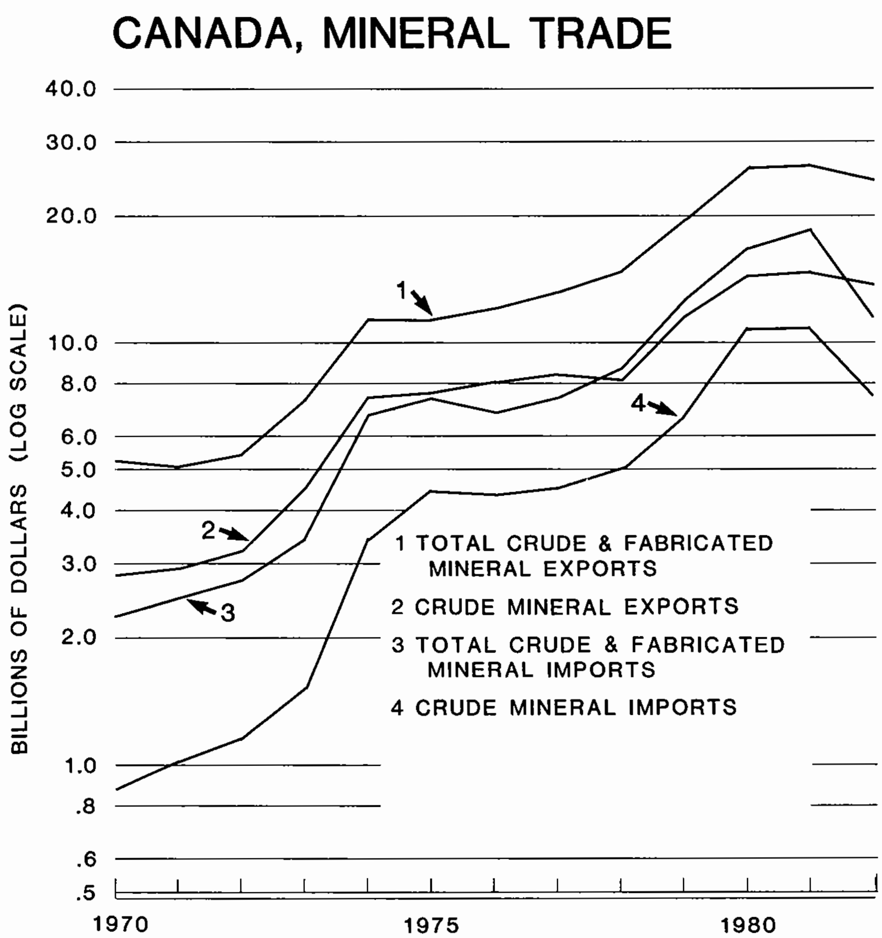

CANADA, MINERAL TRADE
40.0
30.0
20.0
10.0
8.0
6.0
5.0
4.0
3.0
2.0
1.0
.8
.6
.5
BILLIONS OF DOLLARS (LOG SCALE)
1970
1975
1980
1
2
3
4
1 TOTAL CRUDE & FABRICATED MINERAL EXPORTS
2 CRUDE MINERAL EXPORTS
3 TOTAL CRUDE & FABRICATED MINERAL IMPORTS
4 CRUDE MINERAL IMPORTS

Figure 8

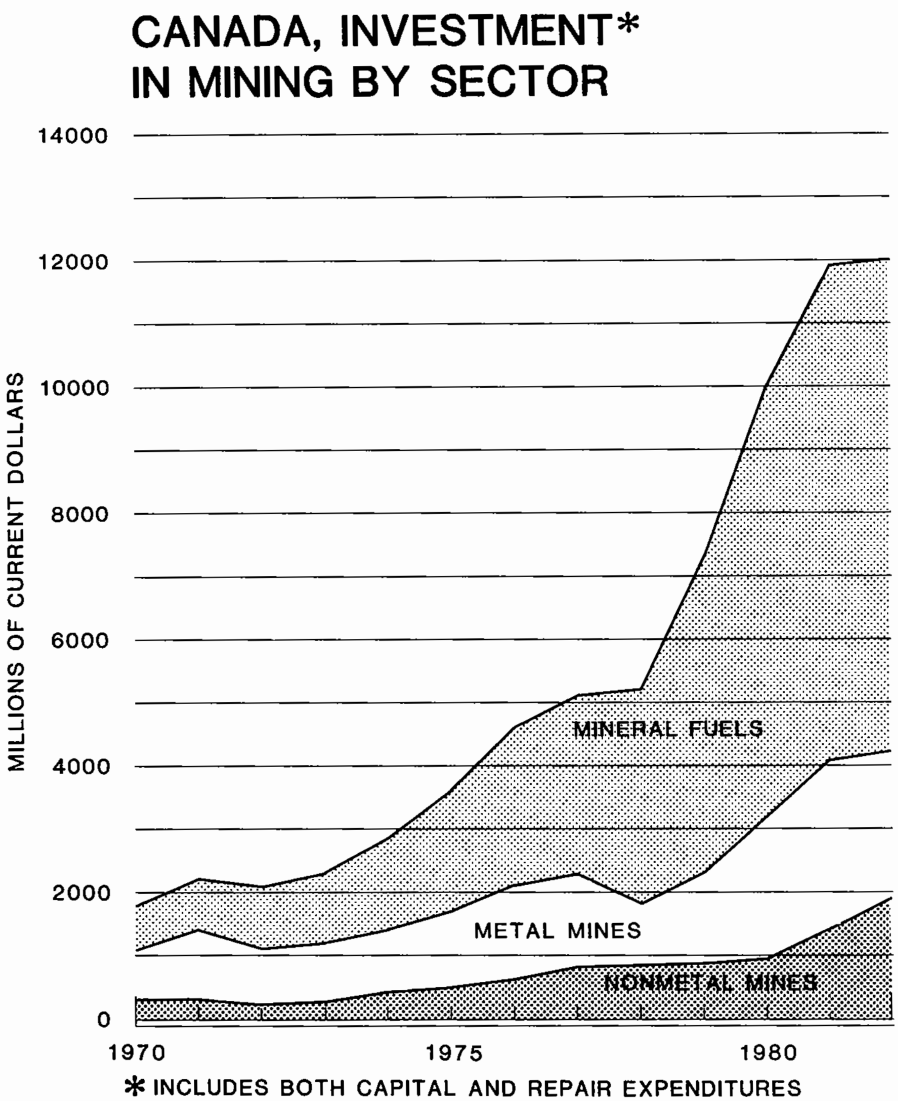

CANADA, INVESTMENT*
IN MINING BY SECTOR
14000
12000
10000
8000
6000
4000
2000
0
MILLIONS OF CURRENT DOLLARS
MINERAL FUELS
METAL MINES
NONMETAL MINES
1970
1975
1980
* INCLUDES BOTH CAPITAL AND REPAIR EXPENDITURES

Figure 9

profits to tumble. Many mining companies in North America reported massive losses in 1982, following a poor financial performance the previous year.

In attempts to cut costs companies reduced capital spending plans and postponed new developments. Statistics Canada reported a sharp revision downwards in their mid-year survey of capital expenditures plans. Predictions of a 21 per cent increase in capital spending in mining early in the year were reduced to an increase of 9 per cent for a total of $10.3 billion. Expenditures in exploration were cut back in all areas except for gold. A major gold project at Detour Lake in Ontario slated to come on-stream in August 1983, was ahead of schedule, providing some relief to the gloom, but in other areas such as iron ore exploration was at a standstill.

Further attempts at cost cutting resulted in the number of unemployed miners in Canada, approaching 55,000. Several mining communities, totally dependent on mining operations were especially hard hit.

A federal/provincial conference of Ministers of Mines held early in the year set up task forces to alleviate some of the problems. One such Task Force on mining communities addressed the short-term problems of creating immediate employment through community improvement projects and changing the eligibility criteria for unemployment insurance benefits. It also recognized the need for more pervasive long range programs for communities subject to such cyclical swings.

As a major contributor to the record merchandise trade surplus in 1982, mineral exports reached $24.3 billion representing 29.7 per cent of total domestic exports. Of that total, 70 per cent went to the United States, by far the largest market for Canadian products. The countries of Japan, the United Kingdom and the European Economic Community (excluding the United Kingdom) represented 7.5, 5.1 and 6.5 per cent of the total respectively.

Total mineral imports reached $13.2 billion, 19.5 per cent of total imports of all products. The United States provided the largest source, representing 51 per cent of the total.

OUTLOOK

For many years Canada has been the world's largest exporter of minerals, the value of which has contributed almost 30 per cent of total export earnings. Dependent on international markets, the health of the mining industry will improve when recovery in economic activity in the western industrialized countries occurs. The Organization for Economic Cooperation and Development (OECD), whose 24 members include such major industrial countries as the United States, the United Kingdom, Japan, West Germany, France, Italy and Canada, has taken a somewhat pessimistic view about the timing and length of a general world recovery. The average growth in output of the members increased less than 0.5 per cent in 1982 and predictions for 1983 suggest a modest 2.0 to 2.5 per cent growth. With the United States being the principal customer for Canadian mineral products, economic recovery there is necessary before a turnaround occurs in Canada. Indicators do not suggest any imminent significant upturn in the United States in the short term and even when it occurs, there will be a time-lag of six to nine months before such an improvement will be felt elsewhere. A relaxation of the tight monetary policy in the last half of 1982 which resulted in a steady drop in interest rates helped improve growth prospects somewhat, but a severe decrease in employment in the latter part of the year caused a low level of consumer spending and hence contracting growth.

With the cost of fighting inflation, namely an increasing unemployment rate, becoming a serious issue in many countries, the pressure on the United States to further cut short-term interest rates will be strengthened. Economists are anticipating that a consumer-demand led recovery will occur by mid-1983 in the United States and hence late 1983, early 1984 in Canada. A slow cautious improvement in the pace of production will follow after inventories of manufactured goods have been reduced and unused capacity has been put back to work.

Predictions of a very modest growth rate in GNP in Canada in 1983 of 1.0 to 2.0 per cent are being made. Unemployment will average just above 12 per cent, but will gradually decline toward the end of the year and inflation will drop to an average 7.5 per cent. Feelings that the recession has bottomed out are becoming more and more prevalent but there is almost universal uncertainty about the length of that recovery.

Aggravating the problems are such issues as the rapid change in the oil supply and demand situation. The appearance of a considerable surplus due to the recession and its dampening of business activity, success in conservation efforts and new discoveries created an instability in the oil market and havoc in most macroeconomic forecasts. With no consensus on pricing within OPEC, fears of a price cutting war caused turmoil in western oil markets forcing delays in many projects and creating the possibility of oil-producing nations such as Mexico or Venezuela to renege on their foreign debts. Great concern was expressed among international financial circles about the critical levels of borrowing by third world countries. Another cause for concern with the world economic crisis was the possibility of protectionism growing among previously open trading nations. At a Geneva meeting of the General Agreement on Tariffs and Trade held in November, attempts were made to prevent just such an occurrence.

In this environment, the Canadian mineral industry faces its most difficult challenge. With close to 30 per cent of Gross National Product directly related to international trade and 29.7 per cent of that trade in minerals, the industry must seek to break down these artificial barriers. At the same time, the need to increase efficiency to become more competitive in world markets is apparent. Markets are being lost to more technologically advanced competitors as profits to make needed investments have been lacking in Canada. Cost-cutting techniques in the short-term such as withdrawal from exploration will have adverse effects on the long-term future of the industry. With the nature of the mining industry based on the exploitation of a diminishing resource, the maintenance of a long-term exploration program is of great importance.

Recovery, when it does occur, will have an initial impact on those minerals that have kept close pace with demand. Zinc will show improvement quite quickly as inventory levels are low, but iron ore and molybdenum will suffer into the mid-1980s. Despite the gloom, minerals are essential industrial commodities and will continue to be needed in great quantities. A slow 1983 and a much more promising 1984 appears to be the condition facing the Canadian mining industry.

Regional Review

T.M. BUCH

The value of Canadian mineral production in 1982 reached an all-time high of $33.08 billion, slightly higher in the previous year. The output of energy commodities increased 16.4 per cent to $22.16 billion. The value of metals declined 19.0 per cent to $7.03 billion, nonmetals fell 20.4 per cent to $2.15 billion, and structural materials dropped 11.1 per cent to $1.57 billion.

The value of production for many of the non-energy mineral commodities experienced sharp declines in 1982. Of the principal metals, iron ore fell 30.7 per cent to $1.21 billion, copper 22.9 per cent to $1.18 billion and nickel 53.1 per cent to $581 million. Zinc, gold and uranium were up slightly to $1.11 billion, $929 million and $815 million, respectively.

Nonmetals and structural materials were also down from 1981. Potash fell 36.8 per cent to $626 million, sulphur 7.3 per cent to $600 million and asbestos 26.5 per cent to $403 million. Cement decreased 8.3 per cent to $610 million and sand and gravel declined 10.4 per cent to $464 million.

Newfoundland

The impact of the worldwide decline in economic activity and the resultant reduction in demand for mineral products was strongly felt in Newfoundland. The total value of mineral production in 1982 was $626 million, down 39.3 per cent from 1981. Production of iron ore, which normally accounts for over 85 per cent of the total value of provincial output, fell 37.0 per cent to $558 million.

Exploration had been expanding actively over the past several years, partly in response to geoscientific information released from federal-provincial mineral development agreements and changes in land tenure legislation, which had opened huge areas of the province for staking. The current economic restraint by companies, however, removed some of the impetus of this expansion in 1982. About 4,600 claims were staked in 1982 compared with more than 13,000 the previous year, and 19,000 claims were in good standing at year-end compared with 26,000 in 1981.

Sharp declines in steel demand in both the United States and Europe led to extended summer shutdowns in the province's iron ore production facilities in Labrador. The Wabush Mines iron mine was closed for 10 weeks, and the Iron Ore Company of Canada closed the Labrador City pellet plant and the Carol project for six weeks.

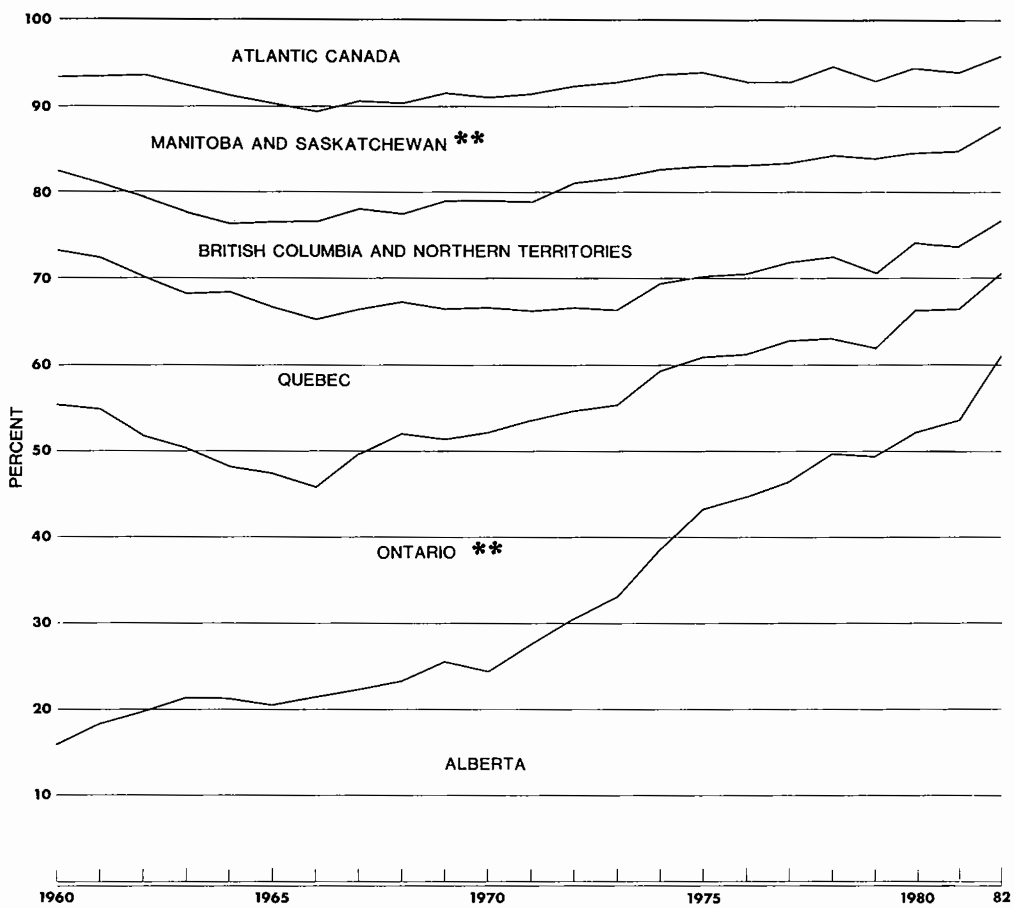
Mining operations at the copper-gold-silver property of Consolidated Rambler Mines Limited at Baie Verte were suspended on April 30, 1982, and ASARCO Incorporated's Buchans mine was put on standby at year-end.

The Advocate Mines Limited asbestos mine at Baie Verte closed at the end of 1981. After months of negotiations with the owners, Johns-Manville Canada Inc. and Cie Financière Eternit SA (Eternit), the Newfoundland government expropriated the mine, and ownership was then obtained by Transpacific Asbestos Inc. with the aid of a $14 million loan and loan guarantees from the federal government. Transpacific rehabilitated the mine and began shipments of asbestos in October.

The five-year, $12.2 million Canada-Newfoundland Mineral Development Subsidiary Agreement came to an end on March 31, 1982. Under this Agreement, geological mapping and geochemical surveys were carried out over large areas of insular Newfoundland and Labrador. Core storage facilities were built at St. John's, Deer Lake, and Goose Bay and equipped with rock slicing tools and instruments for petrographic analysis.

To maintain the continuity of effort in developing the geoscientific data base of the province, the Geological Survey of Canada

PROPORTIONAL SHARE OF MINERAL PRODUCTION BY PROVINCE AND REGION, 1960-1982*



*Based upon current dollar production data

**Does not include uranium prior to 1977 commenced on April 1, 1982, a two-year, $3.4 million program in coordination with a $660,000 provincial program. Together, federal and provincial geoscientists are extending bedrock mapping, carrying out studies near known mineral deposits at Buchans and continuing the geochemical program.

Nova Scotia

The value of mineral production in Nova Scotia increased 8.7 per cent in 1982 to $292 million. The value of coal rose sharply by 32.3 per cent to $170 million but salt decreased 15.7 per cent to $31 million and gypsum 5.8 per cent to $28 million. Nova Scotia is first in Canada as a producer of gypsum, second in salt and third in coal.

Expansion of coal production capacity continued in 1982. The development by Cape Breton Development Corporation (DEVCO) of the offshore Donkin-Morien coal deposits is on schedule, with first production expected in 1985 and a planned output of 3 million tpy by 1990. Novaco Limited, a provincial Crown corporation responsible for mining surface coal to supply Nova Scotia Power Corporation, is developing a new mine at Springhill for production in 1983.

In October, Rio Algom Limited purchased Shell Canada Resources Limited's East Kemptville tin property, estimated to contain 36 million t grading 0.22 per cent tin. Discovery and evaluation of this deposit has generated renewed interest in prospecting in the geological environment in which the deposit is situated.

Preliminary reports indicate that mineral exploration in Nova Scotia may have dropped by as much as 80 per cent from 1981, when approximately $15 million was spent. Low metal demand, the withdrawal of several petroleum companies from the mining sector, and a moratorium on uranium exploration were the main causes for the decline.

Uranium exploration in Nova Scotia has been curtailed since the fall of 1981, when a moratorium was imposed by the provincial government. In January 1982, Justice Robert McCleave was appointed to conduct an inquiry into uranium exploration and development. Briefs were accepted in the initial phase of the inquiry.

During the first full year of the Canada-Nova Scotia Cooperative Mineral Agreement, approximately $1.7 million was committed by the federal Department of Energy, Mines and Resources and the provincial Department of Mines and Energy to coordinated programs. Included were geological studies on the gold-bearing deposits in Guysborough County, geophysical and geochemical surveys, the construction of core library facilities at Stellarton and process testing of gold-bearing samples.

New Brunswick

The value of mineral production in New Brunswick declined 2.7 per cent in 1982 to $517 million, primarily because of a decline of zinc output by 2.9 per cent to $265 million, and of lead by 11.6 per cent to $59 million. New Brunswick is Canada's second largest producer of zinc and third of silver. The effect of the recession on New Brunswick's mineral industry was relatively less severe than in other provinces because it resulted in no major shutdowns or layoffs in 1982.

Two potash mines are being developed, and a third deposit is being explored. The Potash Company of America (PCA) is expected to begin production in early 1983 at its $140 million project. Denison Mines Limited and Potash Company of Canada Limited will have nearly completed their $200 million project by the end of 1983. A total of over 500 new jobs are expected when both projects are fully operational.

The start-up of milling operations at the Mount Pleasant tungsten mine of Brunswick Tin Mines Limited and Billiton Canada Ltd., which was scheduled for September 1982, has been delayed to early 1983, partly because of labour disputes. The project is expected to cost $120 million and require about 250 permanent employees.

The construction of the $360 million zinc reduction plant at Belledune, which was scheduled for start-up in May 1982, has been deferred until economic conditions improve. Low metal prices have reduced the profitability of Brunswick Mining and Smelting Corporation Limited and Heath Steele Mines Limited, both subsidiaries of Noranda Mines Limited, which will be supplying concentrate to the smelter. About 400 jobs would have resulted.

The New Brunswick government announced that it intends to spend $3 million to keep Heath Steele Mines Limited operating until April 1983. The company had previously indicated that it would close its mine in November unless there were improvements in the price of copper, zinc, lead and silver.

Quebec

The Quebec mining industry experienced the full effect of the world recession in 1982. The value of mineral production fell 17.1 per cent from $2.42 billion in 1981 to $2.01 billion. The value of all of the principal minerals, except for gold, fell sharply. In particular, the value of production of iron ore fell 25.6 per cent to $446 million, asbestos 22.6 per cent to $325 million and copper 11.1 per cent to $177 million. Gold was the only bright spot in the Quebec mineral industry, rising 13.1 per cent to $347 million. The unemployment rate among miners was about 50 per cent, making mining one of the industries most severely affected by the recession.

The Iron Ore Company of Canada will close permanently its Knob Lake division at Schefferville in July 1983. About 285 workers will be laid off at Schefferville, and an estimated 500 workers will lose their jobs in Sept-Iles, as a result of the closure. Lack of demand for the type of ore produced at Schefferville was given by the company as the reason for closing the mine. The two other Quebec iron ore producers temporarily shut down in November, resulting in the layoff of about 2,600 workers.

Asbestos production has been affected not only by the world economic recession but also by adverse publicity and regulations limiting its use. The quantity of asbestos fibre produced in 1982 declined 23.9 per cent to 731 million t from the previous year. The result has been numerous shutdowns and the lay-off of thousands of workers, depressing the asbestos-producing region in the Eastern Townships of Quebec. The situation is not expected to improve soon because inventories are high and demand is weak.

Two base-metal mines closed because of ore exhaustion. In June, Madeleine Mines Ltd. closed its Gaspé copper mine after an extensive exploration program failed to locate additional ore. In October, Northgate Exploration Limited shut down its Lemoine zinc-copper-gold mine near Chibougamau.

In March, Belmoral Mines Ltd. was acquitted of charges of criminal negligence in the deaths of eight miners in the May 1980 cave in at the company's Ferderber gold mine near Val d'Or. The Quebec Crown prosecutor has appealed the verdict, which appears to contradict the conclusions of the provincial commission of inquiry.

Two mines opened in 1982. In September, Seleine Mines Inc. started up production at its salt deposit on Magdalen Island, developed at a cost of about $80 million. In November, Exploration Aiguebelle Inc. began shipping ore from its Dest-Or property to the Louvem mill at a rate of 300 tpd, to be increased to 600 tpd by February.

Ontario

The value of production of the Ontario mineral industry fell 23.7 per cent in 1982, compared with the previous year. The value of metals fell sharply, led by nickel, down 58.9 per cent to $413 million, and copper, down 32.7 per cent to $336 million. The value of uranium was $551 million, up 4.7 per cent from 1981.

Gold is currently the active sector of industry, with some of the most promising exploration activity around Hemlo, a settlement 270 km east of Thunder Bay. Since 1980, Corona Resources Ltd. has been exploring on its property and has delineated over 285 000 t grading 4.35 g/t. Agreement was reached with Teck Corporation for further exploration, and a 700 tpd mining operation is being considered.

A number of exploration programs were initiated in the vicinity of the Corona property, resulting in several discoveries. Two of the most promising discoveries are on properties held by the Goliath Gold Mines Ltd./Golden Sceptre Resources Ltd. joint venture, reported to contain 2.5 million t at 8.54 g/t, and by Lac Minerals Ltd. In November, Noranda Mines Limited signed an agreement concerning the Goliath/Golden Sceptre deposit, whereby Noranda could spend $20 million to put the property into production by 1984 and up to $10 million to adapt its Geco concentrator, 50 km to the north, to process ore from the property.

Conditional grants of up to $1 million each may be made to five companies to build custom gold mills in northern Ontario under the Government of Ontario's 'GOMIL' custom milling incentive program. The first of these grants was made in March 1982 to Pancontinental Mining (Canada) Ltd. on the site of the old Northern Empire mine at

TABLE 1. CANADA, PROVINCES AND TERRITORIES, LEADING MINERALS, 1982P

	Value of production ($ million)	Proportion of total (%)	Change from 1981 (%)
Newfoundland			
Iron ore	558.5	89.2	-37.0
Zinc	28.2	4.5	-41.0
Asbestos	9.6	1.5	-81.4
Total	625.9	100.0	-39.3
Prince Edward Island			
Sand and gravel	2.1	100.0	31.3
Total	2.1	100.0	31.3
Nova Scotia			
Coal	170.0	58.2	32.3
Salt	31.0	10.6	15.7
Gypsum	27.7	9.5	-6.1
Cement	27.7	9.5	-12.1
Total	261.9	100.0	6.2
New Brunswick			
Zinc	265.4	51.4	-2.9
Silver	76.3	14.8	-2.4
Lead	59.3	11.5	11.6
Copper	25.0	4.8	-6.0
Total	516.7	100.0	-2.7
Quebec			
Iron ore	446.3	22.2	-25.6
Gold	346.9	17.3	13.1
Asbestos	325.0	16.2	-22.6
Copper	176.7	8.8	-11.2
Total	2,006.1	100.0	-17.1
Ontario			
Uranium	550.6	17.4	4.7
Nickel	412.9	13.0	-58.9
Copper	336.3	10.6	-32.7
Gold	293.9	9.3	-9.1
Total	3,173.1	100.0	-23.7
Manitoba			
Nickel	168.1	32.9	-28.3
Copper	93.3	18.2	-24.7
Petroleum	85.9	16.8	33.6
Zinc	34.6	6.8	-26.7
Total	511.4	100.0	-20.4
Saskatchewan			
Petroleum	1,066.8	48.7	29.6
Potash	625.7	28.6	36.8
Uranium	264.6	12.1	-1.4
Total	2,191.0	100.0	-4.4
Alberta			
Petroleum	10,124.0	50.2	21.9
Natural gas	6,659.1	33.0	11.1
Natural gas byproducts	2,117.7	10.5	2.7
Total	20,155.4	100.0	14.8

TABLE 1. (cont'd)

	Value of production ($ million)	Proportion of total (%)	Change from 1981 (%)
British Columbia			
Coal	635.0	22.3	17.4
Copper	520.4	18.3	-18.4
Natural gas	337.0	11.9	1.4
Petroleum	324.5	11.4	35.9
Total	2,841.7	100.0	3.3
Yukon Territory			
Zinc	63.3	37.7	-32.8
Gold	42.4	25.3	25.1
Lead	26.0	15.5	-52.6
Total	167.9	100.0	-28.7
Northwest Territories			
Zinc	297.9	49.8	86.5
Gold	103.2	17.2	20.7
Lead	58.9	9.8	31.8
Total	598.6	100.0	33.8
Canada			
Petroleum	11,627.9	35.1	23.0
Natural gas	7,081.7	21.4	10.3
Natural gas byproducts	2,154.7	6.5	2.7
Coal	1,297.8	3.9	21.0
Iron ore	1,211.7	3.7	-30.7
Copper	1,179.8	3.6	-22.9
Zinc	1,108.7	3.4	1.8
Gold	929.4	2.8	0.8
Uranium	815.2	2.5	2.6
Potash	625.7	1.9	-36.8
Total	33,081.9	100.0	2.3

P Preliminary.

Beardmore. The second grant, for an amount of $780,000, was made in November to Goldlund Mines Limited, at Sioux Lookout, to install ancillary equipment for custom milling to begin in early 1983.

In the Shebandowan area, a staking rush occurred in the spring of 1982 following reports that a Noranda subsidiary, Mattagami Lake Exploration Limited, had good results from an initial drilling program on a property owned by Band-Ore Gold Mines Limited. A number of relatively high-grade intersections were subsequently reported, and at year-end Mattagami was still evaluating the property.

Kidd Creek Mines Ltd. at Timmins started mining its Owl Creek gold property in the spring, processing the ore in batches through its existing concentrator.

At Detour Lake, 140 km northeast of Cochrane, the Amoco-Dome-Campbell Joint Venture is expected to begin open-pit mining and milling at a rate of 2 000 tpd by October 1983, and to double that rate in 1987 when underground mining begins. The $29 million provincially funded road to Detour Lake was nearing completion at year-end. Fifteen junior companies were reported to be active in the vicinity.

A new shaft is being sunk by Willroy Mines Limited at the Macassa mine at Kirkland Lake. Eventually it is to reach 2 100 m and be the deepest single-stage gold mine shaft in North America. The total cost of the project is expected to be about $30 million.

In northwestern Ontario, the Thierry mine of Umex Inc. closed in April. This 3 600 tpd copper mine had been in operation since 1976, and was the chief economic base of Pickle Lake and surrounding district.

At Cobalt, the silver refinery of Canadian Smelting & Refining (1974) Limited was acquired by Agnico-Eagle Mines Limited. Prior to the purchase, Agnico had been stockpiling concentrate. In September, the company reported that mining, milling and refining costs were about $11.75 an ounce and that silver was being stockpiled until its price rose. Also at Cobalt, Teck Corporation is planning to close the Silverfields mine at the end of February 1983.

Mineral industry activity in eastern Ontario is, for the most part, confined to the production of industrial minerals and structural materials. The Madawaska uranium mine, near Bancroft, which had reopened in 1976 to supply uranium to AGIP S.p.A., the Italian nuclear agency, was placed on a stand-by basis in July.

At Sudbury, the workers at Inco Limited's operation began a strike May 31 that lasted 32 days. However, because of continued low demand for nickel, depressed prices, and excess nickel inventory the company several times postponed the reopening after the strike was settled. At the end of November, Inco announced that the workforce at Sudbury will begin to resume operations on April 4, 1983 and that 1,050 workers will be permanently laid off. Inco's deliveries of nickel for the first nine months of 1982 were 86 million kg, down 30 per cent from the same period last year.

Also at Sudbury, Falconbridge Limited closed its operations from June 26 to January 2, 1983. The workforce was reduced from about 4,000 to 2,600. In the first nine months the company reported selling 14 million kg of nickel, 41 per cent less than the same period a year ago.

Several federal-provincial initiative programs are in place to assist the mineral industry through the provision of information. Under the Canada-Ontario Community and Rural Resource Subsidiary Agreement, $2.2 million has been spent since 1978 under the Kirkland Lake Initiative Program, which has resulted in considerable exploration activity.

The Canada-Ontario Eastern Ontario Subsidiary Agreement was signed in 1980. Under it, $4 million was for geoscientific work that includes Precambrian and Quaternary mapping, delineation and assessment of aggregate resources, and mineral deposit studies. Graphite, calcite and mica deposits have been examined. An airborne gradiometer survey is to be carried out on part of the Grenville basement in 1983.

Community-based geological surveys at Ignace and Wawa and geological work in the Beardmore area have been funded under the Canada-Ontario Northern Ontario Rural Development Agreement (NORDA). Resource diversification projects that are financially assisted under the same Agreement include a silica study near Sudbury and a gold heap-leach demonstration project near Larder Lake.

Manitoba

Mineral production in Manitoba in 1982 was valued at $511 million, down 20.4 per cent from 1981, led by nickel, which fell 28.3 per cent to $168 million, and copper, which dropped 24.7 per cent to $93.3 million. Gold increased by 3.5 per cent to $24 million and petroleum by 33.6 per cent to $85.9 million.

Layoffs and shutdowns took place throughout the Manitoba mineral industry during 1982. Operations of Inco Limited at Thompson were shut down in November, affecting 2,100 employees, but are expected to resume at the end of January 1983. Sherritt Gordon Mines Limited at Lynn Lake and Leaf Rapids terminated 343 employees during 1982. Tantalum Mining Corporation of Canada Limited has announced that its Bernic Lake mine will remain closed for at least one year. Hudson Bay Mining and Smelting Co., Limited resumed production August 23 following an eight-week shutdown of its Flin Flon and Snow Lake operations, which affected about 2,600 employees.

The only primary producer of gold in Manitoba, Brinco Mining Limited at Bisset, has a more positive outlook as a result of improvement in the price of gold since August. The mine opened in early 1982 at a

TABLE 2. EMPLOYMENT STATISTICS IN MINING[1] BY PROVINCE, 1980-82

		Nfld	NS	NB	PEI	Que	Ont	Man	Sask	Alta	BC	YT & NWT	Canada
Mining employ't[1] 1980	'000	5.6	5.0	2.6	..	25.8	33.4	5.9	8.7	63.1	16.9	3.2	170.2
% of total province		4.1	1.9	1.3	..	1.2	1.0	1.7	3.2	7.3	1.7	8.4	1.9
Total prov. employ't[2]	'000	137.4	259.4	199.0	31.8	2,219.2	3,486.5	355.6	274.6	866.2	1,009.0	38.3	8,877.0
Mining employ't[1] 1981	'000	5.6	4.7	3.1	..	24.0	35.6	5.8	9.6	67.5	18.3	3.8	178.0
% of total province		4.0	1.8	1.5	..	1.0	1.0	1.6	3.4	7.3	1.8	9.4	1.9
Total prov. employ't[2]	'000	140.3	264.9	203.8	31.1	2,282.0	3,603.5	368.7	283.9	931.3	1,038.9	40.2	9,188.6
Mining employ't[1] 1982	'000	4.1	5.3	3.1	..	20.2	28.8	4.9	9.3	59.8	16.2	3.9	155.6
% of total province		3.0	2.1	1.6	..	0.9	0.8	1.4	3.3	6.5	1.7	10.1	1.8
Total prov. employ't[2]	'000	136.4	252.8	198.4	29.7	2,160.2	3,532.7	361.3	281.8	917.2	979.5	38.7	8,888.7

Source: Statistics Canada.
[1] Mining, including milling, unadjusted. [2] Total non-agricultural employment, unadjusted.
.. Amount too small to register.

rate of about 100 tpd and was later increased to 500 tpd. Ore reserves are estimated at 800 000 t grading 6.4 g/t.

The chromite deposits in the Bird River area attracted attention during the summer. Their extent is being jointly evaluated by the provincial Department of Energy and Mines and the Geological Survey of Canada. During 1982, samples were collected and analyzed to determine the feasibility of using a gradiometer to delineate the chromite seams.

The effect of the recession has been serious on mining communities in Manitoba. Several mining communities are being affected, and in particular Lynn Lake is being threatened by depletion of Sherritt's Fox copper mine, whose life is estimated to be only five more years. Extensive studies have been conducted in the area by the company and the federal and provincial governments to identify possible new deposits.

Saskatchewan

The value of mineral production in Saskatchewan declined 4.4 per cent to $2.19 billion in 1982. Potash output fell 36.8 per cent to $626 million, but crude petroleum rose 29.6 per cent to $1.07 billion. The value of uranium shipments in 1982 was $265 million, down slightly from last year. Saskatchewan produces all of Canada's potash, almost all of its sodium sulphate and 33 per cent of its uranium, and is a large producer of crude petroleum and coal.

Events in the uranium sector continued to dominate the Saskatchewan mineral industry in 1982. On June 30, Eldorado Nuclear Limited permanently closed its Beaverlodge operations at Uranium City, affecting 830 employees; about 130 remain employed until June 1983 for reclamation work.

Key Lake Mining Corporation expects to start production by mid-1983 at its $500 million uranium mine development, despite a three-month labour dispute of construction tradesmen. Some 5 200 t U has been contracted to Ontario Hydro, reportedly valued at over $380 million; this will cover one-third of Hydro's requirements from 1985 to 1993.

Eldorado Nuclear Limited has acquired sole ownership of the Rabbit Lake mining operations (now Eldorado Resources Limited) and several properties that were previously held by Gulf Minerals Canada Limited and Uranerz Canada Limited. Eldorado proposes to develop the nearby Collins Bay 'B' deposit to supply ore to the concentrator once the Rabbit Lake orebody is exhausted.

Amok Ltd. completed the mining and stockpiling of high-grade ore from the 'D' orebody in 1981 and has begun evaluating other lower-grade deposits in the area to serve as a source of ore when the stockpile is depleted by 1985.

Depressed uranium markets contributed to the suspension of plans for other potential uranium developments in northern Saskatchewan, such as the Midwest Lake project of Esso Minerals Canada, which has been deferred to at least the late 1980s.

Although most of the exploration in northern Saskatchewan in recent years has been for uranium, some interest has been shown in base-metals and gold. Near Flin Flon, Flin Flon Mines Ltd. has been developing two small gold mines and a mill, and Gränges Exploration AB has discovered a copper-zinc deposit that has produced cores indicating high-grade mineralization.

The lagging potash sales and increasing inventory that began in the last quarter of 1981 continued throughout 1982. This resulted in intermittent production cutbacks and layoffs, usually of short duration and often in conjunction with vacations, planned maintenance and mine development. The two-month summer shutdown at the Cory, Allan, Rocanville and Lanigan mines of Potash Corporation of Saskatchewan had the greatest impact, affecting about 1,200 employees.

Kalium Chemicals Division of PPG Industries Canada Ltd. and Potash Company of America became members on July 1 of Canpotex Limited, the producer offshore marketing agency. All Saskatchewan producers are now members of this agency.

Alberta

The value of mineral production in Alberta increased 14.8 per cent to $20.16 billion in 1982, chiefly because of higher prices for crude petroleum, natural gas and natural gas byproducts. The value of elemental sulphur decreased 7.3 per cent to $580 million, while coal output rose 20.6 per cent to $393 million, despite production cutbacks. Alberta produces 87.1 per cent of Canada's fossil fuels and 96.7 per cent of its elemental sulphur.

Events concerning coal mining dominated the non-petroleum mineral industry in 1982. In the west central Alberta coalfields, two mines were shut down for several weeks because of reduced demand for coal caused by the world economic recession. Work is under way on the new Gregg River Coal Ltd. mine, which will begin shipping coking coal to Japanese markets in 1983. Norcen Energy Resources Limited purchased a 40 per cent interest in the 3 million tpy Obed Marsh thermal coal project, which may facilitate its development for late-1984. The Alberta government approved in principle the preliminary disclosure statement of Esso Minerals Canada for the possible development of a 3 million tpy thermal coal mine for the late 1980s. Manalta Coal Ltd. applied for permits to develop its McLeod River and Mercoal thermal coal properties to produce 2.2 and 4.2 million tpy, respectively, for production in the mid-1980s depending on market conditions.

In the south, near Lethbridge, Petro-Canada is in the early stages of pre-development of an underground thermal coal mine on its Kipp property, and nearby, Fording Coal Limited is similarly evaluating its Shaughnessey thermal coal property.

In the central region, near Edmonton, Forestburg Collieries Limited filed a preliminary disclosure statement with the provincial government for a 182 000 tpy mine to supplement production from its nearly depleted Diplomat mine, to supply coal to Alberta Power Limited's Battle River generating station.

The Alberta government turned down a proposal by Fording Coal and TransAlta Utilities Corporation to develop a 10 million tpy thermal coal mine and 2,000 megawatt generating station, 72 km northeast of Red Deer, because of a potentially adverse impact on area farms and water supplies. The power from this project was to have been exported to the United States.

British Columbia

British Columbia is third in the value of mineral production in Canada at $2.84 billion in 1982, which was 3.3 per cent higher than the previous year. The value of copper fell 18.4 per cent to $520 million, but coal increased 17.4 per cent to $635 million. Higher prices caused the value of natural gas and crude petroleum to increase to $337 million and $324 million, respectively. British Columbia is Canada's largest producer of copper, coal, molybdenum and lead.

Coal was the most active sector of the British Columbia mineral industry in 1982, mainly because of the northeast coalfields megaproject. The $850 million Quintette Coal Limited project, controlled by Denison Mines Limited, and the $300 million Bullmoose project of Teck Corporation, are scheduled to be producing at a rate of 6.3 and 1.7 million tpy, respectively, of metallurgical and thermal coal by late-1984. David Minerals Ltd. has a provisional agreement to sell 300 000 tpy of bituminous coal over 10 years from its Willow Creek property, starting in late 1983. Petro-Canada is seeking approval from the provincial coal guidelines steering committee for a proposed 3.3 million tpy coal mine in the Monkman Pass area. BP Canada Inc. has decided not to proceed to develop its proposed $150 million, 1.2 million tpy Sukunka underground thermal and coking coal mine, because of insufficient markets.

In the southeast region of the province, Sage Creek Coal Limited is continuing efforts to find sufficient markets that will enable it to develop its Sage Creek thermal coal property at a cost of $215 million, to produce 2.2 million tpy. In February, Crows Nest Resources Limited began initial shipments, which will rise to 2 million tpy, from its new $300 million Line Creek coking and thermal coal mine. B.C. Coal Ltd. shut down its Balmer metallurgical coal mine from September 18 to November 8 because of excess inventories, affecting about 1,500 employees. On the lower mainland at Roberts Bank, the company has nearly completed an expansion of the capacity of its terminal facilities to 22 million tpy.

On Vancouver Island, Quinsam Coal Ltd. has proposed the development of a 900 000 tpy thermal coal mine on its property near Campbell River.

The metal mining sector in British Columbia struggled through a year of mine shutdowns and layoffs that affected nearly every operation. In the Stewart area, Amax of Canada Limited shut down its Kitsault molybdenum mine in November for a three-month period. Canada Wide Mines Ltd. has kept its Granduc copper mine operating in anticipation of higher copper prices but has delayed a planned expansion of output.

Near Babine Lake, Noranda Mines Limited closed its Granisle copper mine on July 2 for one year and its Bell copper mine on October 29 for an indefinite period, affecting a total of about 630 employees from both mines.

Near Fraser Lake, Placer Development Limited suspended indefinitely in June both mining and concentrating at its Endako molybdenum operation, though roasting will continue on a reduced scale.

In the Williams Lake area, Noranda operated at half capacity its Boss Mountain molybdenum mine. Placer suspended mining operations at its Gibraltar copper mine on July 1, but will continue to process stockpiled ore.

In the Highland Valley area, Teck Corporation closed its Afton copper mine for an indefinite period in June. Craigmont Mines Limited permanently ceased operations at its copper mine because of ore depletion. Bethlehem Copper Corporation suspended operations from June until March 1983, when mining will resume, using ore from the Lake Zone deposit that is currently being developed.

Near Hope, Carolin Mines Ltd. closed its Ladner Creek gold mine from April 8 to June 17 for modifications intended to prevent the discharge of hazardous wastes into waterways.

Yukon

Extended shutdowns of two of the Yukon's three base-metal mines caused the value of mineral production to fall 28.7 per cent to $168 million, led by zinc, down 32.8 per cent to $63 million, and lead, 52.6 per cent to $26 million. The effect on the Yukon economy of the shutdowns has been disastrous, because in recent years mining has accounted for 32 per cent of the gross territorial product, 20 per cent of wages and salaries, and 13 per cent of total employment.

Mineral exploration expenditures in the Yukon for 1982 are estimated at $13 million, or only about one-third of the 1981 expenditures of $40 million.

Whitehorse Copper, the only base-metal mine continuously operating throughout the year, closed at year-end because of ore reserves depletion.

On June 4, 1982, the Faro lead-zinc mine of Cyprus Anvil Mining Corporation (CAMC) shut down temporarily to curb operating deficits, but at the end of the year the mine was still closed despite cost reduction efforts. A joint communiqué was signed in Whitehorse on October 6 by the federal government, CAMC, the Yukon government, and the United Steel Workers, which called for concessions from all parties involved so that an early reopening of the mine can be achieved.

The Elsa silver mine of United Keno Hill Mines Limited was shut down for an indeterminate period in July 1982. Except for a small security crew the workforce was terminated, leaving the town of Elsa virtually empty.

There was some good news for the Yukon economy with the announcement that Yukon Barite Company Ltd. received a two-year contract to supply barite to Gulf Canada Limited for use in Beaufort Sea drilling at a minimum annual rate of 4 500 t. The barite ore will be processed at a crushing plant at Ross River and then shipped by truck to Tuktoyaktuk or Inuvik. The first deliveries are expected in January.

The placer mining gold rush that started in 1978 had ended by mid-1982 because of falling gold prices. The regional office of the Department of Indian Affairs and Northern Development (DINA), along with the Departments of Environment and Fisheries and Oceans, is developing Yukon placer mining guidelines, which will be subject to public review and comment during 1983.

In the MacMillan Pass area on the Yukon/Northwest Territories border, mineral exploration and development activity decreased in 1982. Amax of Canada is considering a mid-1986 production target at its Mactung tungsten project and is consulting with all interested parties. The holders of the Tom and Jason lead-zinc deposits in the same area have deferred development because of depressed metal markets.

Comprehensive land claim negotiations between the Council for Yukon Indians (CYI) and the federal government were held during 1982, and much progress was made. In November, DINA organized a symposium where the CYI met with senior executives of the mining industry to discuss possible means for future direct native involvement in the minerals industry.

The Yukon government formulated and announced a land use planning policy in 1982, based on the federal government's land use policy established in 1981.

The Territorial Coal Regulations are being drafted by DINA, and following a final review by the Northern Mineral Advisory Committee, are expected to be enacted in early 1983.

Northwest Territories

The value of mineral production in the Northwest Territories rose 33.8 per cent in 1982 to $599 million, mainly because of higher production for zinc and lead. These increased in value 86.5 per cent to $298 million and 31.8 per cent to $59 million, respectively. Gold increased in value 20.7 per cent to $103 million. These sharp increases were largely because of several mines coming on-stream during 1982. It is estimated that exploration declined to $25 million from $50 million in 1981.

Three new mines came on-stream in 1982 and two old producers were reactivated. Cominco Ltd.'s Polaris lead-zinc mine, on Little Cornwallis Island, started in January, and Echo Bay Mines Ltd.'s gold mine began production in the spring. Terra Mines Ltd. brought the Smallwood silver mine into production and reactivated the Norex and Silver Bear silver mines at year-end.

The Prairie Creek lead-zinc-silver deposit of Cadillac Explorations Limited was scheduled for production in 1982, but cost overruns on the concentrator construction and changing economics have caused a deferral of the start of production. Declining silver prices and processing problems have forced the company to change plans from producing a copper-silver concentrate, which could be shipped by air, to a lead-silver concentrate, which must be shipped by land and will require construction of an all-weather road.

If the price of gold shows sustained strength, it is expected that Giant Yellowknife Mines Limited's Salmita deposit and Cominco Ltd.'s Ptarmigan deposit will be brought into production in 1983.

On January 2, 1983, Pine Point Mines Limited suspended its operations until the price of lead and zinc improves sufficiently. About 600 employees are affected as well as the community of Pine Point, whose population of 2,000 is dependent upon the mine. Employees are being permitted to remain in company lodging for the time being. The company has asked the union for about $2 million in contract concessions in order to facilitate reopening the mine.

As a direct result of a referendum in the Northwest Territories, the federal government has agreed to separate the Northwest Territories into two political entities, subject to a number of pre-conditions, the primary one being the settlement of Comprehensive Land Claims by the Inuit and Indians.

The Government of the Northwest Territories released a Resource Development Policy in early 1982, followed in October by guidelines and criteria for its application. When implemented, it will require a public review of the exploration, development, and production phases of all non-renewable resources, including minerals, although at present there is no legislative basis requiring compliance.

The negotiation of land claims between the Committee for Original Peoples Entitlement and the federal government resumed at the end of the year, when Simon Reisman was appointed as the new federal negotiator. The negotiation of land claims continued between the Tapirisat Federation of Nunavut and the federal government.

Canadian Reserves of Selected Mineral Commodities

(Data available in 1982)

J. ZWARTENDYK

Any assessment of future supply of a given mineral commodity from Canadian mines requires information on current working inventories, i.e., on the amounts of ore known to be present in operating mines and on additional known tonnages in deposits that are close to being mineable profitably. The tonnages that - in 1982 - were fairly well delineated and judged to be economically mineable are reported below as "reserves". The limits of what is included in reserves are further specified in each case.

(A)	**Copper**	15 815 100 t[1]
	Nickel	8 013 300 t
	Lead	10 244 400 t
	Zinc	29 505 300 t
	Molybdenum	514 400 t
	Silver	32 154 t
	Gold	842 215 kg

The quantities of the metals listed above are contained in ore economically recoverable from producing mines and from deposits that had been committed for production up to January 1, 1982. These quantities represent measured and indicated tonnages and exclude inferred tonnages.

[1] The term "tonne" refers to the metric ton of 2 204.62 pounds avoirdupois.

(B) Iron 2 400 million t

This is the quantity of iron contained in known crude ore in producing mines and properties under development[2]. Ore in undeveloped deposits is not included.

(C) Asbestos 45.7 million t

This represents the fibre content (on average, a little over 5 per cent) of 843 million t of economically mineable ore reserves in producing mines.

(D) Potash 14 000 million t (K_2O equivalent), corresponding to 23 000 million t KCl product (standard fertilizer - exported product).

This amount would be recoverable by conventional mining (to a depth of about 1 100 m) from known potash deposits. At least an additional 42 000 million t (K_2O equivalent) would be recoverable from known deposits by solution mining at depths beyond 1 100 m; this would represent 69 000 million t of KCl product.

[2] **MR 170, A Summary View of Canadian Reserves and Additional Resources of Iron Ore,** Energy, Mines and Resources Canada, 1977.

(E) Uranium

	"Reasonably Assured"	
	Measured	Indicated
	(t U)	
Mineable at uranium prices of:		
$Cdn.110/kg U or less	45 000	153 000
$110 to $160/kg U:	2 000	12 000

The tonnages refer to uranium contained in mineable ore[3]. Unless otherwise specified, uranium "reserves" in Canada refer to the tonnages mineable at uranium prices of $110/kg U or less.

[3] Interim figures for 1981, Energy, Mines and Resources Canada.

(F) Coal

- **Bituminous** 1 607 million t (of which 1 263 million t could be used for metallurgical purposes)
- **Sub-bituminous** 2 182 million t
- **Lignitic** 2 117 million t

These represent tonnages that could be recovered as run-of-mine coal, with current technology and at current market prices, from measured and indicated coal in deposits that are legally open to mining. For the purpose of making these estimates, it was assumed that coal sales would cover the costs of any required infrastructure not already in place[4].

[4] **ER 79-9, Coal Resources and Reserves of Canada,** Energy, Mines and Resources Canada, 1979.

Aluminum

W. McCUTCHEON

Aluminum consumption in Canada and the western world for 1982 exceeded 95 per cent of the combined consumption of copper, lead, zinc and nickel. Production of aluminum from alumina (Al_2O_3) requires large inputs of electrical energy; hence, as electrical prices increase, research has been directed to reduction of energy requirements. The weighted average of power consumption for primary metal production reported by the International Primary Aluminium Institute (IPAI) declined from 16,951 kWh/t to 16,694 kWh/t from 1980 to 1982.

Canada was able to maintain a high level of aluminum production for 1982, despite continuing depressed markets. With access to low cost power and the ability to reduce inventories by selling aluminum metal in Asian markets, Canada was able to hold output to an average of 90 per cent of capacity. However, worldwide aluminum production and consumption have been falling for the past three years, the longest downturn in the history of the industry. A drastic slump in two key segments of the economy - automotive and housing - has adversely affected metal sales. In response to weakening markets and increasing energy costs, major producers, especially in the United States, Japan and the United Kingdom, have idled many hundreds of thousands of tonnes of aluminum ingot capacity, some of it permanently. World production has dropped to 72 per cent of capacity, a record low operating rate.

Although production was cut back below consumption to reduce total IPAI inventories by 293 000 t, a large inventory surplus overhung the market, and prices will remain weak until this is considerably reduced. Rather than finance inventories at high interest rates, companies have closed mines, refineries and smelters to reduce excess stocks, and some new smelter projects have been cancelled or delayed. However, in countries where energy is both abundant and relatively inexpensive, such as Canada, Australia, Brazil and the Middle East, development continues in anticipation of future increases and changing patterns of demand for aluminum.

THE CANADIAN INDUSTRY

Two companies produce primary aluminum metal in Canada - Canadian Reynolds Metals Company, Limited, a subsidiary of Reynolds Metals Company in the United States, and the Aluminum Company of Canada, Limited (Alcan), a subsidiary of Alcan Aluminium Limited of Montréal. Canadian Reynolds operates a 158 760 tpy smelter at Baie Comeau, Quebec, while Alcan has five smelters in Quebec - at Jonquière, Grande Baie, Isle Maligne, Shawinigan and Beauharnois - and one at Kitimat, British Columbia. Alcan had a total smelter capacity of 1 018 000 tpy, but about 120 000 t of this capacity were closed at year-end.

Canada imports all of its aluminum ore requirements in the form of either bauxite or alumina (Table 1). Alcan, one of the world's largest integrated aluminum companies, obtains bauxite for its Jonquière, Quebec, refinery mainly from related companies in Brazil and Guinea and also from an independent source in Guyana. The Jonquière refinery produces alumina (Al_2O_3) mainly for the company's Quebec smelters. The Kitimat smelter uses alumina produced in Australia by an Alcan associated company. Canada also imports alumina from Jamaica and the United States.

Canada has been able to take advantage of favourable power rates to maintain production levels at 90 per cent of primary production capacity: production was 1 064 759 t in 1982, only about 5 per cent lower than the 1981 level. Exports of aluminum ingot and other nonfabricated forms rose by 24 per cent in 1982 (Table 1).

Because of high fixed costs and relatively low energy costs from self-generated power in Canada, Alcan maintained comparatively high production levels. In

TABLE 1. CANADA, ALUMINUM PRODUCTION AND TRADE, 1981 AND 1982

	1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)
Production	1 115 691	..	1 064 795	..
Imports				
Bauxite ore				
Brazil	1 417 678	49,531	1 316 216	49,561
Guinea	661 246	20,333	762 663	23,735
Guyana	508 619	14,970	387 973	13,617
Surinam	71 153	8,879	66 903	7,462
United States	32 229	5,329	20 327	3,618
Australia	31 448	3,876	17 623	1,726
People's Republic of China	22	3	3 057	409
Other countries	12 316	515	–	–
Total	2 734 711	103,436	2 574 762	100,128
Alumina				
Jamaica	299 849	85,089	391 815	112,177
Australia	289 962	72,380	257 481	60,190
Japan	166 247	41,548	194 368	48,561
United States	247 271	79,615	95 562	32,281
West Germany	17 238	5,135	56	30
Other countries	1	38	–	–
Total	1 020 568	283,805	939 282	253,239
Aluminum and aluminum alloy scrap	33 414	24,995	36 757	31,758
Aluminum paste and aluminum powder	2 886	7,270	1 675	4,725
Pigs, ingots, shot, slabs, billets, blooms and extruded wire bars	14 297	28,025	24 379	40,971
Castings	901	10,199	1 129	10,080
Forgings	761	10,919	616	10,931
Bars and rods, nes	3 286	10,049	3 453	9,617
Plates	12 059	38,150	5 930	18,926
Sheet and strip up to .025 inch thick	24 383	63,083	13 241	37,903
Sheet and strip over .025 inch up to .051 inch thick	11 488	34,510	7 629	23,777
Sheet and strip over .051 inch up to .125 inch thick	30 682	73,983	34 702	79,493
Sheet over .125 inch thick	32 140	75,548	27 957	62,796
Foil or leaf	1 416	5,135	501	1,661
Converted aluminum foil	..	22,508	..	10,398
Structural shapes	2 012	9,274	1 656	7,120
Pipe and tubing	1 154	5,316	1 160	5,175
Wire and cable, not insulated	1 891	6,454	7 295	4,921
Aluminum and aluminum alloy fabricated materials, nes	..	67,413	..	48,536
Total aluminum imports	..	492,831	..	408,788
Exports				
Pigs, ingots, shot, slabs, billets, blooms and extruded wire bars				
United States	509 784	929,878	418 669	658,945
Japan	124 631	208,786	161 163	208,737
People's Republic of China	2 004	3,338	168 019	190,223
Hong Kong	9 724	15,785	46 324	64,488
Turkey	8 025	16,720	18 099	26,206
Taiwan	3 080	6,044	11 992	14,616
Portugal	1 631	2,806	8 498	12,165
West Germany	–	–	7 820	12,104
Australia	3 077	5,602	7 992	10,425
Thailand	15 075	29,641	6 264	9,267
Israel	2 947	5,760	5 758	8,705
Other countries	45 475	89,351	35 780	53,894
Total	725 453	1,313,711	896 378	1,269,775

TABLE 1. (cont'd)

	1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)
Exports (cont'd)				
Castings and forgings				
United States	5 883	43,715	4 870	39,055
United Kingdom	32	3,955	26	3,985
West Germany	103	2,988	49	2,431
France	16	1,761	17	1,563
Other countries	72	1,893	279	3,488
Total	6 106	54,312	5 241	50,522
Bars, rods, plates, sheets and circles				
United States	14 551	37,455	20 901	54,968
Mexico	152	525	1 045	3,237
Trinidad-Tobago	333	945	457	1,162
Jamaica	237	660	440	1,144
South Africa	160	368	387	783
Bangladesh	-	-	448	730
Indonesia	914	2,541	282	591
Philippines	34	79	239	553
Pakistan	1 750	3,863	249	400
Guyana	210	698	98	398
Other countries	2 274	7,322	907	2,732
Total	20 615	54,456	25 453	66,698
Foil				
United States	117	379	612	2,000
Mexico	-	-	196	720
Venezuela	-	-	100	286
New Zealand	-	-	31	111
El Salvador	-	-	18	46
Other countries	108	364	7	21
Total	225	743	964	3,184
Fabricated materials, nes				
United States	7 193	25,722	7 667	29,453
Philippines	478	1,110	921	2,052
United Kingdom	339	1,448	565	1,650
Egyptian A.R.	580	1,418	216	943
Mexico	40	136	230	613
Sri Lanka	97	198	115	486
South Africa	50	146	187	364
Other countries	4 822	13,520	633	2,624
Total	13 599	43,698	10 534	38,185
Ores and concentrates				
United States	38 031	15,711	23 000	10,041
United Kingdom	2 034	976	2 035	1,301
France	940	497	778	471
Venezuela	803	386	599	355
Brazil	526	303	486	343
India	-	-	54	165
Other countries	1 363	680	795	466
Total	43 697	18,553	27 747	13,142
Scrap				
United States	61 734	79,153	53 395	56,779
Japan	14 845	19,757	7 729	7,167
West Germany	146	168	500	392
Spain	352	141	412	226
Italy	151	134	104	66
Belgium-Luxembourg	43	52	59	64
France	-	-	107	59
Other countries	717	597	304	206
Total	77 988	100,002	62 610	64,959
Total aluminum exports	..	1,585,475	..	1,506,465

Sources: Statistics Canada; Energy, Mines and Resources Canada.
P Preliminary; - Nil; .. Not available; nes Not elsewhere specified.

TABLE 2. CANADA, CONSUMPTION OF ALUMINUM AT FIRST PROCESSING STAGE, 1979-82

	1979	1980	1981r	1982e
		(tonnes)		
Castings				
Sand	1 792	1 788	1 397	1 300
Permanent mould	11 680	8 500	9 358	9 400
Die	26 293	20 452	18 777	19 100
Other	148	135	-	-
Total	39 913	30 875	29 532	29 800
Wrought products				
Extrusions, including tubing	99 438	94 129	89 057	71 200
Sheet, plate, coil and foil	166 049	112 890	138 905	99 500
Other wrought products (including rod, forgings and slugs)	80 910	83 001	71 210	67 600
Total	346 397	290 020	299 172	238 300
Other uses				
Destructive uses (deoxidizer), non-aluminum base alloys, powder and paste	12 524	8 505	8 285	5 700
Total consumed	398 834	329 400	336 989	273 800
Secondary aluminum[1]	35 527	39 723	48 453	34 900

	Metal entering plant				On hand December 31			
	1979	1980	1981r	1982e	1979	1980	1981r	1982e
Primary aluminum ingot and alloys	344 215	297 515	292 100	237 800	94 106	92 659	80 037	72 685
Secondary aluminum	49 402	27 691	31 791	26 500	3 501	3 447	3 004	2 728
Scrap originating outside plant	47 367	42 166	46 305	35 500	16 287	16 037	13 856	12 584
Total	440 984	367 372	370 196	299 800	113 894	112 143	96 897	87 997

[1] Secondary metal totals not included in above consumptions.
e Estimated; r Revised; - Nil.

addition, by successfully penetrating Asian markets, particularly in China and Japan, the company has been able to reduce inventories. In spite of these advantages, Alcan's profits suffered drastically as a result of low ingot prices: the company showed a loss of $US 58 million for the year compared to a profit of $US 264 million earned in 1981.

Alcan closed 43 000 tpy of capacity at its Arvida smelter early in the year, reducing its operating rate to 88.2 per cent of capacity from 92 per cent at the end of 1981. The closure affected 150 workers in the Saguenay - Lac St. Jean area of Quebec.

In order to conserve cash, Alcan reduced capital expenditures considerably in 1982. Projects in the planning stage have been postponed such as the proposed $1.25 billion Manitoba smelter and hydroelectric project; however, work continued on projects such as Grande Baie which was 99 per cent complete. The first of three 57 000 tpy potlines at the Grande Baie smelter came into production in 1980, but the second completed in 1981 and third to be completed in 1983 will remain on standby until markets improve. Alcan purchased a site in June for possible construction of a new aluminum smelter at Laterrière, about 10 km southeast of Jonquière.

Based on expected growth in demand over the next 20 years Alcan suggested that three or four new smelters will be required in Canada. Technical studies are planned to investigate the possibility of a 180 000 tpy smelter near Vanderhoof, British Columbia, about 320 km east of Kitimat. The viability of the project will depend on expansion of Alcan's Kemano hydroelectric plant, which supplies power to its Kitimat complex.

Canadian Reynolds continued to operate its Baie Comeau smelter, in Quebec, at full production. A $500-million expansion from the present 158 760 tpy to 272 000 tpy will proceed after the Quebec government agreed, during the fall, to reduce electricity rates by 50 per cent for five years to match the offer made to Pechiney Ugine Kuhlmann (PUK) of France. The new capacity is expected to come on-stream in 1985.

PUK is studying the feasibility of a 230 000 tpy aluminum smelter at Bécancour, on the south shore of the St. Lawrence River opposite the city of Trois Rivières. Although studies indicated that the first 110 000 t potline could start producing in 1986, with a final expansion to 345 000 tpy possible, the company reported that no decision could be expected before the end of the year.

ARCO Aluminum, an Atlantic Richfield Company subsidiary, began a prefeasibility study for a 163 500 tpy primary smelter in Newfoundland. The report, funded by ARCO and the provincial and federal governments, was expected to be completed in the second quarter of 1983.

The first aluminum can recycling program in Canada was started by Canadian Reynolds in Quebec. The company may build a can manufacturing plant if the Quebec government rescinds its special tax on aluminum beverage cans.

Reported consumption at the first processing stage is shown in Table 2 for 1979 to 1982. Consumption of aluminum in Canada decreased by approximately 20 per cent from 1981 levels for wrought and secondary aluminum products, as well as shipments to first stage processing plants (i.e., where smelter output is transformed into the next stage toward final product). Consumption of primary aluminum for die and permanent mold castings increased in 1982 over 1981, unlike estimated consumption in other uses.

TABLE 3. CANADA, PRIMARY ALUMINUM PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975, 1977-1982

	Production	Imports	Exports	Consumption[1]
	(tonnes)			
1970	962 541	12 179	761 671	250 150
1975	878 056	18 302	512 050	293 280
1977	973 524	20 788	655 353	332 393
1978	1 048 469	11 481	863 320	380 290
1979	860 286	23 985	551 958	398 834
1980	1 068 198	9 908	784 721	329 400
1981	1 115 691	14 297	725 453	336 989[r]
1982P	1 064 795	24 379	896 378	237 800[e]

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Excluding aluminum metal used in the production of secondary aluminum.
P Preliminary; [r] Revised; [e] Estimated.

Consumption by sector in Canada was estimated by Alcan to be 281 000 t, distributed as: building products, 26 per cent; appliances, 21 per cent; packaging, 16 per cent; transport, 14 per cent; machinery and equipment, 13 per cent; durable goods, 6 per cent; other, 4 per cent. This represented an estimated 27 per cent decrease from 1981 consumption with decreases in all sectors except for small increases in consumption in the packaging and appliances sectors.

A summary of Canadian production, trade and consumption data is given in Table 3.

WORLD INDUSTRY

Western world production of aluminum exceeded consumption from May 1980 through to February 1982 when total inventories, recorded by the IPAI, peaked at 5.178 million t. By year-end 1982, because of production cutbacks, total inventories had been drawn down to 4.767 million t, equivalent to those of the summer of 1981. The majority of the cutbacks took place in Japan and the United States due to the combination of low prices due to oversupply and relatively high power costs. The western world aluminum industry operated at 72 per cent of capacity in December 1982. On the other hand some countries such as

TABLE 4. CANADA, ALUMINUM SMELTER CAPACITY

(as of January 1, 1983)

	Annual tonnes
Aluminum Company of Canada, Limited	
Quebec	
Grande Baie	114 000
Jonquière	432 000
Isle-Maligne	73 000
Shawinigan	84 000
Beauharnois	47 000
British Columbia	
Kitimat	268 000
Total Alcan capacity	1 018 000
Canadian Reynolds Metals Company, Limited	
Quebec	
Baie Comeau	158 760
Total Canadian capacity	1 176 760

Source: Compiled from company reports by Energy, Mines and Resources Canada.

Note: The third 57 000 tpy potline at Grande Baie is expected to be completed in early 1983.

TABLE 5. ESTIMATED WORLD PRODUCTION OF BAUXITE, 1981 AND 1982

	1981	1982P
	(million tonnes)	
Australia	25.4	23.5
Guinea	12.8	12.8
Jamaica	11.6	8.1
Brazil	4.7	4.5
Surinam	4.0	3.1
Greece	3.2	3.0
India	1.9	1.9
Guyana	1.9	1.9
France	1.8	1.7
Other market economy countries	5.9	4.1
Total market economy countries	73.2	64.6
Central economy countries[1]	15.0	15.2
World total	88.2	79.8

Source: American Bureau of Metal Statistics.
[1] Includes Yugoslavia.
P Preliminary.

Dubai, Bahrain and Brazil have increased output significantly, and Indonesia's new smelter came into production in 1982. Primary production in the western world was 10.5 million t in 1982 with consumption at 10.7 million t (including Yugoslavia). The United States and Europe account for over 65 per cent of annual western world consumption.

The general world economic slowdown has caused decreased aluminum production with corresponding decreases in alumina and bauxite production (Tables 5, 6 and 7).

Aluminum has become a world wide industry with smelters producing ingot in more than 40 countries, yet only eight countries supply 80 per cent of the world's bauxite - Australia, Guinea, Jamaica, U.S.S.R., Brazil, Surinam, Yugoslavia and Greece. Of these countries, Australia is by far the largest producer, accounting for nearly 30 per cent of the world's production. Historically, six large integrated producers have dominated the aluminum industry; these are: Kaiser Aluminum and Chemical Corporation, Reynolds Metals Company, Alcan, Aluminum Company of America (Alcoa), Swiss Aluminium Ltd. (Alusuisse) and PUK. This has changed over the last thirty years through the entry of new, private-sector producers and an increase in level of government participation in the non-communist aluminum industry from about 10 per cent to over 33 per cent. Based upon total world capacity, the United States Bureau of Mines estimated that in 1981 the six major integrated companies control only 38 per cent of primary capacity, the less integrated or "second tier" companies control 26 per cent and governments including those of the U.S.S.R., China and other controlled economies accounted for 36 per cent of capacity.

Most of the 33 primary aluminum smelters in the United States have experienced cutbacks or closures as a result of high inventories, low prices and increasing energy costs: only six operated at full capacity through 1982. By year-end, the industry was operating at 58 per cent of its 4 897 500 tpy capacity. At least seven smelters have been closed, two permanently. Several plants are vulnerable to permanent closure due to high energy costs

TABLE 6. ESTIMATED NON-COMMUNIST WORLD PRODUCTION OF ALUMINA 1981 AND 1982

	1981	1982
	(million tonnes)	
Europe[1]	4.95	4.46
Africa	0.68	0.58
Asia	2.26	1.81
North America	7.17	5.27
South America	4.49	3.48
Australasia	7.09	6.63
Total	26.65	22.23
of which nonmetallic uses	2.19	1.97

Source: International Primary Aluminium Institute Statistical Summaries, Volumes 2 and 3.
[1] Excludes Yugoslavia.

and technological obsolescence. Alcoa announced in May, that its smelter at Point Comfort, Texas, which has been down for 18 months, will remain permanently closed. Because it depends on natural gas for power it is Alcoa's most expensive smelter. Kaiser Aluminum & Chemical Corporation, which is operating at only 26 per cent of capacity, reduced production to 50 000 tpy at its 236 000 tpy Chalmette, Louisiana smelter. Chalmette also uses natural gas and might be permanently closed.

About one-third of the aluminum capacity in the United States is located in the Pacific northwest, where the Bonneville Power Administration (BPA) announced a rate increase of 50 per cent to take effect October 1, 1982. The new rate of 25.9 mills per kWh has increased considerably from the 6 mills per kWh of two years ago. The rate increase followed the April court ruling that public utilities and not industries have prior right to non-firm power supplied by the BPA. Consequently the 20 year power contracts negotiated by the aluminum companies in 1981 were ruled invalid. As a result of rate increases coupled with weak metal prices, some capacity was cut back. Temporary (until economics improve) closures included: Kaiser, 50 000 tpy of its 200 000 tpy Mead smelter, Washington; Martin Marietta Aluminum Inc. delayed start up of 30 000 tpy of new capacity at its Goldenvale, Washington, smelter.

Elsewhere in the United States, Reynolds Metals Company has closed about 508 000 t of its 708 500 tpy capacity at five U.S. smelters, including 286 750 tpy at plants in Listerhill, Alabama and San Patricio, Texas that have been closed indefinitely. Noranda Aluminum Inc. shut one quarter of its 127 000 tpy New Madrid, Missouri smelter but continued construction of the $US 240 million third 77 100 tpy potline completing it before year-end. The expansion will not be started up until economic conditions improve. Most of the shut capacity in the United States should be restarted if ingot prices rise sufficiently in the next year.

Martin Marietta completed a $46 million expansion of its alumina refinery on the U.S. Virgin Islands, increasing capacity to 635 000 tpy. The company continues to seek funds in order to expand the plant by an additional 800 000 tpy at a cost of $500 million.

The depressed aluminum industry has adversely affected countries such as Jamaica with economies that rely heavily on bauxite and alumina sales. Jamaica's bauxite production in 1982 was 8.3 million t, down from over 12 million t in 1980. Part of the decline was caused by plant closures early in the year as a result of labour strikes. Agreement on a three-year contract was reached in February; however, due to market conditions Alcoa Minerals of Jamaica Inc. (Jamalco) (Alcoa 94 per cent), announced that it would restart its Clarendon refinery at only 53 per cent of capacity and produce 33 per cent less alumina than the pre-strike level.

The United States government helped reduce Jamaica's oversupply of bauxite, by signing an agreement to purchase 1.45 million t of the bauxite in 1982 for the U.S. stockpile of strategic materials. Part of the deal included a barter arrangement whereby 363 000 t of the excess bauxite was exchanged for surplus U.S. dry milk products.

Although the continued development of the Australian aluminum industry remains bright due to abundant resources of bauxite and coal, the effects of the continuing world recession has removed the "boom" from the industry; however, a more moderate growth pattern should emerge. Electricity for Australia's new aluminum smelters will increasingly be obtained from coal-fired power stations operated by several of the state utilities, especially New South Wales,

TABLE 7. WORLD PRIMARY ALUMINUM PRODUCTION AND CONSUMPTION, 1981 AND 1982

	Production		Consumption	
	1981	1982P	1981	1982P
	(000 tonnes)			
United States	4 488.8	3 274.0	4 140.1	3 648.0
Europe[1]	3 551.9	3 306.7	3 360.5	3 494.7
Japan	770.6	350.7	1 566.6	1 636.8
Canada	1 115.7	1 064.8	337.0	230.0
Australia and New Zealand	534.8	548.0	260.7	242.1
Asia (excluding Japan and People's Republic of China)	564.4	675.3	744.7	728.9
Africa	483.2	501.2	175.8	171.5
America (excluding United States and Canada)	786.8	795.8	516.7	505.8
Sub-total	12 296.2	10 516.1	11 102.1	10 657.8
Central economy countries	3 400.4	3 469.5	3 464.5	3 512.0
Total	15 696.6	13 991.1	14 566.6	14 169.8

Sources: American Bureau of Metal Statistics; Energy, Mines and Resources Canada, World Bureau of Metals Statistics (for 1982P).
[1] Excludes Yugoslavia.
P Preliminary.

Victoria and Queensland. Costs to the industry, especially for labour, construction and energy, have been increasing. A dispute over power rates proposed for Alcoa's Portland smelter (comparable with the recent price structure in U.S. Pacific northwest) was one factor in the deferral, from 1983 to 1985, of the first phase (132 000 tpy). The proposed plant has been designed for eventual expansion to 528 000 tpy at a cost that is expected to exceed $US 1 billion for the first phase. As a result of prevailing economic conditions Australia is experiencing cutbacks, deferrals of projects, and plant closures within the aluminum industry. Symptomatic of these conditions was Alcoa's decision in January to mothball 500 000 tpy of alumina capacity at its Wagerup refinery, near Perth, before the first phase came into production.

In the coal-rich Hunter Valley, north of Sydney, Alcan's 45 000 tpy expansion at its Kurri Kurri smelter has been delayed and the proposed 118 000 tpy Lochinvar smelter was abandoned after Japanese interests withdrew from the consortium. On the other hand, the nearby 200 000 tpy Tomago smelter (35 per cent PUK, 35 per cent Gove Alumina Ltd., 12 per cent Vereinigte Aluminium-Werke AG (VAW), 3 per cent Hunter Douglas Ltd. and 15 per cent Australian Mutual Provident Society) is on schedule with the first 110 000 tpy stage expected to come on-stream in mid-1983, and the remaining capacity in 1984. At the Bunbury project in Western Australia, near Perth, a feasibility study will be undertaken for Alcoa and a Korean company's plan to build a 220 000 tpy, $A 1.2 billion aluminum smelter and associated 600 MW coal-fired power station with a 1986 target date. The South Korean government offered to guarantee access to the Korea market for some of the aluminum that is to be produced from this proposed smelter.

The opening of the Boyne Island smelter (30 per cent Comalco Limited, 20 per cent Kaiser, 9 per cent Kobe Steel Ltd., 19 per cent Mitsubishi & Yoshida Kogya K.K., 22 per cent Sumitomo Light Metals Industries Ltd., (5 per cent through a subsidiary) in 1982 completes the cycle from raw material to metal in Queensland. Bauxite mined by Comalco at Weipa is refined to alumina at Gladstone (Comalco, 30 per cent) and smelted to aluminum metal at Boyne. The consortium which owns the smelter, Gladstone Aluminium Ltd., changed its name to Boyne Smelter Ltd. on January 1, 1982. The plant is scheduled to reach its designed capacity of 206 000 tpy by 1984.

Despite current world economic conditions Brazil continues to develop its aluminum industry, although projects have been delayed: production in 1982 was 4.2 million t of bauxite, 588 000 t of alumina and 299 000 t of primary aluminum. The new Valesul Aluminio S.A. smelter (51 per cent state-owned Cia Vale do Rio Doce (CVRD), 5 per cent Reynolds and 44 per cent Shell Brasil S.A.), which came on-stream early in the year, helped increase primary metal production by 17 per cent compared to 1981. The smelter, located at Santa Cruz, west of Rio de Janeiro, should reach its full 86 500 tpy capacity in 1983. Power from the state grid accounts for approximately 23 per cent of operating costs.

Nippon Amazon Aluminium Co. Ltd. (Nalco) continues to supply loans to cover 44 per cent (Brazilian government 51 per cent) of the Alumina do Norte do Brasil SA (Alunorte) and Aluminio Brasileiro SA (Albras) alumina/aluminum complex at the mouth of the Amazon River. The 800 000 tpy refinery is scheduled for completion in 1986 and the 320 000 tpy smelter in 1989, but initial production from both plants is expected in 1985. However, the Brazilian partner, CVRD, proposed a freeze on construction of the alumina plant because of world oversupply and the country's recent financial problems. Low-cost power will be supplied by the huge Tucurui hydroelectric project scheduled for completion by 1984-85. The 300 000 tpy Alcoa smelter, under construction at Sao Luis about 500 km to the southeast, which is expected to start at 100 000 tpy in 1985, also will use power from this source.

Venezuela plans to integrate its aluminum industry by developing the Los Pijiguaos bauxite deposits to supply, after 1985, the country's first alumina refinery, under construction at Ciudad Guyana by the national company, Interamericana de Alumina CA (Interalumina). The refinery is expected to produce 300 000 t in 1983, increasing to 1 million t by 1985. Alumina from the refinery will eventually feed Industria Venezolana de Aluminio CA (Venalum) and Aluminio del Caroni SA (Alcasa), Venezuela's two smelters, which are estimated to have produced 280 000 t in 1982, although their combined capacity is 400 000 tpy. Venalum has signed a barter agreement with Jamaica for the exchange of aluminum for alumina beginning in 1983.

The Japanese aluminum industry lost much of its international competitiveness as a result of high energy costs from oil-fired power stations, plus the appreciation of the yen over the past few years. Breakeven costs to produce a pound of aluminum in Japan were estimated to be in the range of 95 cents US per pound whereas the cash price averaged 44.7 cents US a pound in December 1982. As a result of these conditions Japan has been restructuring its primary industry according to a plan approved by the Ministry of International Trade and Industry (MITI). Capacity of the industry, which reached a peak of 1 640 000 tpy in 1978, has been reduced and is expected to be 750 000 tpy in 1983. Domestic primary production has followed this downward trend, from more than 1 million t in the late 1970s to 295 000 t in fiscal 1982. Since domestic consumption is expected to increase by 3 per cent annually - estimated to exceed 1.6 million t during the year - Japan must increasingly rely on imports to meet the shortfall between demand and production. The nation's six smelting companies (operating 17 smelters in 1981) will be allowed to import duty free ingot each year (400 000 t in 1982), based on the amount of capacity to be scrapped by industry in the 1982-85 period. Canada is in a good position to supply a portion of this duty free metal due to the country's low energy costs and Alcan's corporate link with Nippon Light Metal Co. Ltd. (50 per cent), one of Japan's largest smelters and fabricators.

Other means to aid the uncompetitive Japanese industry include: government stockpiling to reduce surplus producers' stocks (30 000 t now in stockpile, with further purchases of 150 000 t from local smelters proposed); subsidies to power stations changing from oil to coal; and encouragement of industrial groups to financially support ailing smelting companies.

By 1985, Japanese aluminum needs will be met by international producers (contract and spot sales) of about 800 000 t, another 700 000 t by Japanese financed offshore projects, and the remaining one-third by domestic smelters.

The western European aluminum industry, expecting an early improvement in the U.S. market, was slow to react to declining world aluminum demand. In response to the build-up of inventories, low prices and rising energy costs, major producers have been reducing output and deferring or cancelling expansion plans. Some of the smaller smelters (to 20 000 tpy) in France, Austria, Switzerland and Norway, may be forced to close permanently. As a result of these pressures, primary production in western Europe fell by 7 per cent to 3.3 million t in 1982. At the end of this period, smelters in West Germany were operating at 72.5 per cent of capacity. West German aluminum producers operated at 89 per cent of capacity through 1982, with VAW reducing capacity by 33 000 t at its 80 000 t Innwerk smelter. Faced with a steep increase in the price of electricity, Alcan announced that it would close its 44 000 tpy Ludwigshafen primary smelter at the end of 1982 unless power rates were reduced.

The Italian government was restructuring its financially troubled aluminum industry through long-term reduction of primary capacity and expansion of secondary aluminum and fabrication operations. The state owned company has closed two obsolete smelters with combined capacity of 65 000 tpy.

Sweden is the only European country that is planning any significant aluminum expansion. Gränges Aluminium AB is scheduled to add 59 000 tpy which will increase plant capacity to 138 000 tpy by 1986-87.

OTHER DEVELOPMENTS

- Umatilla, Oregon: Alumax, Inc. is to review the feasibility of its proposed 181 500 tpy smelter, estimated to cost $660 million, due to power rate increases by the BPA.

- Altamira, Mexico: to start constructing a 218 000 tpy smelter in 1984, estimated to cost $800 million, based on abundant natural gas.

- Recife, Brazil: construction of 220 000 tpy smelter by VAW postponed indefinitely.

- Aughinish, Ireland: 800 000 tpy alumina refinery 85 per cent complete (Alcan-Billiton N.V.-The Anaconda Company consortium), start-up date depends on market conditions.

- Middle East: petroleum-coke plant proposed for Abu Dhabi to feed aluminum smelters in Bahrain and Dubai, would allow potential production increase from present 227 000 tpy to 680 000 tpy.

- Libya: proposed 109 000 tpy smelter by 1986, subject to feasibility study in progress.

- Taiwan: all smelter operations to permanently close in January 1983 due to high electricity costs.

- Bintan Island, Indonesia: West German consortium plans to build a 600 000 tpy alumina refinery to come on-stream in 1986 to feed the new Indonesia Asahan Aluminum, P.T. smelter.

- Sayansk, Siberia: 500 000 tpy smelter under construction, scheduled for production in 1984.

PRICES AND STOCKS

The U.S. market price of primary aluminum in 1982, under pressure from oversupply, fell from a monthly average of 51 cents US a pound in January to 42 cents in June, but then rose to 47 cents a pound in December to average 46.8 cents for the year (see below). The lowest price quoted for aluminum on the London Metal Exchange (LME) in 1982 was recorded in mid-June when the price reached 40 cents US a pound. Although the producer list price of primary ingot remained at 76 cents, actual prices during the year were discounted to the 50 to 55 cent range.

PRICES

Month	Alcan and U.S. List	U.S. Market	LME Cash
		¢ U.S./pound	
January	76.00	51.250	50.478
February	76.00	51.500	49.344
March	76.00	50.087	46.618
April	76.00	47.810	45.229
May	76.00	46.250	44.094
June	76.00	42.852	41.668
July	76.00	44.107	43.444
August	76.00	44.761	43.447
September	76.00	45.369	43.484
October	76.00	44.975	43.127
November	76.00	46.026	43.768
December	76.00	46.576	44.696
1982 Average	76.00	46.797	44.966

Source: Metals Week and Northern Miner quotes as compiled by Energy, Mines and Resources Canada.

Producer stocks of primary metal, as reported by the IPAI, increased steadily from 1 432 000 t at the end of the first quarter of 1980 to 3 315 000 t at the end of February 1982, which is just short of the historical high reached in mid-1975. However, by the end of 1982 stocks had fallen by 379 000 t to 2 936 000 t. Total company aluminum stocks (including scrap, primary and secondary ingot) reached a peak of 5 178 000 t in February, almost 1 million t higher than the level of February 1981. By year-end the total inventories had declined to 4 767 000 t.

OUTLOOK

Aluminum is a light metal, the most abundant in the earth's crust but not found as a free element in the crust. It has a specific gravity of 2.698 at 25°C, a melting point of 660°C, tensile strength of 50 MPa (7100 psi), Young's Modulus of 65,000 MPa (about one-third that of steel), an electrical conductivity of 65 per cent IACS* and a rapidly forming stable adherent oxide layer. For these and other reasons, since its first isolation in the 1850s and the first economic recovery process in 1886, it has grown to be the second-most used metal after iron.

Market conditions for aluminum in the short-term are uncertain due to the extent and severity of the current recession. Although capacity utilization still may decline slightly in early 1983, encouraging signs of economic recovery started to emerge toward the end of 1982 in those segments of the economy especially important to the aluminum industry; U.S. automobile sales and housing starts, spurred by declining interest rates, increased significantly in December. If the recovery is sustained and capacity restarts are matched to increasing demand, the price could increase significantly so that some majors, especially Alcan and Alcoa, would generate more normal profits by late-1983.

Medium to long-term overall growth of the aluminum industry continues to be quite positive and, due to the metal's advantageous characteristics, aluminum use is expected to expand at a more rapid pace than other metals, albeit at lower than historical growth rates. Demand will continue to increase in packaging, especially beverage cans (except where legislation prohibits aluminum's use), transportation and construction markets, although consumption is projected to grow by an average of slightly less than 4 per cent annually over the next ten years. Because the aluminum markets of the industrialized nations have matured, use in these geographic areas may just keep pace with natural economic growth, unless new applications and products are developed to offset market loses from substitute materials such as plastics. To this end, the prevailing recession forced large multinational companies to reconsider long range strategies that will depend less on the profitability of bauxite and ingot production and more on that of fabricated and specialized aluminum products by stressing better use of technology and innovation.

Availability of low-cost power will increasingly favour future construction of aluminum smelters in Canada, Brazil, Australia, Africa and the Middle East, whereas industrialized Europe and the United States will be limited to replacing and modernizing existing plants as long as power rates remain reasonable and market forces are allowed to act. With less chance for capacity expansion, these markets will become net importers of aluminum and, by the end of the decade, the United States may turn to foreign sources for as much as 40 per cent of its aluminum supply. These conditions should continue to encourage recycling, especially since smelting scrap aluminum consumes less than one tenth of the energy required to smelt primary aluminum.

As the aluminum industry in Canada plans for the future it can anticipate new opportunities for metal sales in both developing and industrialized countries.

* International Annealed Copper Standard.

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
32910-1	Bauxite	free	free	free	free
35301-1	Aluminum pigs, ingots, blocks, notch bars, slabs, billets, blooms and wire bars, per pound	free	.6¢	5¢	free[1]
35302-1	Aluminum bars, rods, plates, sheets, strips, circles, squares, discs and rectangles	free	2.3	9	free
35303-1	Aluminum channels, beams, tees and other rolled, drawn or extruded sections and shapes	free	10.8	30	free
35305-1	Aluminum pipes and tubes	free	10.8	30	free
92820-1	Aluminum oxide and hydroxide; artificial corundum (this tariff includes alumina)	free	free	free	free

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
			(%)			
35301-1	.6¢	.5¢	.4¢	.3¢	.1¢	free
35302-1	2.3	2.3	2.2	2.2	2.1	2.1
35303-1	10.8	10.3	9.7	9.1	8.6	8.0
35305-1	10.8	10.3	9.7	9.1	8.6	8.0
92820-1						

UNITED STATES (MFN)		1982	1983	1984	1985	1986	1987
				(%)			
417.12	Aluminum compounds: hydroxide and oxide (alumina)	Remains free					
601.06	Bauxite	Remains free					
618.01	Unwrought aluminum in coils, uniform cross section not greater than 0.375 inch, per pound	3.0	2.9	2.8	2.8	2.7	2.6
618.02	Other unwrought aluminum, excluding alloys, per pound	0.6¢	0.5¢	0.3¢	0.2¢	0.1¢	free
618.04	Aluminum silicon, per pound	2.4	2.3	2.3	2.2	2.2	2.1
618.06	Other aluminum alloys, per pound	0.6¢	0.5¢	0.3¢	0.2¢	0.1	free
618.10	Aluminum waste and scrap, per pound	2.0	2.0	2.0	2.0	2.0	2.0

Sources: The Customs Tariff and Commodities Index, Revenue Canada; Tariff Schedules of the United States Annotated 1982, USITC Publication 1200; U.S. Federal Register Vol. 44, No. 241.

[1] Pending passage by Parliament of the Notice of Ways and Means Motion tabled on November 12, 1981.

Asbestos

G.O. VAGT

Shipments of asbestos fibre declined 26 per cent, primarily as a result of worldwide recessionary conditions, the attendant slowdown in the construction industry, adverse publicity and increasing use of substitutes. Preliminary figures indicate that total 1982 shipments were 822 000 t valued at $403 million, compared with 1981 shipments of 1 122 000 t valued at $548 million. Exports were proportionally lower.

Intermittent work stoppages of varied lengths were common in the industry during 1982. Total employment declined from 8,000 in 1979 to about 4,000 in late-1982. Very high inventories of more than 200 000 t were maintained for the second consecutive year.

Canada recognizes that asbestos dust in the workplace is potentially hazardous but takes the position that regulation and control should be based on objective and internationally acceptable scientific evidence. This approach is receiving wider acceptance by some, but not all regulatory authorities.

CANADIAN SCENE

Based on a decision announced in late 1981, the Quebec government negotiated a 51 per cent controlling interest in Asbestos Corporation Limited (ACL). Under an agreement signed in February 1982, following an initial investment by Quebec for control of General Dynamics Corporation (Canada) Limited (now SNA Mines Inc.), Quebec and General Dynamics can exercise an option from late-1983 to about mid-1986 to proceed with a transaction involving the sale of the United States parent company's 1,550,010 common shares of ACL. The price of the shares will be $42 each, to be escalated at 16 per cent interest compounded annually.

Acting on a bill passed in July, the Government of Newfoundland expropriated on September 3, 1982 the property of Advocate Mines Limited idle since December 30, 1981. Financial problems stemming from the weak demand for asbestos were cited as the reason for closure. Expropriation was resorted to because the prospective buyer, Transpacific Asbestos Inc. of Toronto, and the owners, Johns-Manville Canada Inc. and Belgian-Swiss controlled Cie Financiere Eternit SA (Eternit), could not arrive at a satisfactory negotiated price. The cost of acquisition was $4.02 million raised through a bank loan guaranteed in part by Newfoundland. Financial support includes $3.25 million in loan guarantees from Newfoundland and $1.0 million in equity and loan guarantees from Transpacific. Nearly $14 million in loans and loan guarantees for operating needs was made available by a federal Cabinet agreement signed in August 1982. Reactivation of the mine and mill as Baie Verte Mines Inc. started in September 1982 and shipments of fibre were being made by year-end.

The World Symposium on Asbestos, held in May in Montreal, was sponsored by the Governments of Canada and Quebec and the Commission of the European Communities. This symposium was attended by 700 delegates including most of the leading medical authorities on asbestos. The program was divided into seven sessions dealing with the following: medical data; protection in the workplace; rights and responsibilities with views by science, industry, labour and government; substitutes; risks associated with non-occupational exposure; present and future research in fibre technology and legislative perspectives. Participants gave an affirmative answer, with a proviso to the question, "Can society live with asbestos?" Environmental technology is available and suitable measures must be taken to limit exposure to asbestos dust. It was generally acknowledged that the general population is not at risk. Also, it was stressed that there are uncertainties as to potential health hazards of fibrous substitutes. Discussions following the symposium helped serve as guidelines for future research.

The Canadian Asbestos Information Centre was established in Montreal in 1982 to disseminate information on asbestos and

TABLE 1. CANADA, ASBESTOS PRODUCTION AND TRADE, 1981 AND 1982

	1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)
Production (shipments)[1]				
By type				
Crude, groups 1, 2 and other milled	10	23	..	..
Group 3, spinning	15 629	19 693	..	..
Group 4, shingle	396 926	326 814	..	..
Group 5, paper	154 733	85,813	..	..
Group 6, stucco	169 977	58,845	..	..
Group 7, refuse	384 570	57,218	..	..
Group 8, sand	-	-	-	-
Total	1 121 845	548,406	821 816	402,995
By province				
Quebec	960 641	420,045	731 000	324,992
British Columbia	90 914	76,770	78 279	68,431
Newfoundland	70 290	51,591	12 537	9,572
Total	1 121 845	548,406	821 816	402,995
Exports				
Crude				
Turkey	10	26	-	-
United States	-	-	61	9
Japan	-	-	494	148
Total	10	26	555	157
Milled fibre (groups 3, 4 and 5)				
United States	64 640	56,260	34 907	30,219
Mexico	33 441	29,088	20 102	16,015
France	33 948	28,618	30 509	25,421
India	32 892	28,530	27 223	23,397
United Kingdom	26 438	24,608	25 031	23,495
Japan	30 741	22,600	36 630	25,049
West Germany	28 283	21,763	68 633	50,375
Italy	21 007	19,159	16 141	15,628
Belgium-Luxembourg	18 545	16,490	7 853	7,281
Australia	15 466	14,778	15 422	14,786
Spain	16 426	14,383	10 161	10,198
Malaysia	16 582	14,129	15 355	13,419
Other countries	181 368	152,714	146 206	122,270
Total	519 777	443,120	454 173	377 553
Shorts (groups 6, 7, 8 and 9)				
United States	265 080	54,228	191 031	38,587
Japan	69 523	20,654	68 878	18,802
West Germany	56 919	13,273	17 081	4,884
United Kingdom	26 210	5,352	17 558	4,240
France	15 743	4,095	13 308	2,601
India	10 435	3,887	10 978	3,366
Mexico	13 057	3,568	13 097	3,591
Taiwan	8 200	3,270	6 572	2,490
Thailand	5 289	1,922	7 610	2,603
Nigeria	4 926	1,657	2 446	696
Venezuela	5 410	1,570	4 401	1,112
Switzerland	4 352	1,441	804	199
Belgium-Luxembourg	4 020	1,369	5 684	1,940
South Korea	3 937	1,356	4 862	945
Argentina	3 915	1,092	4 156	1,163
Other countries	45 386	12,834	52 311	15,399
Total	542 402	131,568	420 777	102,618
Grand total crude, milled fibres and shorts	1 062 189	574 714	875 505	480,328

TABLE 1. (cont'd)

	1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)
Manufactured products				
Asbestos cloth, dryer felts, sheets				
United States		2,654		1,847
United Kingdom		485		505
Japan		192		-
Venezuela		153		-
Nigeria		78		-
Taiwan		68		-
Other countries		387		501
Total	..	4,017	..	2,853
Brake linings and clutch facings				
United States		5,516		9,691
Australia		253		160
Hong Kong		133		152
Mexico		87		-
France		78		13
Ecuador		63		66
West Germany		35		128
Uruguay		18		-
Guatemala		13		-
Other countries		56		160
Total	..	6,252	..	10,370
Asbestos and asbestos cement building materials				
United States		12,542		12,805
Australia		880		636
United Kingdom		529		816
Iraq		494		24
Singapore		411		370
South Africa		403		81
Malaysia		258		64
Thailand		218		37
Venezuela		211		359
Other countries		927		2,296
Total	..	16,873	..	17,488
Asbestos basic products, nes				
United States		7,732		6,646
West Germany		1,033		158
Australia		109		37
Taiwan		68		-
Venezuela		61		2
Other countries		438		441
Total	..	9,441	..	7,284
Total exports, asbestos manufactured	..	36,583	..	37,995
Imports				
Asbestos, unmanufactured	934	687	573	687
Asbestos, manufactured				
Cloth, dryer felts, sheets, woven or felted		1,910		1,306
Packing		3,535		2,803
Brake linings		8,342		9,740

TABLE 1. (cont'd)

	1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)
Imports (cont'd)				
Clutch facings		1,502		1,224
Asbestos-cement shingles and siding		52		56
Asbestos-cement board and sheets		470		439
Asbestos building materials, nes		2,214		1,856
Asbestos basic products, nes		3,547		4,846
Total asbestos, manufactured	..	21,572	..	22,270
Total asbestos, unmanufactured and manufactured	..	22,259	..	22,957

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Value of containers not included.
P Preliminary; - Nil; nes Not elsewhere specified; .. Not available.

promote its safe use. Additional responsibilities of the Centre are to evaluate the safety of asbestos products and to promote the adoption of suitable control measures on a worldwide basis. Financing was contributed by industry and the Governments of Canada and Quebec.

Federal emission regulations pursuant to the Clean Air Act as defined by Environment Canada require that the concentration of asbestos fibres contained in emissions to the ambient air at a mine or mill from crushing, drying or milling operations, or from dry rock storage, shall not exceed 2 fibres/cm^3. The Ontario Ministry of Labour put its asbestos regulation into effect on August 20, 1982. Following the British standard, the regulation establishes different permissible exposure limits according to fibre type. These limits are 0.5 fibres/cm^3 for amosite, 0.2 fibres/cm^3 for crocidolite and 1.0 fibres/cm^3 for all other types as measured over a 40-hour time-weighted period by the membrane filter method. The regulation will be reviewed and possibly revised when the Ontario Royal Commission studying asbestos completes its work and issues a final report. This Commission held an intensive series of public hearings in 1982 and nine Study Papers and two Background Papers were published.

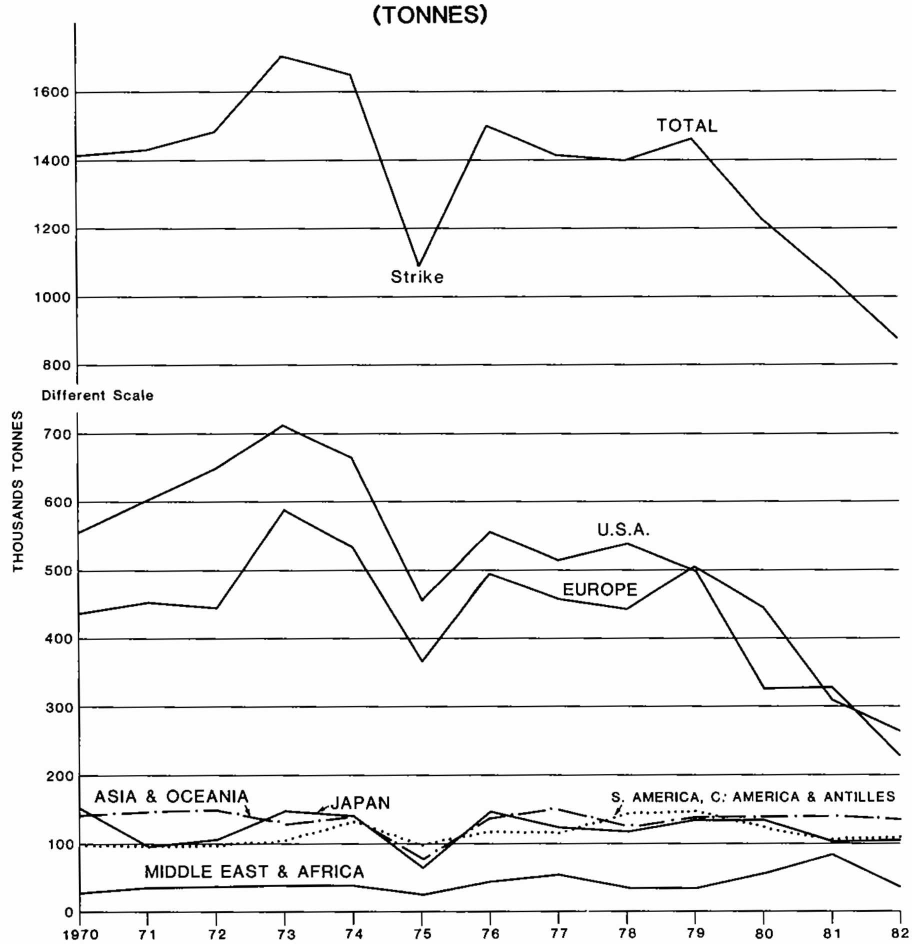
The future of the industry continued to be threatened by adverse publicity, often more sensationalist than informative. Also an increasing number of health-related lawsuits, stemming mainly from conditions that prevailed in some manufacturing plants during World War II, threaten the financial status of major companies. To date, Johns-Manville Canada Inc. has not been directly affected by the parent company's filing in August for reorganization under Chapter XI of the U.S. federal bankruptcy code. This filing halts all legal action against Manville Corporation, and federal or state courts would not be expected to decide on cases. The parent company were advised earlier that over 16,500 lawsuits are pending against it or its subsidiaries and that lawsuits may continue unabated for the foreseeable future.

WORLD SCENE

Based on an estimated 1982 world production of 4.3 million t of fibre, major world producers and their approximate percentage share of production are: U.S.S.R., 50; Canada, 20; Republic of South Africa, 5.0; Zimbabwe, 6.0; Brazil, 3.0; Italy, 3.0; and others, 13.0. An exact breakdown for 1981 is given in Table 4.

Quebec's shipments amounted to an estimated 730 000 t in 1982. Quebec's annual production consistently represents from 85 to 90 per cent of total Canadian production. Canadian asbestos fibre exports account for approximately 65 per cent of total world exports. Expansions to production facilities

CANADIAN EXPORTS OF ASBESTOS (ALL GROUPS) BY COUNTRY OR REGION (1970-1982) (TONNES)



CANADIAN EXPORTS OF ASBESTOS (ALL GROUPS)
BY COUNTRY OR REGION (1970-1982)
(CONSTANT 1979 $)

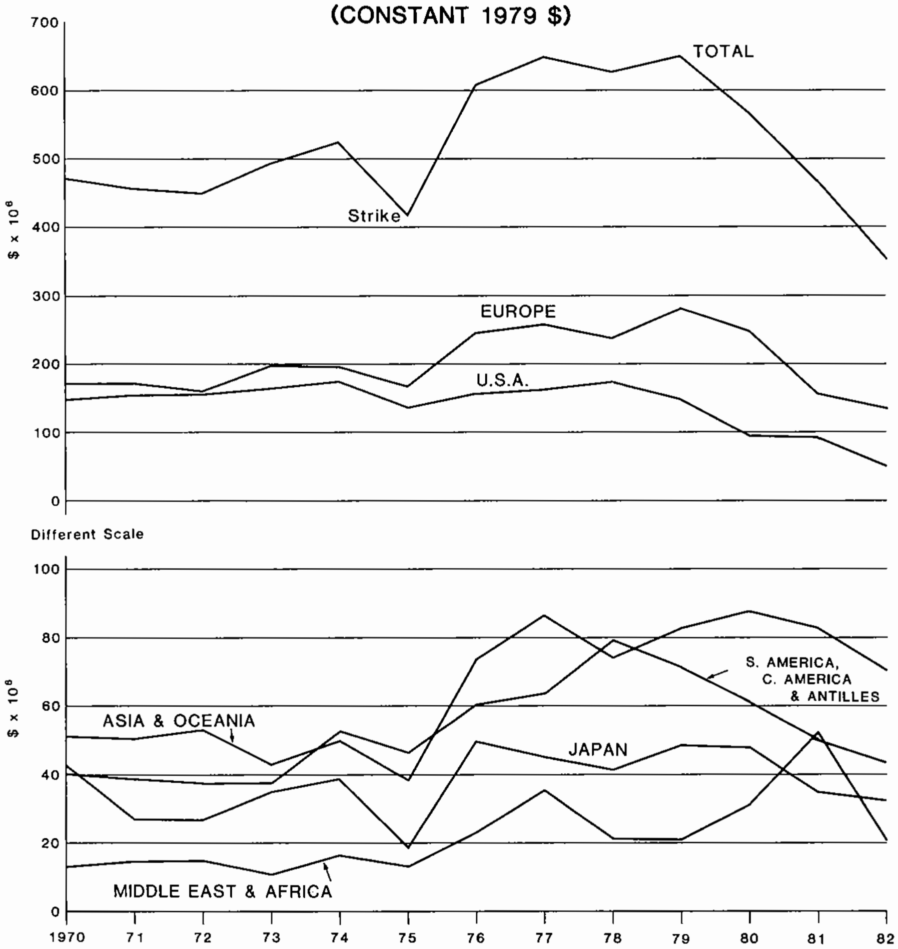


TABLE 2. CANADIAN ASBESTOS PRODUCERS, 1982

Producers	Mine Location	Mill Capacity (tonnes) ore/day	Mill Capacity (tonnes) fibre/year	Remarks
Baie Verte Mines Inc.	Baie Verte, Nfld.	6 600	80 000	Open-pit.
Carey Canada Inc.	East Broughton, Que.	6 800	210 000	Open-pit. Mainly produces groups 6 and 7.
Asbestos Corporation Limited				Purchased in 1982 by Société nationale de l'amiante (SNA) (Quebec Crown corporation).
Asbestos Hill mine	Putuniq, Que.	5 400	90 000	Annual rated capacity 272 000 t concentrate. Final processing of fibre in West Germany.
British Canadian mine	Black Lake, Que.	12 000		Open-pit, two milling plants.
King-Beaver mine	Thetford Mines, Que.	7 000	210 000	Underground and open-pit.
Normandie mine	Black Lake, Que.			Reserves exhausted. Mill processes K-B open-pit ore.
Bell Asbestos Mines, Ltd.	Thetford Mines, Que.	2 700	55 000	Underground. Purchased in 1980 by SNA (Quebec Crown corporation).
Lake Asbestos of Quebec, Ltd.	Black Lake, Que.	9 000	235 000	Open-pit.
National Mines Division	Thetford Mines, Que.	4 000		Open-pit.
Johns-Manville Canada Inc.				
Jeffrey mine	Asbestos, Que.	30 000	645 000	Open-pit (western world's largest known asbestos deposit).
Brinco Mining Limited				
Cassiar mine	Cassiar, B.C.	5 000	100 000+	Open-pit.

Sources: Energy, Mines and Resources Canada; The Quebec Asbestos Mining Association, Quebec.

TABLE 3. CANADA, ASBESTOS PRODUCTION AND EXPORTS, 1970, 1975, AND 1978-82P

	Crude	Milled	Shorts	Total
	(tonnes)			
Production[1]				
1970	6 579	668 629	832 210	1 507 418
1975	5	480 579	575 083	1 055 667
1978	1	673 910	747 897	1 421 808
1979	4	725 649	767 066	1 492 719
1980	-	690 493	632 560	1 323 053
1981	10	567 288	554 547	1 121 845
1982P	..	..	..	821 816
Exports				
1970	91	747 814	669 509	1 417 414
1975	183	570 418	514 997	1 085 598
1978	1	689 690	708 392	1 398 083
1979	20	719 075	741 947	1 461 042
1980	-	653 358	564 379	1 217 737
1981	10	519 777	542 402	1 062 189
1982P	555	454 173	420 777	875 505

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

[1] Producers' shipments.
P Preliminary; .. Not available; - Nil.

in Russia are under way, reportedly to serve the needs of a substantial increase in industrial and residential construction. The Republic of South Africa and Zimbabwe each produce annually from 200 000 t to 250 000 t of asbestos.

DEVELOPMENTS

Shutdowns amounting to nearly 50 per cent of normal operating time continue at some operations. Asbestos Corporation closed the British Canadian No. 2 mill indefinitely and reduced the company's workforce to about 1,000 employees.

In early-1982, Johns-Manville (JMC) ceased development work to reduce expenses at the Jeffrey mine. In August, the company announced it was seeking a $35 million federal grant to resume development work that would create an additional 220 jobs for two years and to preserve jobs for about 1,200 employees for an unspecified time. Under the federal Industrial and Labour Adjustment Program, the towns of Asbestos, Black Lake and Thetford Mines were declared designated zones because of their importance as major commercial centres. Subsidies up to $10 million, among other incentives, are available to firms undertaking capital projects in these regions.

Environmental control legislation is becoming stricter worldwide. In a brief entitled, "Current Approach to the Regulation of Asbestos in Canada", the Federal-Provincial Working Group on Asbestos concluded that workers and the general public can be protected from risks associated with exposure to asbestos dust. The approach is comprehensive and it emphasizes that suitable product design and enforcement of appropriate regulations on occupational health, environmental control, sale and use of products and handling and transportation, should consider all of the important medical, technical and substitution factors. Present knowledge does not allow satisfactory short-term substitution of asbestos in numerous products, however, considerable research is being directed toward developing suitable alternatives.

TABLE 4. WORLD ASBESTOS PRODUCTION, 1981

Country	tonnes
U.S.S.R.	2 220 000
Canada	1 122 000
Zimbabwe	253 000
Rep. of South Africa	237 000
Brazil	180 000
Italy	142 000
China	140 000[1]
United States	76 000
Australia	50 000[e]
Cyprus	34 000
India	32 000
Korea	10 000
Turkey	10 000
Swaziland	34 000 (exports)
Mozambique	800
Argentina)	
Bulgaria)	21 800
Yugoslavia)	
Japan)	
Taiwan)	
	4 562 600

Source: United States Bureau of Mines and Energy, Mines and Resources Canada.
[1] USBM estimates 250 000 tonnes.
[e] Estimated.

In the United States the asbestos standard of the Occupational Safety and Health Administration (OSHA) is under review and subject to regulatory reform. OSHA's current standard is 2 fibres/cm^3, based on a fibre length to width ratio of 3:1. The American Society for Testing and Materials similarily recommends a standard of 2 fibres/cm^3 but this should be based on a 5:1 ratio intended to exclude many non-asbestiform, acicular rock slivers.

The European Community (EC) has nearly finalized its draft directives on asbestos regulations regarding marketing and use (DG III) and protection in the workplace (DG V). The approach taken to date, to control rather than to ban, is pragmatic and generally acceptable from the industry viewpoint. In the United Kingdom, control limits for exposure to asbestos fibre in a 4-hour sampling period are 0.2 fibres/cm^3 for crocidolite and 1.0 fibres/cm^3 for chrysotile. Although recommendations become effective January 1, 1983, the application of control limits will be coordinated with the EC draft directives. Manufacturers in West Germany are reducing voluntarily the asbestos content in asbestos-cement products.

OUTLOOK

Demand for asbestos will mainly depend on the extent and timing of world economic recovery and the degree to which world public opinion regards asbestos as a current health problem. A positive rate of growth in the developing countries may be possible because of the need for suitable low-cost asbestos-cement construction products characterized by fibre that is well locked-in. Given this assumption, a likely scenario to 1990 would indicate some overall increase in Canadian production by 1984-85 as the world economy improves. This trend would be followed by decreasing output, depending upon inroads made by substitutes, until production in 1990 would approximately equal that of 1982. A pessimistic scenario could develop however, depending on the extent to which banning initiatives rather than controls-type legislation are applied in the developed and developing countries alike. Other contributing factors difficult to quantify, concern the overall success of substitutes in major markets and the degree to which current manufacturers and fibre producers continue to be threatened by lawsuits emanating mainly from the United States.

Some issues expected to draw an increasing amount of attention are: a need to harmonize federal and provincial regulations based on a national consensus for "safe and reasonable levels of exposure"; a need for increased levels of medical research on asbestos and substitutes and improved standardization procedures for measuring levels of asbestos dust in the workplace; a possible need to consider some form of rationalization of production; and, a need to provide technical advice and assistance to Third World countries, particularly those considering regulations on the safe use of asbestos and products.

PRICES

Asbestos producer prices were increased 11 per cent effective January 1, 1983, the first increase since January, 1981.

Canadian asbestos prices quoted in **Asbestos** November, 1982[1].

	January 1, 1981
	($ per short ton)
Asbestos Corporation, fob mine	
Group	
No. 3 (spinning fibre)	1,202 - 1,995
No. 4 (asbestos-cement fibre)	850 - 1,256
No. 5 (paper fibre)	497 - 687
No. 6 (paper and shingle fibre)	408 - 426
No. 7 (refuse, shorts)	125 - 253
Paperbestos No. 1 to 5 H.D. Blocks	237 - 782
Cassiar, fob North Vancouver, B.C.	
Canadian group	
No. 3 (nonferrous spinning fibre)	
AAA grade	2,000
AA grade	1,600
A grade	1,265
AC grade	1,155
No. 4 (single fibre asbestos-cement)	
AK grade	1,075
AS grade	1,000
AX grade	930
No. 5 AY grade	660
No. 6 AZ grade	430

[1] **Asbestos** is a magazine published monthly by D & B Enterprises, Inc.

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
31200-1	Asbestos, in any form other than crude, and all manufactures thereof, nop	10.8	10.8	25	7.0
31205-1	Asbestos in any form other than crude, and all manufactures thereof, when made from crude asbestos of British Commonwealth origin, nop	free	10.8	25	free
31210-1	Asbestos, crude	free	free	25	free
31215-1	Asbestos, yarns, wholly or in part of asbestos, for use in manufacture of clutch facings and brake linings	6.8	6.8	25	4.5
31220-1	Asbestos woven fabric, wholly or in part of asbestos for use in manufacture of clutch facings and brake linings	10.8	10.8	30	7.0
31225-1	Asbestos felt, rubber impregnated for use in manufacturing floor coverings	free	free	25	free

MFN REDUCTIONS (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
			(%)			
31200-1	10.8	10.3	9.7	9.1	8.6	8.0
31205-1	10.8	10.3	9.7	9.1	8.6	8.0
31215-1	6.8	6.5	6.3	6.0	5.8	5.5
31220-1	10.8	10.3	9.7	9.1	8.6	8.0

UNITED STATES

518.11	Asbestos, not manufactured, crudes, fibres, stucco, sand and refuse	free
518.41	Asbestos cement pipes, tubes and fittings	0.15¢ per lb
518.44	Other asbestos cement articles	free

		1982	1983	1984	1985	1986	1987
				(%)			
518.21	Asbestos, yarn, slivers, rovings, wick, rope, cord, cloth, tape and tubing	2.5	2.0	1.5	1.0	0.5	free
518.51	Asbestos articles nop	2.8	2.3	1.7	1.1	0.6	free

Sources: The Customs Tariff and Commodities Index, Revenue Canada; Tariff Schedules of the United States, Annotated 1982, USITC Publication 1200. U.S. Federal Register Vol. 44, No. 241.
nop Not otherwise provided for.

Barite and Celestite

G.O. VAGT

Barite

SUMMARY

Canadian shipments of barite in 1982 were valued at $2.4 million, while imports of barium carbonate, one of the most important barium chemicals derived from barite, amounted to 2 500 t valued at $824,000.

Barite ($BaSO_4$) is a valuable industrial mineral because of its high specific gravity (4.5), low abrasiveness, chemical stability and lack of magnetic and toxic effects. Its dominant use is as a weighing agent in the oil- and gas-well drilling muds required to counteract high pressures confined by the substrata.

Barite is found in many countries of the world and is the raw material from which nearly all other barium compounds are derived. The major western world producers of barite are: the United States, Peru, India, Ireland and Morocco.

CANADIAN SCENE

Production

Barite was produced during 1982 from operations in British Columbia, Ontario, Nova Scotia and Newfoundland.

Mountain Minerals Co. Ltd. mines barite underground from vein deposits near Parson and Brisco in eastern British Columbia, and recovers crude barite from lead-zinc tailings at the Mineral King mine near Invermere. All of the crude barite is shipped to the company's grinding plant at Lethbridge, Alberta. Baroid of Canada, Ltd. processes imported crude barite from the United States at its grinding plant in Onoway, Alberta.

Extender Minerals of Canada Limited operates a mine near Matachewan, Ontario from which barite is produced from a vein deposit by open-pit methods, with all beneficiation being done on the site.

Recovery of barite from mine tailings for well drilling commenced in late 1981 on a seasonal basis at the Buchans mine, Newfoundland. Operations in 1982 were limited to less than four months.

Nystone Chemicals Ltd. produces pharmaceutical-grade barium sulphate from a deposit two miles northeast of Brookfield, Nova Scotia. Ore reserves are over 100 000 t virtually free of heavy metals.

CONSUMPTION

In 1981, consumption of barite in Canada was an estimated 94 000 t with over 90 per cent utilized for drilling muds.

The balance of Canada's barite consumption was in the manufacture of ceramic products, chemicals, plastics and brake linings. Barite may become an important ingredient in heavy concrete for nuclear reactors because it reduces the amount of lead shielding required. Data on stocks are not available.

WORLD SCENE

The recession, uncertainty over oil prices and other factors have slowed drilling activity. World production of barite in 1982 was 6.8 million t, according to the United States Bureau of Mines. An estimated 80 per cent of this quantity was consumed in oil-well drilling operations and most barite was supplied by oil-field service companies closely inter-related with the drilling companies. Most of these companies are controlled by or associated with one of the following major United States organizations: Baroid Division of N L Industries, Inc.; Dresser Industries, Inc.; Milchem, Inc.; and Imco Drilling Services, a division of Halliburton Company.

TABLE 1. CANADA, BARITE PRODUCTION AND TRADE, 1981 AND 1982 AND CONSUMPTION, 1980 AND 1981

	1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)
Production (mine shipments)	..	5,124	..	2,359
Imports				
United States	10 962	1,141	8 558	1,185
Ireland	5 000	118	11 500	319
Netherlands	254	72	398	108
Other	62	25	3 001	541
Total	16 278	1,356	23 457	2,153
Exports				
United States	405	196	470	315
United Kingdom	-	-	6	4
Japan	-	-	6	12
Total	405	196	482	331
	1980		1981P	
Consumption[1]				
Well drilling[e]	135 359		89 652	
Rubber goods	915		1 192	
Paint and varnish	1 567		1 598	
Glass and glass products[2]	121		-	
Other[3]	867		1 585	
Total[e]	138 829		94 027	

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

[1] Available data reported by consumers with estimates by Energy, Mines and Resources Canada. Does not include inventory adjustments. [2] Includes glass fibre and glass wool. [3] Other includes bearings and brake linings, chemicals, floor covering, adhesives, explosives, asbestos products, etc.
P Preliminary; [e] Estimated; .. Not available; - Nil.

TABLE 2. CANADA, BARITE PRODUCTION TRADE AND CONSUMPTION, 1970, 1975, AND 1978-82

	Production[1]	Imports	Exports	Consumption[e]
	($)	(tonnes)		
1970	1,388,125	6 827	90 305	50 106
1975	2,305,819	4 479	45 606	40 229
1978	2,656,672	15 635	56 783	58 191
1979	1,953,000	20 765	2 038	96 315
1980	4,380,000	45 157	645	138 829
1981	5,124,000	16 278	405	94 027
1982P	2,359,000	23 457	482	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Mine shipments.
P Preliminary; [e] Estimated; .. Not available.

The United States is by far the world's largest producer of barite and its mines produced an estimated 1.8 million t in 1982, derived mainly from Nevada. More than 90 per cent of this production was used as a weighting agent in drilling muds. Annual imports of barite to the United States during 1981 and 1982 were 1.75 and 2.0 million t respectively. Following the United States, which accounted for 26.7 per cent of the total world production were Peru, 5.5; India, 5.1; Morocco and Thailand each with 4.1; Mexico and Ireland each with 3.7; France, 2.8; Italy, 2.4; Yugoslavia, 0.6; other market economy countries 18.0; U.S.S.R., 7.3 and other centrally planned economies, 16.0.

The United States, the principal consumer of barite, used an estimated 3.8 million t in 1982. However, lower oil- and

TABLE 3. WORLD PRODUCTION OF BARITE 1980-82 AND RESERVES, 1982

	Mine production			Reserves
	1980	1981P	1982e	1982e
	(000 tonnes)			
United States	2 037	2 585	1 814	54 000
China, P.R.	680	771	725	18 000
U.S.S.R.	500	500	499	9 000
Peru	415	409	372	7 000
India	345	354	344	36 000
Morocco	320	327	281	4 000
Mexico	269	318	254	9 000
Thailand	305	300	281	9 000
Ireland	260	260	249	8 000
Chile	226	224	..	..
France	227	209	190	5 000
Canada	86	82	77	18 000
Other free-world countries	1 215	1 137	1 315	32 000
Communist countries	435	430	403	12 000
World totals	7 320	7 906	6 804	221 000

Sources: United States Bureau of Mines, Mineral Commodity Summaries, 1983. U.S. Bureau of Mines Preprint, 1981.
P Preliminary; e Estimated; .. Not available.

gas-well drilling activity in the latter half of 1982 resulted in cutbacks in mine production and output at grinding plants.

In Venezuela, Baroid is expanding a grinding plant and in Turkey the company is building a grinding plant under a joint venture. In Chile, Milchem Inc. completed a jig plant and in the Cameroons a grinding plant was constructed. Perubar S.A. completed a jig plant at the Graciela mine northeast of Lima, Peru. Imports into the United States for the years 1978 to 1981, inclusive, came from the following countries, by per cent: China, 24; Peru, 21; Chile, 13; Morocco, 11; and other 31.

USES

The dominant use for barite is as a weighting agent in oil- and gas-well drilling muds to control their density. Principal specifications usually require a minimum specific gravity of about 4.0, a particle size of 90-95 per cent minus 325 mesh, and a maximum of 250 ppm soluble alkaline earth metals, as calcium.

Barite is used in paint as a special filler or "extender pigment". This is a vital constituent that provides bulk, improves consistency of texture, surface characteristics and application properties, and controls prime pigment settling and the viscosity of paints. Specifications for barite used in the paint industry call for 95 per cent $BaSO_4$, particle size at least minus 200 mesh, and a high degree of whiteness or light reflectance. Final "wet milled" and "floated" products result in smooth micro-crystalline surfaces that prevent agglomeration, thus allowing easy dispersal in water as well as in oil-soluble binders. A degree of light scattering is attributed to barite used in highly pigmented distemper or latex paints, allowing it to function as a pigment.

The glass industry uses barite to increase the workability of glass, to act as a flux, assist decolouration and increase the brilliance or lustre of the product. Specifications require a minimum of 96 to 98 per cent $BaSO_4$, a particle size range of 40 to 140 mesh and usually a magnetically separated ore is used with iron often reduced to 0.1 per cent. However, producers of fine glassware use precipitated barium carbonate to circumvent impurity problems often associated with natural barite.

The specifications for natural barite used as a filler in rubber goods vary, but the main factors are whiteness and particle size range. For general filler and extender uses most manufacturers want a fine-grained product that is virtually all minus 325 mesh. Colour is important to many users.

OUTLOOK

In 1982, 6,561 wells or 7.2 million m were drilled in Canada according to preliminary statistics, compared to 1981 when 7,186 wells or 8.2 million m were drilled. In 1983 drilling activity is expected to be about 10 per cent more than in 1982. Factors such as foreign demand for natural gas, taxation policies, the extent of jurisdictional disputes over ownership of offshore rights and the relative amount of drilling activity in the conventional and offshore regions will influence future needs of barite for oil- and gas-well drilling activity.

There is good potential for discovery and development of barite deposits near most regions in the world where there is drilling activity. However, increasing rail transportation rates in North America and downward trending prices of foreign ores in response to oversupply, may provide additional incentives for overseas suppliers to penetrate N.A. markets. On the other hand, restrictions on exports of crude barite in favour of ground barite, or other possible disruptions to world trade, could place more emphasis on exploration for barite in North America.

PRICES

Listed prices of domestic U.S. drilling mud grade barite changed little in 1982 and large inventories encouraged price cutting.

PRICES

United States prices of barite as reported in Engineering and Mining Journal[1], of December 1982.

	($ per short ton)
Unground	
Chemical and glass grade:	
Hand picked, 95% $BaSO_4$, not over 1% Fe	90.00
Magnetic or flotation, 96-98% $BaSO_4$, not over 0.5% Fe	105.00
Imported drilling mud grade, specific gravity 4.20 - 4.30, cif Gulf ports	32.00-59.00
Ground	
Water ground, 95% $BaSO_4$ 325 mesh, 50-lb bags	80.00-155.00
Dry ground, drilling mud grade, 83%-93% $BaSO_4$, 3-12% Fe, specific gravity 4.20-4.30	87.00-120.00
Imported	
Specific gravity 4.20-4.30	65.00-75.00

[1] Published by McGraw-Hill.

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
49205-1	Drilling mud and additives	free	free	free	free
68300-1	Barytes	free	10	25	free
92818-1	Barium oxide, hydroxide peroxide	10	9.4	25	6
92842-1	Barium carbonate	10	14.1	25	9
93207-5	Lithopone	free	11.8	25	free

MFN REDUCTIONS UNDER GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
			(%)			
92818-1	9.4	7.5	5.6	3.8	1.9	free
92842-1	14.1	13.8	13.4	13.1	12.8	12.5
93207-5	11.8	11.5	11.3	11.0	10.8	10.5

UNITED STATES (MFN)

	Barium carbonate:	
472.02	Natural, crude (witherite)	free
472.06	Precipitated	0.5¢ per pound
	Barium sulfate:	
472.10	Natural, crude (barytes)	$1.27 per long ton
472.12	Natural, ground (barytes)	$3.25 per long ton
472.14	Precipitated (blanc fixe)	0.2¢ per pound
473.72	Lithopone	2.5%
473.74	Lithopone	4.7%

		1982	1983	1984	1985	1986	1987
				(%)			
472.04	Barium carbonate, natural ground (witherite)	5.3	5.1	4.9	4.7	4.4	4.2

Sources: The Customs Tariff and Commodities Index, January 1982, Revenue Canada; Tariff Schedules of the United States Annotated (1982), USITC Publication 1200; U.S. Federal Register Vol. 44, No. 241.

Celestite

SUMMARY

There has been no Canadian production of celestite ($SrSO_4$), the main source of strontium, since Kaiser Celestite Mining Limited, a subsidiary of Kaiser Aluminum & Chemical Canada Investment Limited, closed its mining operation at Loch Lomond, Nova Scotia and its strontium products plant at Point Edward, Nova Scotia, in 1976.

NORTH AMERICAN SCENE

North American consumers continue to depend totally on imports of strontium minerals. The strontium-mining industry in the United States has been dormant since 1959 and Mexico and West Germany are the major suppliers of celestite and strontium compounds to the U.S. market.

Consumption of strontium in the United States in 1982 was approximately 15 000 t valued at $0.95 million. Demand for strontium in the United States from a 1978 base is expected to increase at an annual rate of about 1.3 per cent through 1990, according to the United States Bureau of Mines.

USES

Celestite is used to produce commercial strontium compounds, principally strontium carbonate and strontium nitrate. In the sulphate form it is used for purifying electrolytic zinc. Strontium carbonate is primarily used in glass faceplates for colour television picture tubes where it improves the absorption of X-rays emitted by the high voltage tubes. Other uses include pyrotechnics and signals, and ferrite ceramic permanent magnets used in small electric motors.

PRICES

United States prices of celestite according to Chemical Marketing Reporter, December 27, 1982

	($ per short ton)
Strontium carbonate glass grade, bags, truckload, works	655.00
	($ per 100 pounds)
Strontium nitrate, bags, carlot, works	24.00

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
92839-5	Strontium nitrate	free	free	free	free

UNITED STATES, MFN Reductions under GATT (effective January 1 of year given)

Item No.		1982	1983	1984	1985	1986	1987
					(%)		
Strontium metal:							
473.19	Chromate	4.5	4.4	4.2	4.0	3.9	3.7
632.46	Unwrought, waste and scrap	4.5	4.4	4.2	4.0	3.9	3.7
632.68	Alloys	5.8	5.3	4.7	4.1	3.6	3.0
Strontium compounds:							
421.70	Carbonate, not precipitated		Remain free				
421.72	Carbonate, precipitated	5.3	5.1	4.9	4.7	4.4	4.2
421.74	Nitrate	5.3	5.1	4.9	4.7	4.4	4.2
421.76	Oxide	5.3	5.1	4.9	4.7	4.4	4.2
421.82	Sulfate, mineral (celestite)		Remain free				
421.84	Sulfate, other	4.5	4.4	4.2	4.0	3.9	3.7
421.86	Other	4.5	4.4	4.2	4.0	3.9	3.7

Sources: The Customs Tariff and Commodities Index, January 1982, Revenue Canada; Tariff Schedules of the United States Annotated (1982), USITC Publication 1200; U.S. Federal Register Vol. 44, No. 241.

Beryllium

W. McCUTCHEON

Beryllium is a light metal rarely seen in the pure form. It has a specific gravity of 1.846, between aluminum and magnesium, but a tensile strength considerably greater than either of those metals. It has a high melting point (1290°C) and useful nuclear moderating and reflecting properties.

Beryllium is used in the alloy, oxide and metal forms. An estimated 1.7 million kWh of energy are required to convert beryl into 1 t of beryllium metal. Distribution of demand in the United States by end-use in 1979 was: 20 per cent nuclear reactors, 18 per cent aerospace, 53 per cent electrical and electronic, and 9 per cent other. World reserves are very large in relation to demand.

OCCURRENCES

Canada. Beryllium-containing deposits have been reported in over 75 locations throughout Canada; nearly all are related to granitic intrusions. Past attempts to recover beryllium either as a primary product or as a byproduct from deposits in Canada were not economically viable on a sustained basis.

In late 1982, the Iron Ore Company of Canada announced that it would study the development of its Strange Lake deposit on the Newfoundland-Quebec border. The high-grade yttrium and zirconium deposit, discovered in 1979 by the Geological Survey of Canada, also contains beryllium silicate and could yield byproduct beryllium as either marketable grade BeO or a hydroxide. The feasibility of mining the large deposit by open-pit methods will be examined throughout 1983.

World. There are two main sources of beryllium: beryl and bertrandite. Beryl, the traditional source, is found in crystalline form in pegmatite dikes. Because these deposits are generally small, requiring hand sorting and cobbing, the majority of beryl mining takes place in developing countries. Brazil and China are the most important sources of imported beryl for the United States.

In 1969, a bertrandite deposit was discovered in Utah amenable to open-pit mining and upgrading by wet concentration. This non-pegmatitic deposit is the only U.S. domestic source of beryllium of any significance and is responsible for a large portion of the world's beryllium supply. Proven ore reserves at the end of 1982 were 3.9 million t grading 0.23 per cent beryllium.

PRODUCTION

Production data are incomplete due to confidentiality regulations in the United States and inadequacy of data for China, Bolivia and Namibia. Available data on world beryllium production are shown in Table 1 and on beryl production in Table 2. Beryllium contained in ore concentrate from Brush Wellman's bertrandite source declined from 221 t in 1980 and 1981 to 163 t in 1982.

The majority of the world's beryllium production is handled at some point by either Brush Wellman Inc. or Cabot Wrought Products Division of the Cabot Corporation in the United States. Brush Wellman has operated an open-pit mine at its bertrandite deposit in the volcanic tuff beds of the Topaz-Spor Mountain area of Utah since 1969. The output from the mine and imported beryl are processed in separate circuits at the company's mill in Delta, Utah, into beryllium hydroxide. This is later processed into beryllium metal, beryllium-copper (Be-Cu) master alloy and beryllium oxide. Cabot Wrought Products, formerly Kawecki Berylco Industries, Inc. until purchased by the Cabot Corporation, obtains beryllium hydroxide from Brush Wellman to produce Be-Cu master alloy. Roskill Information Services Ltd. reported that metal recovery from beryl is said to be 60-65 per cent while recovery of Be-Cu alloy from beryl is about 70 per cent.

CONSUMPTION

Canadian consumption data are not available. Import data shown in Table 3 for 1979-82 imply that consumption of metal decreased in 1982 while beryllium alloy consumption fell in 1981 and remained depressed in 1982. However, changes in stocks may also explain import trends. World consumption data are not available in detail. There is no direct relationship between world production and world consumption due to unannounced changes in the substantial stocks held by consumers, producers and governments. As noted beryllium and beryl production figures are incomplete.

USES

Three forms of beryllium are consumed: beryllium-copper and other alloys, beryllium metal and beryllium oxide (in decreasing order of importance). Beryllium-copper

TABLE 1. WORLD MINE PRODUCTION OF BERYLLIUM, 1980 TO 1982

	1980	1981	1982[e]
	(tonnes)		
Brazil	31	22	24
Argentina	3	1	1
Zimbabwe	2	-	-
South Africa, Republic of	-	3	4
Rwanda	-	3	4
Other market economy countries	3	3	3
Central economy countries	73	73	73
Sub Total	112	105	109
United States	w	w	w
China	..	..	..

Source: United States Bureau of Mines Mineral Commodity Summaries, 1982 and 1983.

w United States production figures are withheld to avoid disclosing confidential data, and therefore are not included in world totals; .. not available; [e] Estimated; - Nil.

TABLE 2. ESTIMATED WORLD PRODUCTION OF BERYL, 1978-81

Country	1978	1979	1980P	1981[e]
	(tonnes)			
U.S.S.R.[e]	1 751	1 814	1 814	1 814
Brazil	739	454	500	544
Republic of South Africa	4	1	...	100
Rwanda	58	46	107	90
Argentina	22[r]	12	31	30
Mozambique	..	28	20	18
Zimbabwe	35[r]	28	9	10
Madagascar	11	10[e]	10	9
Other Countries	-	5	19	18
World total[1]	2 620	2 398	2 510	2 633

Source: U.S. Bureau of Mines Minerals Yearbook Preprint, 1981.
[1] United States figures are withheld to avoid disclosing confidential data and therefore are not included in world totals. Data are inadequate for estimates of production from China, Bolivia and Namibia.
P Preliminary; [r] Revised; [e] Estimated; .. Not available; ... Under ½ unit; - Nil.

TABLE 3. CANADA, BERYLLIUM IMPORTS, 1979-82

	1979		1980		1981		1982P	
	(kg)	($ 000)	(kg)	($ 000)	(kg)	($000)	(kg)	($000)
Beryllium metal	3 040	224	3 606	224	4 501	225	2 192	166
Beryllium alloys	25 872	360	8 537	155	4 411	82	4 522	83

Source: Statistics Canada.
P Preliminary.

alloys (0.25-2.15 per cent Be) consume the greatest amounts of beryllium. The addition of beryllium improves the physical properties of copper. The increased strength, hardness and excellent conductivity of wrought or cast Be-Cu alloy makes it excellent for springs, electrical/electronic connectors and contacts, diaphrams, injection molds for plastic and for some applications in oil and gas drilling.

Powder metallurgy is the preferred method to fabricate beryllium metal as the metal develops coarse crystals when cast. Use of the high priced metal is justified by its superior strength and stiffness relative to density in aerospace use for structural applications, navigational systems and aircraft brakes. Beryllium metal's high moderating ratio and high neutron reflection properties have led to its use in reactors despite embrittlement after long exposure to radiation. Defence and energy related uses are estimated to account for over 90 per cent of beryllium metal consumption.

Beryllium oxide ceramics have excellent insulating properties, high thermal conductivity and thermal shock resistance. Applications include heat sinks, lasers, and substrata for dense electronic circuits. Beryllium oxide has superior microwave transmission characteristics, hence it is used for radomes and microwave windows.

Beryl is an important source of gem stones. When pure, the mineral is colourless but impurities impart a variety of colours to produce gems such as the green-coloured emerald and the sea blue variety called aquamarine. Most of the world's emeralds come from Colombia, Brazil and Russia.

HEALTH AND SAFETY

Exposure to small concentrations of beryllium dust has been recognized as the cause of berylliosis, a serious chronic lung disorder. More restrictive exposure limits were proposed in the United States in 1975. This was followed by public hearings and submission of additional information. To date, changes to standards have not been finalized.

SPECIFICATIONS AND PRICES

Quoted U.S. prices of beryl, beryllium-copper alloy and beryllium rod are shown below.

PRICES

	1982 price range ($U.S.)
Beryl ore, per metric ton unit	110.23 - 148.81
U.S. beryllium copper alloy 25; 2% Be content, available in strip, rod, bar and wire, per kilogram	14.57 - 15.65
U.S. beryllium copper casting ingot, alloy 20C, 2-2¼% Be, 5-pound ingots, per kilogram	10.14 - 10.91
U.S. beryllium copper master alloy, 4% Be, 5-pound ingots, per kilogram	266.76 - 286.60
Beryllium rod, 5-inch diameter, delivered price, per kilogram	532.17

Source: Metals Week.

OUTLOOK

The majority of beryllium is used to make Be-Cu alloys. Use of the metal itself is strongly related to levels of military expenditures. Beryllium oxide uses are expected to increase with high growth of the electronics industry. Primary beryllium demand was forecast by the United States Bureau of Mines (USBM) to grow at an annual rate of 0.5 per cent for the United States and 0.4 per cent for the rest of the world. New uses for beryllium to be discovered could significantly increase demand.

The producers evidently expect future demand to grow as Brush Wellman and Cabot announced expansion plans. Brush Wellman will spend $US 13 million to expand Be-Cu round products production at its Elmore, Ohio plant. Cabot increased its Be-Cu processing capacity in 1982 by opening a new $US 58 million mill at Kokomo, Ind. for Be-Cu and other specialty metals.

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			%		
34907-1	Copper beryllium alloys	4.6	4.6	25	free
35101-1	Beryllium metal	free	4.6	25	free

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
				%		
34907-1	4.6	4.5	4.4	4.3	4.1	4.0
35101-1	4.6	4.5	4.4	4.3	4.1	4.0

UNITED STATES (MFN)

417.90	Beryllium oxide or carbonate	3.7%
601.09	Beryllium ore	free
628.05	Unwrought beryllium, waste and scrap (duty on waste and scrap suspended to June 30, 1981)	8.5%
628.10	Beryllium, wrought	9.0%

		1982	1983	1984	1985	1986	1987
					%		
612.20	Beryllium copper master alloy	8.9	8.3	7.7	7.2	6.6	6.0
417.92	Other beryllium compounds	4.5	4.4	4.2	4.0	3.9	3.7

Sources: The Customs Tariff and Commodities Index, January 1982, Revenue Canada; Tariff Schedules of the United States Annotated 1982, USITC Publication 1200; U.S. Federal Register, Vol. 44, No. 241.

Calcium

W. McCUTCHEON

The effects of world recession on the metal fabricating industry combined with reduced sales of U.S. automobiles continued to inhibit the demand for calcium metal. The United States market remained the most significant for Canadian calcium metal exports.

Calcium is a light element (specific gravity of 1.55) with a low tensile strength (48 MPa) and a melting point of 839° C. It is the fifth most abundant element and third most abundant metal in the earth's crust, occurring abundantly in limestones, gypsum, fluorite and apatite, and in solution in sea water. This element is essential to all plant and animal life. Calcium metal is highly reactive and therefore does not occur in nature in the pure state. The metal is soft, ductile and easily shaped. Metallic calcium is used as a reducing agent and as an alloying element with other metals.

Metallic calcium can be produced either by electrolysis or by the aluminothermic reduction of lime. The latter method is used exclusively by the four producers in the non-communist world.

CANADIAN INDUSTRY

Since Chromasco Limited is the only producer in Canada, data on Canadian production and trade are no longer published for reasons of confidentiality. This company produces a number of metals and alloys at its metallurgical plant at Haley, near Renfrew, Ontario. To make calcium, high-purity quicklime (CaO) and commercially pure aluminum are briquetted, and the briquettes are charged into horizontal electric retorts. Under vacuum, the aluminum reduces the quicklime so that calcium is liberated as a vapour which crystallizes in a water-cooled condenser section of the retort at about 700°C. The crystallized product, known as "crowns", is about 98 per cent Ca. Higher purities are obtained by subsequent refining operations.

Chromasco markets four calcium products. There is a commercial grade which is 98.0 per cent minimum calcium with maximum contents of 0.5 per cent aluminum and 1.5 per cent magnesium. The battery grade is 98.5 per cent minimum calcium with maximum contents of 0.45 per cent aluminum, 0.5 per cent magnesium and 0.015 per cent nitrogen. The redistilled grade is 99.4 per cent minimum calcium with maximum contents of 0.01 per cent aluminum, 0.5 per cent magnesium, 0.006 per cent nitrogen, 0.005 per cent iron, 0.005 per cent manganese, 0.0006 per cent chromium, 0.001 per cent chromium plus copper plus nickel and 0.003 per cent silicon. Finally, there is a 75/25 calcium alloy nominally 75 per cent calcium (ranging from 72 to 78.5 per cent) with 0.5 to 1.5 per cent magnesium and the balance, nominally 25 per cent, aluminum.

The United States was the most important export market for Canadian calcium metal in 1982, followed by Australia, western Europe and Mexico. Domestic sales were also a significant portion of total sales.

WORLD MARKETS

Non-communist metallic calcium production in Canada, France, Japan and the United States was estimated to be about 1 360 t by the United States Bureau of Mines in 1982. Production from China and the U.S.S.R. was estimated at about 450 t.

Canadian production was estimated to be about 35 per cent of non-communist production by the United States Bureau of Mines. Other producers were: Planet-Wattohm S.A., a subsidiary of Compagnie de Mokta, which exported about 10.9 t of metal to the United States; Furukawa Magnesium Company of Japan; China Nuclear Energy Industry Corp. of the Peoples Republic of China which exported about 86.4 t of metal to the United States; the U.S.S.R. which apparently did not export any metal in 1982.

PRICES

The United States producer list price for calcium metal crowns remained at $US 3.05/lb in 20,000 lb lots. United States producer list price for calcium-silicon alloy (28-32 per cent Ca, 62-67 per cent Si, maximum 0.3 per cent Fe) was reduced from $US 0.82/lb to $US 0.66/lb on August 1, 1982 for 40,000 lb lots and remained at that level to year-end.

USES

Calcium's powerful reducing properties make it valuable in the manufacture of many of the less common metals such as columbium, tantalum, chromium, plutonium, titanium, thorium, tungsten, uranium, yttrium, vanadium and zirconium. In nonferrous metallurgy, its uses are in debismuthizing lead; as an alloying additive to harden lead plate storage battery grids in the "maintenance free" battery; and as an alloying element with magnesium and aluminum. Calcium metal, calcium compounds and ferrosilicon alloys containing calcium are widely used in ferrous metallurgy to control grain size, inhibit carbide formation, improve ductility and reduce internal flaws in castings. In addition, some calcium metal is used as a reducing agent in manufacturing rare earth magnetic alloys, in the preparation of Vitamin B, and in a number of chemicals.

OUTLOOK

Demand for calcium metal should increase with the economic recovery expected in 1983. Increased automotive sales would increase demand for calcium used to make steel and batteries.

TARIFFS

CANADA

Item No.	British Preferential	Most Favoured Nation	General	General Preferential
		(%)		
92805-1 Calcium Metal	10	12.8	25	8.5

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
			(%)			
92805-1	12.8	12.1	11.4	10.7	9.9	9.2

UNITED STATES (MFN)	1982	1983	1984	1985	1986	1987
			(%)			
632-16 Calcium, unwrought, waste and scrap	5.8	5.3	4.7	4.1	3.6	3.0
633-00 Calcium, wrought	7.7	7.3	6.8	6.4	5.9	5.5

Sources: The Customs Tariff and Commodities Index, Revenue Canada; Tariff Schedules of the United States Annotated (1981), USITC Publication 1111; U.S. Federal Register Vol. 44, No. 241.

Cement

D.H. STONEHOUSE

SUMMARY 1982

Total cement shipments from Canadian plants in 1982 were down about 20 per cent from 1981 which in itself was not a good year. Capacity, unchanged at 15.920 million tpy, was only 50 per cent utilized. Domestic demand was reduced quite evenly across the country with Quebec and Atlantic Canada being the hardest hit by lack of, or postponed, construction projects. In western Canada, which enjoyed increased construction activity during most of the last decade, demand dropped off slightly in 1981 and by a further 16 per cent in 1982.

Exports of cement were down about 8 per cent while clinker exports were down about 45 per cent. The principal market for clinker has been in the State of Michigan where both Lake Ontario Cement Limited and St. Marys Cement Limited operate grinding plants supplied with clinker from their Ontario plants. The troubled auto industry has been the cause of severely reduced demand for cement in this region.

The cement industry cannot conveniently scale down operations in response to weak demand without suffering much higher unit production costs. For example, three-and-four kiln plants can stop clinker production from one or two kilns, but operating costs are not proportionately reduced. In fact, labour costs may be down only 15 to 20 per cent and many other costs may not be reduced at all. One-kiln operations have no alternative but to close down while inventories are reduced and to absorb the high, unproductive costs of start-up. Temporary layoffs and plant closures through 1981 gave way to extended layoffs and plant closures during 1982. The beginning of 1983 offers no immediate solution. The first quarter of the year is normally the period of lowest demand for cement.

In Canada, construction is categorized broadly as building construction and engineering construction, and the values of each type, discounted by inflationary factors, provide a basis for comparison of annual construction in place. In current dollars, construction is credited with about 17 per cent of gross national expenditure. In 1982 capital and repair expenditure on construction was $55.7 billion, down about 2 per cent from expenditures in 1981. Housing starts in 1982 were only 125,860, down from 177,973 starts in 1981. Expectations are that demand for single detached units will decrease and that total starts of all types will be less than 160,000 units.

Canada Cement Lafarge Ltd., Canada's largest cement producer, with well-integrated operations from coast to coast, chose some time ago to expand into the United States. The company is now 56 per cent owned by Lafarge Coppée, of Paris. In 1973 an investment was made in Citadel Cement Corporation with plants in Demopolis and Birmingham, Alabama, the latter plant being converted to a distribution centre in 1980. By late-1981 arrangements were completed for the purchase of General Portland Inc., the third largest cement company in the United States. Canada Cement pursued a policy of acquisition by which capacity could be obtained at well below replacement costs. During 1982, in settlement of an anti-trust complaint and with the approval of the U.S. Federal Trade Commission, Canada Cement arranged to sell General Portland's Chattanooga Tenn. plant to R C Cement Co. of St. Louis, Mo. Nearly half of the company's combined assets are now in the U.S.

The seriousness of the depressed markets in Canada was evidenced by August 1982 when Canada Cement announced closure of its Floral, Saskatchewan grinding plant and its Woodstock, Ontario and Fort Whyte, Manitoba clinker-producing plants. The company's Richmond, British Columbia plant closed in September and its Brookfield, Nova Scotia plant was closed in November. All

TABLE 1. CANADA, CEMENT PRODUCTION AND TRADE, 1981 AND 1982

	1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)
Production[1]				
By province				
Ontario	3 595 000	235,994	2 800 000	215,208
Quebec	2 573 000	168,919	2 307 000	129,987
Alberta	1 455 000	94,848	1 468 000	112,830
British Columbia	737 000	48,405	776 000	70,352
Nova Scotia	..	31,549	..	27,670
Manitoba	627 000	41,132	275 000	21,137
Saskatchewan	369 000	24,205	206 000	15,833
New Brunswick	..	15,304	..	13,066
Newfoundland	..	5,580	..	4,304
Total	10 145 000	665,936	8 418 000	610,387
By type				
Portland	9 784 000	..	8 152 000	..
Masonry[2]	361 000	..	266 000	..
Total	10 145 000	665,936	8 418 000	610,387
Exports				
Portland cement				
United States	1 513 379	65,695	1 464 650	66,829
Saudi Arabia	60 001	2,561	285 339	12,446
St. Pierre and Miquelon	1 634	160	1 555	189
Other countries	3 644	271	597	59
Total	1 578 658	68,687	1 752 141	79,523
Cement and concrete basic products				
United States	..	34,237	..	30,103
Other countries	..	1,351	..	1,870
Total	..	35,588	..	31,973
Imports				
Portland cement, standard				
United States	469 643	32,508	180 953	14,442
United Kingdom	-	-	64	9
France	-	-	1	--
Total	469 643	32,508	181 018	14,451
White cement				
United States	4 716	386	5 745	453
Japan	477	83	1 422	241
France	50	6	-	-
Total	5 243	475	7 167	694
Aluminous cement				
United States	14 251	2,833	7 749	918
People's Republic of China	-	-	20	8
South Africa	8	11	-	-
United Kingdom	-	-	2	--
Total	14 259	2,844	7 771	926

TABLE 1. (cont'd)

	1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)
Cement, nes				
United States	189 255	19,175	35 291	4,797
Japan	-	-	250	44
United Kingdom	1 330	85	67	9
West Germany	76	10	30	4
France	4	1	14	2
Italy	124	15	6	1
Switzerland	1	..	-	65
Total	190 790	19,286	35 658	4,857
Total cement imports	679 935	55,113	231 614	131,594
Refractory cement and mortars				
United States	..	14,474	..	12,308
Ireland	..	1,552	..	625
Austria	..	50	..	157
West Germany	..	200	..	88
United Kingdom	..	75	..	21
Other countries	..	1	..	65
Total	..	16,352	..	13,264
Cement and concrete basic products, nes				
United States	..	3,016	..	2,712
Japan	..	8	..	64
Austria	..	-	..	11
France	..	7	..	3
United Kingdom	..	11	..	2
Other countries	..	3	..	9
Total	..	3,045	..	2,801
Cement clinker				
United Kingdom	334	156	180	63
United States	18 336	831	36	29
Japan	22 600	975	-	-
Total	41 270	1,962	216	92

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Producers' shipments plus quantities used by producers. [2] Includes small amounts of other cement.
P Preliminary; .. Not available; - Nil; nes Not elsewhere specified; -- Amount too small to be expressed.

closures are temporary but of unknown duration pending recovery in demand for cement and concrete.

Although suffering the same adverse market conditions as other cement producers through 1982, Lake Ontario Cement Limited continued to integrate into the concrete industry with the purchase of KVN Ready-Mix Concrete, a division of Kilmer Van Nostrand Co. Limited. Lake Ontario Cement serves the eastern Great Lakes region of Canada and the United States. To augment its fleet of two cement carriers the company purchased a lake freighter with a capacity of about 8 000 t of cement from the CSL Group Inc. in late-1982.

St. Marys Cement Limited, which continues to develop its markets in the United States, particularly in the Michigan/Wisconsin region, purchased the cement distribution facilites at Milwaukee and at Green Bay from Lehigh Portland Cement

TABLE 2. CANADA, CEMENT PRODUCTION, SHIPMENTS, TRADE AND CONSUMPTION, 1970, 1975, 1978-82

	Production	Shipments[1]	Exports[2]	Imports[2]	Apparent Consumption[3]
			(tonnes)		
1970	7 304 813	7 208 413	513 941	88 172	6 782 644
1975	9 740 502	10 193 984	934 981	420 430	9 679 433
1978	10 472 724	10 558 279	1 634 583	219 925	9 143 621
1979	11 459 509	11 765 248	2 288 822	194 433	9 670 859
1980	10 340 302	10 274 000	1 527 483	222 751	8 969 268
1981	10 152 199	10 145 000	1 578 658	679 935	9 246 277
1982P	8 080 038	8 418 000	1 752 141	231 614	6 897 473

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

[1] Producers' shipments plus quantities used by producers. [2] Does not include cement clinker, but does include exports from other than producer plants. [3] Producers' shipments plus imports, less exports.
P Preliminary.

Co. of Allentown, Pa. The centres will operate as St. Marys Wisconsin Cement Inc.

CANADIAN SCENE

The Canadian cement industry is strongly regionalized on the basis of market availability. Capacity concentration is closely aligned to population density, reflecting the importance of transportation costs to the consumer. The availability and cost of energy could weigh just as heavily as product transportation costs on decisions regarding new plant locations in future, and perhaps even on the viability of existing plants.

The three plants in the **Atlantic region** constitute about 6 per cent of total clinker producing capacity. All three obtain raw materials at or near the plant site. North Star Cement Limited purchases gypsum from Flintkote Holdings Limited, which quarries at Flat Bay about 65 km south of Corner Brook while National Gypsum (Canada) Ltd. supplies the Brookfield plant of Canada Cement Lafarge Ltd. (CCL) from its Milford, Nova Scotia quarry. CCL's New Brunswick plant contracts the quarrying of its own gypsum at Havelock. The region consumed 364 100 t of cement in 1982 according to Canadian Portland Cement Association data. This is down 15.7 per cent from 1981 and represents 6.1 per cent of Canadian consumption.

In the **Quebec region** the five clinker-producing plants have 23 per cent of the Canadian total in an area that has 26.1 per cent of Canadian population and which, in 1982, consumed about 1.2 million t of portland cement or 20 per cent of total consumption, down 24.3 per cent from 1981. The depressed construction markets through 1981 and 1982 led CCL to close its Hull, Quebec terminal and to forego the rehabilitation of its Montreal East plant. At its St. Constant plant, south of Montreal, CCL began to test the use of waste tires and rubber as an alternate fuel, as part of a program administered by the federal departments of Environment and Energy, Mines and Resources - Development and Demonstration of Resources and Energy Conservation Technology.

Miron Inc. continued a $13 million anti-pollution program ranging from site protection to the utilization of methane gas from a garbage disposal project on the company's property. St. Lawrence Cement Inc. continued the energy-saving efforts begun in 1981 at its two Quebec plants. The company manages its United States operations through Independent Cement Corporation headquartered in Albany, N.Y. Ciment Québec Inc. continued through 1982 with the installation of a Fuller suspension preheater with a precalciner flash furnace system of 2 000 tpd capacity to replace the existing wet plants.

TABLE 3. CEMENT PLANTS, APPROXIMATE ANNUAL GRINDING CAPACITY, END OF 1982

Company	Plant	Wet, Dry, Pre-heater	Fuel (Coal Oil Gas)	No. of Kilns	Grinding Capacity Tonnes a Year (000)	Clinker Capacity Tonnes a Year (000)
Atlantic						
Canada Cement Lafarge Ltd.	Brookfield, N.S.	D	C,O	2	580	469
	Havelock, N.B.	D	C,O	2	330	274
North Star Cement Limited	Corner Brook, Nfld.	Dx	O	1	250	130
Atlantic Region Total				5	1 160	873
Quebec						
Canada Cement Lafarge Ltd.	St. Constant	D	O,G	2	950	910
Ciment Québec Inc.	St. Basile	W	O	2	450	305
Miron Inc.	Montreal	D	O,G	2	1 000	838
St. Lawrence Cement Inc.	Beauport	W	C,O	2	625	623
(Independent Cement Inc.)	Joliette	D	C,O	4	1 000	976
Quebec Region Total				12	4 025	3 652
Ontario						
Canada Cement Lafarge Ltd.	Woodstock	W	C,G	2	842	455
	Bath	Dx	O,G	1	770	866
Federal White Cement	Woodstock	D	O	1	100	96
Lake Ontario Cement Limited	Picton	D,Dx	C,G	4	750	1 442
St. Lawrence Cement Inc.	Clarkson	W,Dx	C,O,G	3	1 986	2 000
St. Marys Cement Limited	Bowmanville	W	C	2	790	602
	St. Marys	W,Dx	O,G	3	800	991
Ontario Region Total				16	6 038	6 452
Prairies						
Canada Cement Lafarge Ltd.	Fort Whyte, Man.	W	O,G	2	498	465
	Floral, Sask.				220	
	Exshaw, Alta.	D,Dx	G	3	1 180	1 170
	Edmonton, Alta.				215	
Genstar Cement Limited	Winnipeg, Man.	W	O,G	1	325	305
	Regina, Sask.	D	O,C	1	250	236
	Edmonton, Alta.	W,Dx	G	4	1 022	1 182
Prairies Region Total				11	3 710	3 358
British Columbia						
Canada Cement Lafarge Ltd.	Kamloops	D	G	1	392	190
	Richmond	W	O,G	2	404	445
Genstar Cement Limited	Tilbury Island	Dx	O,G	1	1 042	950
B.C. Region Total				4	1 838	1 585
CANADA TOTAL (9 companies)				48	16 771	15 920

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

TABLE 4. CANADA, CEMENT PLANTS, KILNS AND CAPACITY UTILIZATION, 1976-82

	Clinker Producing Plants	Kilns	Approximate Cement Grinding Capacity[1]	Portland Cement Production[2]	Clinker Exports[3]	Approximate Total Production[4]	Capacity Utilization
			(tpy)	(t)	(t)	(t)	(%)
1976	22	51	14 987 000	9 515 452	645 377	10 160 829	70
1977	22	49	14 885 000	9 639 679	775 145	10 414 824	72
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

Sources: Statistics Canada, U.S. Bureau of Mines, Portland Cement Association (PCA)

[1] Includes two plants that grind only. [2] Producers' shipments and amounts used by producers. [3] Imports to United States from Canada. [4] Cement shipments plus clinker exports.

Portland cement consumption was down 22 per cent in the **Ontario region** maintaining 32 per cent of total Canadian consumption. The region has 40 per cent of the nation's clinker producing capacity. Canada Cement Lafarge Ltd. has brought into production about 3 million t of new cement capacity over the past seven years and currently over half of its operating kilns are less than 10 years old. The limestone for CCL's Bath, Ontario plant is quarried on site while silica is supplied from a Potsdam sandstone at Pittsburgh about 65 km east of Bath and iron oxide is purchased from Hamilton. Gypsum is from Nova Scotia. The Woodstock plant has experimented with the use of selected, processed garbage as fuel. The plant obtains limestone on site, silica from Indusmin Limited, iron oxide from Stelco Inc. and gypsum from southern Ontario mines.

At Picton, Lake Ontario Cement Limited operates one of the largest cement producers in North America. The four-kiln plant supplies cement and clinker to its U.S. subsidiaries - Rochester Portland Cement Corp. in New York state and Aetna Cement Corporation in Michigan - and cement to its Ontario markets.

At its Mississauga plant, St. Lawrence Cement Inc. has continued to research energy saving techniques. The company obtains limestone from Ogden Point, 160 km east of Toronto on the shore of Lake Ontario and gypsum is purchased from Nova Scotia or from southern Ontario mines.

The Bowmanville plant of St. Marys Cement Limited was expanded in 1973 with the addition of a second kiln. With the acquisition of Wyandotte Cement Inc., the company began shipments of clinker through a newly constructed lakefront loading facility at Bowmanville. The original plant at St. Marys, constructed in 1912 to serve the Toronto area, has been expanded and modernized over the years, most recently with the installation of a 680 000 tpy kiln and four-stage suspension preheater.

Federal White Cement's plant at Woodstock, can produce up to 100 000 tpy of white cement. Limestone is purchased from Canada Cement Lafarge's Woodstock quarry.

Two companies, Canada Cement Lafarge Ltd. and Genstar Cement Limited operate a total of five clinker producing plants in the **Prairie region** and three in the **Pacific region** along with two clinker grinding plants. This **Western region** has 31 per cent of clinker producing capacity, including the recently completed expansion at Genstar's Edmonton, Alberta plant and removing the capacity of that company's Bamberton, British Columbia plant. Consumption of portland cement in the western provinces accounted for 41.4 per cent of Canadian total. Cement and clinker were again imported from the eastern producers to meet the high demand. Expansion at Edmonton and at Exshaw increased capacity by about 1.3 million tpy through 1981.

Canada Cement Lafarge Ltd., completed expansion of its Exshaw, Alberta plant and a

TABLE 5. CANADA, DISTRIBUTION OF DOMESTIC CEMENT SALES[1] FROM PRODUCERS' PLANTS, 1978-1982

	1978	1979	1980	1981	1982
		(tonnes)			
Quebec					
Portland	1 818 456	1 817 792	1 609 900	1 580 769	1 196 120
Masonry	80 672	78 617	68 564	66 785	49 973
Total	1 899 128	1 896 409	1 678 464	1 647 554	1 246 093
Ontario					
Portland	2 819 248	2 734 519	2 537 150	2 507 932	1 953 964
Masonry	171 622	173 507	144 394	150 835	102 328
Total	2 990 870	2 908 026	2 681 544	2 658 767	2 056 292
Other Provinces					
Portland	3 720 725	3 875 740	3 815 150	3 669 306	2 843 879
Masonry	63 273	66 698	59 470	56 269	37 265
Total	3 783 998	3 942 438	3 874 620	3 725 575	2 881 144
Canada					
Portland	8 358 429	8 428 051	7 962 200	7 758 007	5 993 963
Masonry	315 567	318 822	272 428	273 889	189 566
Total	8 673 996	8 746 873	8 234 628	8 031 896	6 183 529
Exports					
Portland	1 390 243	1 817 243	1 626 502	W	W
Masonry	38 595	43 158	25 349	W	W
Total Cement	1 428 838	1 860 401	1 651 851	2 047 985	1 886 502
Clinker[2]	1 077 274	1 530 537	726 087	524 006	290 329
Total Sales					
Portland	9 748 672	10 245 294	9 588 702	W	W
Masonry	354 162	361 980	297 777	W	W
Total cement	10 102 834	10 607 274	9 886 479	10 079 881	8 070 031
Total clinker[3]	1 077 274	1 530 537	726 087	524 006	290 329

Sources: Energy, Mines and Resources Canada; Statistics Canada; United States Bureau of Mines, Mineral Industry Surveys.
[1] Does not include amounts used at producers' plants sites. [2] United States Bureau of Mines, Division of Non-Metallic Minerals. [3] Interplant shipments are not reported.

new 600 000 tpy kiln was fired in March 1981.

Genstar Cement Limited completed an expansion program at its Edmonton cement plant in late-1980, and through 1982 continued a $26 million project to increase the productive capacity at its Cadomin limestone property which supplies the Edmonton plant through a 4 500 t unit train and materials handling system. A limestone quarry at Mafeking, Manitoba, near the Manitoba-Saskatchewan border, supplies limestone to Genstar's Regina plant, while the Winnipeg plant is supplied from Steep Rock, Manitoba. Genstar Corporation's Canadian head office is now in Vancouver.

CCL's Winnipeg plant obtains limestone from the company's quarry at Steep Rock on Lake Manitoba, gypsum from Westroc Industries Limited at Amaranth, silica from Beausejour and clay adjacent to the plant site at Fort Whyte. Raw material for the Exshaw plant is mainly from the plant site but for gypsum from Westroc and iron oxide from Cominco Ltd. Limestone from Texada Island supplies the company's Vancouver

TABLE 6. CAPACITY CHANGES DURING 1982

Company	Plant Location	Net Capacity Change Compared With Table 3 (tpy)	Remarks
Quebec			
Ciment Quebec Inc.	St. Basile	430 000	Replaced 2-kiln, wet process plant with 735 000 tpy suspension preheater, flash calciner system. Operative in late 1982, not included in totals in Table 3.

plant at Richmond. Their Kamloops plant is supplied from resources close to the plant site.

A typical feature of the cement-manufacturing industry is its diversification and vertical integration into related construction materials industries. Many cement companies also supply ready-mix concrete, stone, aggregates and pre-formed concrete products such as slabs, bricks and pre-stressed concrete units.

Although individual companies continued to conduct research in relation to cement production, much experimentation concerning the use of cement and concrete is done through the Portland Cement Association (PCA), an industry-supported, nonprofit organization whose purpose is to improve and extend the uses of cement and concrete through scientific research and engineering fieldwork. The Association is active in all parts of Canada, and can offer detailed information on concrete use, design and construction, from regional offices of the Canadian Portland Cement Association.

WORLD SCENE

Cement markets are regional and centred in developing urban areas where construction activity is concentrated, or in areas where mining or heavy engineering construction projects are being carried out. The normal market area of a given cement-producing plant depends on the amount of transportation cost that the selling price can absorb. A potential large volume of sales could warrant a secondary distribution terminal; water transportation to a distribution system could extend a plant's market area even farther. Because raw materials for cement manufacture are generally widespread, most countries can supply their own cement requirements if the market volume warrants a plant. Few countries rely entirely on imports for their cement needs. However, some countries rely heavily on export markets for their surplus cement production in order to operate facilities economically.

Specialty cements such as white cement can be transported greater distances than ordinary grey portland cement because the transportation costs do not represent as high a proportion of the landed price, and because quantities required are generally much smaller than for portland cement.

Cement shortages in countries experiencing a buoyant surge in construction have led to exceptions to the norm and resulted in cement being shipped unusual distances.

A review of the international cement scene is provided in the April 1982 issue of Rock Products, a publication of MacLean-Hunter Publishing Corp., Chicago, Illinois.

TRADE

The state of the portland cement industry in the United States, and a surprisingly large demand for cement in construction, particularly in the west and mid-west, created improved export opportunities for Canadian portland cement during the late

TABLE 7. CANADA, HOUSE CONSTRUCTION, BY PROVINCE, 1981 AND 1982

	Starts			Completions			Under Construction		
	1981	1982	% Diff.	1981	1982	% Diff.	1981	1982	% Diff.
Newfoundland	3 210	2 793	-13.0	3 936	2 331	-40.8	2 966	3 373	13.7
Prince Edward Island	203	248	22.2	320	98	-69.4	48	196	308.3
Nova Scotia	3 715	3 691	- 0.6	4 374	3 174	-27.4	2 052	2 506	22.1
New Brunswick	2 188	1 680	-23.2	2 477	1 427	-43.4	978	1 122	14.7
Total (Atlantic Provinces)	9 316	8 412	- 9.7	11 107	7 030	-36.7	6 044	7 197	19.1
Quebec	29 645	23 492	-20.8	30 691	21 526	-29.9	12 815	14 164	10.5
Ontario	50 161	38 508	-23.2	45 557	40 437	-11.2	34 071	31 009	-8.9
Manitoba	2 824	2 030	-28.1	4 515	1 633	-63.8	764	1 149	50.4
Saskatchewan	5 972	6 822	14.2	8 085	5 666	-29.9	3 864	4 583	18.6
Alberta	38 470	26 789	-30.4	34 755	31 364	- 9.8	22 960	17 663	-23.1
Total (Prairie Provinces)	47 266	35 641	-24.6	47 355	38 663	-18.4	27 588	23 395	-15.2
British Columbia	41 585	19 807	-52.4	40 286	26 286	-34.8	22 311	13 290	-40.4
Total Canada	177 973	125 860	-29.3	174 996	133 942	-23.5	102 829	89 055	-13.4

Source: Canada Mortgage and Housing Corporation.

1970s. Exports peaked in 1979 but during the past three years, as the U.S. construction industry struggled through a recessionary period, exports dropped by as much as 36 per cent.

In an effort to buoy up the U.S. construction industry, a major highway construction and rehabilitation program has been undertaken. The United States Surface Transportation Assistance Act will be funded by increased taxes on gasoline, on new truck sales and other such transportation-oriented taxes. Total funding over four years will be approximately $50 billion. Because the Act has a "Buy America" clause, the Canadian cement industry was registering concern at year-end that, although competitive in many border states, they might lose markets to U.S. producers.

Cement imports, mainly from the United States, were reduced over 60 per cent in 1982.

GOVERNMENT INITIATIVES

Cement manufacture is energy-intensive. It is obvious that research should be concentrated in this area, and specifically within the pyroprocessing sector where over 80 per cent of the energy is consumed. Raw material grinding and finish grinding are being studied to determine optimum particle size for energy consumed.

In terms of the energy required to make concrete components and to build concrete structures, along with energy requirements to service and maintain them, they are not so energy-intensive as the nearly 6 giga joules required per t of cement would at first indicate.

Energy conservation programs adopted by the Canadian cement industry resulted in reaching the goal of a 9 to 12 per cent reduction in energy consumption per unit of

TABLE 8. CANADA, VALUE OF CONSTRUCTION[1] BY PROVINCE, 1981-83

	1981			1982			1983		
	Building Construction	Engineering Construction	Total	Building Construction	Engineering Construction	Total	Building Construction	Engineering Construction	Total
				(thousands of dollars)					
Newfoundland	449,744	584,714	1,034,458	399,131	797,298	1,196,429	429,579	1,010,474	1,440,053
Nova Scotia	703,274	601,938	1,305,212	627,338	884,530	1,511,868	668,280	1,097,108	1,765,388
New Brunswick	598,748	423,569	1,022,317	570,115	498,826	1,068,941	571,098	443,574	1,014,672
Prince Edward Island	82,732	70,835	153,567	91,536	70,444	161,980	90,106	56,054	146,160
Quebec	5,787,061	4,521,719	10,308,780	5,330,316	5,018,167	10,348,483	5,655,742	4,821,108	10,476,850
Ontario	9,351,968	4,836,498	14,188,466	8,657,087	5,687,399	14,344,486	8,749,495	5,211,675	13,961,170
Manitoba	864,922	674,106	1,539,028	775,844	649,473	1,425,317	830,915	658,977	1,489,892
Saskatchewan	1,207,783	1,391,803	2,599,586	1,113,910	1,338,345	2,452,255	1,138,025	1,320,210	2,458,235
Alberta	6,378,099	8,112,208	14,490,307	5,977,214	8,025,352	14,002,566	5,405,653	8,025,362	13,431,015
British Columbia, Yukon and Northwest Territories	6,112,925	4,129,286	10,242,211	4,664,244	4,566,626	9,230,870	4,562,538	4,797,645	9,360,183
Canada	31,537,256	25,346,676	56,883,932	28,206,735	27,536,460	55,743,195	28,101,431	27,442,187	55,543,618

Source: Statistics Canada.

[1] Actual expenditures 1981, preliminary actual 1982, intentions 1983.

TABLE 9. CANADA, VALUE OF CONSTRUCTION[1] BY TYPE, 1981-83

	1981	1982	1983
		($ millions)	
Building Construction			
Residential	16,365	13,342	14,414
Industrial	3,498	2,966	2,569
Commercial	6,986	6,868	5,979
Institutional	2,571	2,896	3,114
Other building	2,117	2,135	2,026
Total	31,537	28,207	28,102
Engineering Construction			
Marine	377	459	465
Highways, airport runways	4,092	4,304	4,306
Waterworks, sewage systems	2,145	2,295	2,421
Dams, irrigation	300	260	264
Electric power	4,801	5,428	5,722
Railway, telephones	1,870	2,067	1,977
Gas and oil facilities	7,110	7,440	8,186
Other engineering	4,652	5,283	4,101
Total	25,347	27,536	27,442
Total construction	56,884	55,743	55,544

Source: Statistics Canada.
[1] Actual expenditures 1981, preliminary actual 1982, intentions 1983.

production, based on 1974 calculations. In 1982 the average plant consumption of energy of all types was 5,355 mega joules a tonne, a 14 per cent fuel saving over 1974.

A change in the fuel mix from 1974 to 1982 is noted. In 1974 natural gas accounted for 49.5 per cent, petroleum products 39.7 per cent and coal and coke 10.8 per cent. For 1982 natural gas usage was 32.2 per cent of the total energy requirements while petroleum products were 21.9 per cent and coal and coke rose to 45.9 per cent.

The dry process now accounts for 67 per cent of Canadian portland cement capacity.

Energy conservation demonstration projects have been funded through the Conservation and Non-Petroleum Sector of Energy, Mines and Resources. The industry is represented on the Industrial Minerals Task Force on Energy Conservation and continues to play an active role in this voluntary organization.

Through the Canada Centre for Mineral and Energy Technology, a branch of Energy, Mines and Resources and through the Building Research Division of the National Research Council a continuing program of concrete research is managed.

Concrete research has generally been confined to strength determination, durability, placement and curing. Currently, great emphasis is being placed on researching the use of superplasticizers in concrete. Super-plasticizers, a group of admixtures described chemically as naphthalene or melanine sulphonate polymers, have been found to provide greatly increased workability over short time spans or to provide high strength by permitting lower water-cement ratios.

Portland cement used in Canada should conform to the specifications of CAN 3-A5-M83, 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 CAN 3-A8-M83. Blended hydraulic cements are covered by CAN 3-A362-M83. 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).

Regulations governing the design and application of these and other associated materials of construction are generally covered by CSA Standards or by those of the American Concrete Institute.

Cembureau, The European Cement Association, has published Cement Standards of the World - Portland Cement and its Derivatives, in which standards are compared. Cembureau's World Cement Directory lists production capacities by country and by company.

USES

Portland cement is produced by burning, usually in a rotary kiln, an accurately proportioned, finely ground mixture of lime-stone, silica, alumina and iron oxide. The three basic types of portland cement, Normal Portland, High-Early-Strength Portland, and Sulphate-Resisting Portland, are produced by most Canadian cement manufacturers.

Cement has little use alone but, when combined with water, sand, gravel, crushed stone or other aggregates in proper proportions acts as a binder, cementing the materials together as concrete. Concrete has become a widely used and readily adaptable building material which can be poured on site in large engineering projects, or used in the form of delicate precast panels or heavy, prestressed columns and beams in building construction.

Kiln discharge, in the shape of rough spheres, is a fused, chemically complex mixture of calcium silicates and aluminates termed clinker, which is mixed with gypsum (4 to 5 per cent by weight) and ground to a fine powder to form portland cement. By close control of the raw mix, the burning conditions and of the use of additives in the clinker-grinding procedure, finished cements displaying various desirable properties can be produced.

Moderate Portland Cement and Low-Heat-of-Hydration Portland Cement, designed for use in concrete to be poured in large masses, such as in dam construction, are manufactured by several companies in Canada. Masonry cement (generic name) includes such proprietary 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 to 65 per cent by weight) and a plasticizer. The other products do not necessarily consist of portland cement and limestone, and may include a mixture of portland cement and hydrated lime and/or other plasticizers.

OUTLOOK

The mining industries which supply the materials of construction fared no better during 1982 than did either the construction industry or the mining industry in general. Total plant shutdowns of unprecedented extent were not uncommon in the cement industry.

None of the mineral producing industries is expecting a great recovery in early-1983. Housing starts could increase to about 150,000 in 1983 with the encouragement offered by federal and provincial incentives to first-time homebuyers, especially if mortgage interest rates become attractive. The Canadian Construction Association predicts slow recovery in the non residential building sector through the next two years and about 4 per cent real growth in the heavy construction sector to 1984. The capital investment intentions of major Canadian companies for 1983 and beyond were adjusted downward by some 8 per cent in real terms during 1982 as caution and uncertainty prevailed. Statistics Canada's half year review of private and public investment in Canada reduced expected expenditure in construction in 1982 from $63.6 billion to $60.1 billion.

The Canadian Portland Cement Association has forecast domestic consumption for 1983 to be 6.55 million t with total cement and clinker exports of 1.800 million t. The slight overall growth of 3.3 per cent will be utilized mainly in the building construction sector. In the western region they predict that reduced activity in mega engineering projects will offset gains in the building contruction sector and result in zero growth in cement consumption.

A healthy economy would permit the construction industry and that portion of the mining industry which depends on it to plan five to ten years ahead with obvious benefits in efficiency, rather than to invest with short-term survival as the main incentive.

The cement industry in Canada is capable of meeting immediate demands and is also capable of expansion to meet even greater demand from domestic and foreign markets should opportunities be presented.

Conservation of energy and raw materials within the cement industry is of worldwide concern and provides a theme around which major developments in the industry have taken place. Of particular note is the emphasis on blended cements and the utilization of slag, ash and other byproducts. Even greater additions to production capacities than those witnessed during the past few years will be needed to meet demand in many developing countries.

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(cents per hundred pounds)		
29000-1	Portland and other hydraulic cement, nop; cement clinker	free	free	6	free
29005-1	White, nonstaining Portland cement	3.9	3.9	8	2 2/3

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
	(cents per hundred pounds)					
29005-1	3.9	3.9	3.8	3.8	3.7	3.7

UNITED STATES (MFN)

511.11	White, nonstaining Portland cement per 100 pounds including weight of container	1¢
511.14	Other cement and cement clinker	free
511.21	Hydraulic cement concrete	free

		1982	1983	1984	1985	1986	1987
		(% ad valorem)					
511.25	Other concrete mixed, per cubic yard	6.5	6.2	5.9	5.6	5.2	4.9

Sources: The Customs Tariff and Commodities Index, January 1982, Revenue Canada; Tariff Schedules of the United States Annotated 1982, USITC Publication 1200; U.S. Federal Register Vol. 44, No. 241.

Chromium

D.G. LAW-WEST

Canada imports all of its chromium requirements, largely in the form of ore and ferrochromium. During 1982, chromite ore imports fell 83 per cent from 47 626 t in 1981 to 8 053 t. At the same time, imports of ferrochromium fell 31 per cent from 31 573 t in 1981 to 21 783 t in 1982. These severe reductions in imports reflected the depressed state of the Canadian refractory brick industry as well as the stainless and specialty steel industries.

While there is no chromite ore presently mined in Canada, large resources of chromite exist in the Bird River area of Manitoba and the Eastern Townships of Quebec.

The Bird River deposits are a continuous band of chromite mineralization, similar in type to the important chromite deposits in Zimbabwe and the Republic of South Africa. These deposits have been considered uneconomic in the past although mounting concern about the supply of strategic materials such as chromite has led to increased exploration activity in the area. Dynamic Mining Exploration Ltd. has optioned two deposits, and Inco Limited and Belmoral Mines Ltd. have both been actively staking claims in the area.

Chromite mineralization in the Eastern Townships, which was exploited early in the century and during the Second World War, occurs as discontinuous and podiform deposits. Although these small deposits are generally satisfactory in grade and composition, they are not well defined and require further exploration to delineate and quantify the resource potential. The region has not been systematically explored, largely because the mineral rights were held by many independent land owners. This situation should change, however, with the introduction of legislation by the provincial government to separate land ownership from mineral rights. Land owners, in order to maintain their mineral rights, will have to stake claims on their property and carry out a specified amount of exploration and development work each year.

WORLD DEVELOPMENTS

South Africa remained the world's largest producer of chromite with an estimated output of 2.4 million t of chromite ore in 1982. While this production was down from the previous year, South Africa remained well placed to resume higher production levels in the future. For example, Rand Mines Ltd., a subsidiary of Barlow Rand Limited, reduced production to about 75 000 t per month. However, the company could increase production to 180 000 t per month within six months, given an upturn in demand.

Chromite production in Zimbabwe was cut back substantially during 1982. Rio Tinto Mining (Zimbabwe) Ltd. closed four of its mines and will not reopen them until there is a major recovery in demand. In addition, the Zimbabwe government prohibited the export of ore, except under exceptional circumstances, to encourage local beneficiation. Chromium exports, for example, must be in the form of ferrochromium. Legislation was also introduced to establish a state-run Minerals Marketing Corp. (MMC).

In New Caledonia, the Tiebaghi chromite mine started production on schedule in May 1982. The mine is expected to reach full capacity of 85 000 tpy of ore in 1983. The production output will comprise 55 000-60 000 tpy of high-grade lumpy ore grading 50-52 per cent Cr_2O_3, high grade fines grading 50-52 per cent Cr_2O_3 and a refractory grade chromite with 56 per cent Cr_2O_3, 2-3 per cent SiO_2 and minor amounts of Fe. The project is owned 55 per cent by Inco Limited, 22.5 per cent by Banque de Paris, and 22.5 per cent by Dong-Trieu and Cie Française d'Entreprises Minières, Metallurgiques & d'Investissements SA (Confremmi).

Hellenic Ferroalloys SA, a subsidiary of Hellenic Industrial Mining & Investment Company (HIMIC) of Athens was on schedule with its major development program to

TABLE 1. CANADA, CHROMIUM IMPORTS, 1981 AND 1982

	1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)
Imports				
Chromium in ores and concentrates				
Philippines	8 214	3,261	1 771	754
United States	28 493	5,620	1 483	612
South Africa	6 081	879	2 353	390
Albania	4 782	1,251	-	-
Other countries[1]	56	51	2 446	399
Total	47 626	11,062	8 053	2,155
Ferrochromium				
United States	9 838	9,402	5 957	5,482
South Africa	13 023	8,760	8 288	5,116
Zimbabwe	2 497	1,696	4 066	2,871
Brazil	5 400	3,146	2 500	1,481
Sweden	738	1,125	305	474
Other countries[2]	77	88	667	603
Total	31 573	24,217	21 783	16,027
Chromium sulphates, including basic				
United Kingdom	314	321	558	571
United States	1 402	1,301	359	381
Japan	-	-	158	124
West Germany	98	94	34	38
Poland	18	15	-	-
Total	1 832	1,731	1 109	1,114
Chromium oxides and hydroxides				
United States	1 365	3,945	841	2,374
United Kingdom	214	834	245	749
West Germany	54	162	22	70
Italy	158	396	-	-
Other countries[3]	-	-	54	110
Total	1 791	5,337	1 162	3,303
Chromium dyestuffs				
United States	16	129	29	157
West Germany	17	134	12	85
Netherlands	11	79	4	26
Other countries[4]	26	135	10	69
Total	70	477	55	337

Source: Statistics Canada.

[1] Includes West Germany, Cyprus, Mexico, Mozambique, Netherlands. [2] Includes Belgium, Luxembourg, Netherlands, Spain, West Germany, Yugoslavia. [3] Includes Belgium, Luxembourg, France and Netherlands. [4] Includes Italy, People's Republic of China, Poland, Switzerland, United Kingdom and Japan.
P Preliminary; - Nil.

become the first producer of ferrochromium in Greece. The $US 65 million undertaking includes expanding production at the Skoumtsa underground mine from 55 000 tpy to 250 000 tpy of chromite ore, building a 200 000 tpy concentrator and constructing a ferrochromium plant that will initially be rated at 30 000 tpy of high carbon and charge ferrochromium. All of the ferrochromium will be exported, mainly to EEC countries.

USES

While many minerals contain chromium, chromite is the only commercial ore mineral.

TABLE 2. CANADA, CHROMIUM TRADE AND CONSUMPTION, 1970, 1975, 1978-82

	Imports		Consumption[2]	
	Chromite[1]	Ferro-Chromium[2]	Chromite	Ferro-Chromium[3]
	(tonnes)			
1970	27 619	20 814	56 212	28 356
1975	29 663	41 109	36 790	18 417
1978	28 497	30 432	27 472	36 572
1979	27 373	34 720	27 205	23 916
1980	28 373	41 369	27 900	30 175
1981	47 626	31 573	24 771	29 547
1982P	8 053	21 783	..	..

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

[1] Chromium content. [2] Gross weight. [3] Includes charge chrome.
P Preliminary; .. Not available.

The theoretical formula for chromite is $FeCr_2O_4$, although it usually contains several other elements and is represented by the general formula $(FeMn)O\ (CrAlFe)_2O_3$. Traditionally, chromite ores have been classified as metallurgical, chemical and refractory grades, according to the expected industrial end-uses. However, recent technological advances have allowed some degree of interchange in the usage of these three product categories with the result that the classification has become less meaningful. Current nomenclature is based upon chromite composition in addition to end-use. High-chromium ores, defined by high Cr/Fe ratios, are used for making ferrochromium for metallurgical applications. High-iron chromites, previously limited almost entirely to the production of chromium-based chemicals, are now finding growing usage in the production of low quality ferrochromium, refractories and foundry sands. High-aluminum chromites with relatively low iron and silica have application mainly for refractory purposes, primarily in the manufacture of magnesite-chromite and chromite-mangnesite brick.

The principal use of chromium ferroalloys is in the production of stainless and heat-resistant steels. Most applications of stainless and heat-resistant steels are in corrosive environments such as petrochemical processing, high-temperature environments such as turbines and furnace parts, and consumer goods such as cutlery and decorative trim. Chromium is added to alloy and tool steels to increase their hardening ability and to improve mechanical properties such as yield strength. Superalloys containing chromium have a high degree of resistance to oxidation and corrosion at elevated temperatures and are used in jet engines, gas turbines and chemical process equipment. Chromium-containing castings are usually used in high-temperature applications.

The refractory industry uses chromite in the manufacture of refractory bricks, castables, mortars and ramming gun mixes. Chromite castables, mortars and gunning mixes are used for repairs and in the bonding and coating of basic bricks, and in areas where the separation of various types of bricks by a chemically neutral substance is desirable.

Refractories containing both chromite and magnesite are used in furnaces wherever basic slags and dust are encountered, such as in the ferrous and nonferrous metal industries. In the ferrous industry, chrome-magnesite brick is used in basic open-hearth and electric furnaces. The phasing-out of open-hearth furnaces has led to a decline in the amount of chromite used as a refractory in the steel industry. However, this trend has been offset to a certain extent by an increase in electric furnace production and, overall, chromite refractory consumption in the steel industry is expected to stabilize in the next few years. In the nonferrous industry, chrome-magnesite brick is used mainly in converters. The increasing use of oxygen in oxygen-blowing converters, resulting in higher operating temperatures, has changed refractory requirements to a higher magnesite-content brick, thereby decreasing the consumption of chromite in this application. The glass industry uses chrome-magnesite brick in the reheating chambers of glass furnaces, while the kraft paper industry requires a dense chromite brick in recovery furnaces to resist chemical attack by spent liquors.

Chromium chemicals have a wide variety of applications in a number of industries. Most chromium chemicals are produced from sodium dichromate, which is manufactured directly from chemical-grade chromite. Chromium compounds are used as pigments, mordants and dyes in the textile industry; tanning agents for all types of leathers; and for chrome electroplating, anodizing, etching and dipping. Chromium compounds are also

TABLE 3. WORLD CHROMITE MINE PRODUCTION AND RESERVES, 1981 AND 1982

Country	Mine Production 1981	1982e	Reservese
	(000 tonnes, gross weight)		
Republic of South Africa	2 867	2 631	2 268 000
Philippines	444	363	3 000
Zimbabwe	526	499	1 000 000
Turkey	399	363	5 000
Finland	413	408	25 000
Other market economy countries	1 035	998	13 000
Central economy countries	3 592	3 538	20 000
World total	9 276	8 800	3 334 000

Source: U.S. Bureau of Mines, Mineral Commodity Summaries, 1983.

e Estimated.

used as oxidants and catalysts in the manufacture of various products such as saccharin; in the bleaching and purification of oils, fats and chemicals; and as agents to promote water insolubility of various products such as glues, inks and gels.

TECHNOLOGY

Middleburg Steel and Alloy of South Africa installed a thermal plasma unit for the production of ferrochromium at its Krugersdorp works. The plasma unit could represent substantial savings as its costs are predicted to be only a fraction of those for a traditional submerged electric arc furnace. Middleburg was also studying the possibility of forward integrating into the production of stainless steel directly from its plasma plant.

Union Carbide Corporation and Joslyn Stainless Steels division of Joslyn Mfg. & Supply Co. together developed the argon-oxygen decarburization (AOD) process, now widely used in the production of stainless and heat-resistant steels. The process is essentially a refining step after the ferrochromium charge has been melted. Argon, an inert gas, and oxygen are added to the melt in order that carbon instead of chromium is preferentially oxidized. This allows the less expensive high-carbon ferrochrome to be used in place of high-priced, low-carbon ferrochrome. The overall advantages obtained are a lower cost for chromium additions as well as energy savings in the initial production of the ferroalloy. In Europe, a similar technology, known as the Creusot-Loire-Uddleholm (CLU) process, was being commercially developed by steelmakers.

The United States Bureau of Mines has developed a recycling technology to recover chromium from spent etching solution. In current practice, chromic acid is added to solutions used in finishing brass, etching printed circuit boards and preparing plastics for plating. After continued use the solution loses its etching ability because the initial trivalent chromium transforms to hexavalent chromium, a toxic substance that is subsequently treated and discarded. The Bureau of Mines new electrolytic process allows 88 to 96 per cent of chromium in spent solutions to be regenerated. The process is currently being tested on different electroplating solutions.

OUTLOOK

Chromite is expected to remain in oversupply, with a corresponding weakness in prices, until ferrochromium producers can reduce their high inventories of chromite ores and concentrates. The demand for chromite ores has been depressed in part because ferrochromium producers have been operating at rates well below capacity due to weak stainless steel markets. At the same time, the recession in the world iron and steel industry has been a major factor in the reduced demand for chromium.

The medium- and long-term outlook is overshadowed by uncertainty in regards to supply continuity of South African chromium, largely because of the fragile political stability of this country. An interruption in supply from South Africa could have serious economic consequences in Canada and the rest of the western world, as other producing countries could not immediately increase chromium production to fill the gap left by the sudden loss of South African supply. A prolonged interruption would probably result in real physical shortages.

PRICES

Chrome prices published by **Metals Week**

	December 31, 1981	December 31, 1982
	($US)	
Chrome ore, dry basis, fob shipping point		
Transvaal 44% Cr_2O_3, no ratio (per tonne)	51.00-55.00	48.00-52.00
Turkish 48% Cr_2O_3, 3:1 ratio (per tonne)	110.00	110.00
Chromium metal		
Electrolytic 99.1% Cr, fob shipping point (per kg)	8.27	8.27
	(¢US)	
Ferrochrome, fob shipping point (per kg Cr content)		
High carbon 66-70% Cr, 5.0-6.5% C	114.64-119.05	94.80
Imported 60-65% charge chrome	105.82-109.13	90.39
Low carbon 67-73% Cr, 0.025% C	220.46	220.46

fob - Free on board

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
32900-1	Chrome ore	free	free	free	free
34700-1	Chromium metal in lumps, powder, ingots, blocks or bars, and scrap alloy metal containing chromium for use in alloying purposes	free	free	free	free
37506-1	Ferrochrome	free	4.8	5	free
92821-1	Chromium oxides and hydroxides	10	14.1	25	9
	With the following exceptions: For use in the manufacture of artificial resins and plastics (expires June 30, 1987)	free	free	25	free
	For use in the manufacture of additives for heating, lubricating and fuel oils (expires June 30, 1987)		5		
92821-2	Chromium trioxide for use in the manufacture of galvanized and tin plated steel (expires June 30, 1987)	free	free	25	free
92838-8	Chromium potassium sulphate	free	free	10	free
92838-9	Chromium sulphate, basic	free	free	10	free

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
			(%)			
37506-1	4.8	4.7	4.5	4.3	4.2	4.0
92821-1	14.1	13.8	13.4	13.1	12.8	12.5

TARIFFS (Cont'd.)

UNITED STATES

473.10-20	Chrome colours	4.5%					
601.15	Chrome ore	free					
606.24	Ferrochromium, containing over 3% by weight of carbon	1.9%[1]					
632.86	Chromium alloys, unwrought, 96-99% silicon	9.0%					

		1982	1983	1984	1985	1986	1987
				(%)			
420.98	Chromate and dichromate	2.7	2.7	2.6	2.5	2.5	2.4
531.21	Chrome refractory and heat insulating bricks	10.3	9.6	8.8	8.1	7.3	6.6
606.22	Ferrochromium, not containing over 3% by weight of carbon	3.9	3.7	3.6	3.4	3.3	3.1
632.18	Chromium metal, unwrought and waste and scrap	4.5	4.4	4.2	4.0	3.9	3.7
632.88	Chromium alloys, unwrought, not otherwise specified	7.7	7.3	6.8	6.4	5.9	5.5

EUROPEAN ECONOMIC COMMUNITY

		1982
28.21	Chromium oxides and hydroxides	15
28.38	Sulphates (excluding alums) of chromium	15
	Alums: chromium potassium bis(sulphate)	13
28.47	Salts of metallic acids:	
	Chromates	15
	Dichromates and perchromates	14
28.56	Carbides of chromium	12
69.02	Refractory bricks, blocks, tiles and similar refractory construction goods with a basis of chromite	10[2]
69.03	Other refractory goods with a basis of chromite	12
73.02	Ferro-alloys:	
	Ferro-chromium	8
	Ferro-silico-chromium	7
81.04	Chromium:	
	Unwrought, waste and scrap	
	Chromium alloys containing more than 10% by weight of nickel	Free
	Other	6
	Other	8

Sources: The Customs Tariff and Commodities Index, January 1982, Revenue Canada; Tariff Schedules of the United States Annotated (1982), USITC Publication 1200; U.S. Federal Register Vol. 44, No. 241; Official Journal of the European Communities, L335, Vol. 24.
[1] Temporarily increased to 4.625¢ per pound on or before November 15, 1982.
[2] Subject to a min. of 1.10 ECU per 100 kg gross.

Clays and Clay Products

M. PRUD'HOMME

Clays are a complex group of industrial minerals, each generally characterized by different mineralogy, occurrence and uses. All are natural, earthy, fine-grained minerals of secondary origin, composed mainly of a group of hydrous aluminum phyllosilicates and may contain iron, alkalis and alkaline earths. The clay minerals, formed by the chemical weathering or alteration of aluminous minerals are generally classified into four major groups based on detailed chemistry and crystalline structure - the kaolinite group, the smectite group (montmorillonite group of some usages), the clay-mica group and the chlorite group. Clay deposits suitable for the manufacture of ceramic products may include non-clay minerals such as quartz, calcite, dolomite, feldspar, gypsum, iron-bearing minerals and organic matter. The non-clay minerals may or may not be deleterious, depending upon individual amounts present and on the particular application for which the clay is intended.

The commercial value of clays, and of shales that are similar in composition to clays, depends mainly on their physical properties - plasticity, strength, shrinkage, vitrification range and refractoriness, fired colour, porosity and absorption - as well as proximity to growth centres in which clay products will be consumed.

Brick and drain tile manufacturing included in the heavy clay products category accounts for nearly 77 per cent of the total value of output by clay products manufacturers using material from domestic sources.

USES, TYPE AND LOCATION OF CANADIAN DEPOSITS

Common clays and shale. Common clays and shales are the principal raw materials available from Canadian deposits for the manufacture of structural clay products. They are found in all parts of Canada, but deposits having excellent drying and firing properties are generally scarce and new deposits are continually being sought.

The clay minerals in common clays and shales are chiefly illitic or chloritic. The material is sufficiently plastic to permit molding and vitrification at low temperature. Suitable common clays and shales are utilized in the manufacture of heavy clay products such as common brick, facing brick, structural tile, partition tile, conduit tile, quarry tile and drain tile. There are no specific recognized grades of common clay and shale. Specifications are usually based upon the physical and chemical tests of manufactured products. The raw materials utilized in the heavy clay industry usually contain up to 35 per cent quartz. If the quartz, together with other nonplastic materials, exceeds this percentage, the plasticity of the clay is reduced and the quality of the ware is lowered. If calcite or dolomite is present in sufficient quantities, the clay will fire buff and the fired strength and density will be adversely affected.

Most of the surface deposits of common clays in Canada are the result of continental glaciation and subsequent stream transport. Such Pleistocene deposits are of interest to the ceramic industry and include stoneless marine and lake sediments, reworked glacial till, interglacial clays and floodplain clays.

The shales provide the best source of raw material for making brick. In particular, those found in Cambrian, Ordovician and Carboniferous rocks in eastern Canada, and Jurassic, Cretaceous and Tertiary rocks in western Canada, are utilized by the ceramic industry.

China Clay (Kaolin). China clay is a white clay composed mainly of kaolinitic minerals formed from weathered igneous rocks. Some deposits occur in sedimentary rocks as tabular lenses and discontinuous beds or in

TABLE 1. CANADA, PRODUCTION OF CLAYS AND CLAY PRODUCTS FROM DOMESTIC SOURCES, 1980-82

	1980	1981	1982P
		($000)	
Production from domestic sources, by provinces			
Newfoundland	806	921	821
Nova Scotia	5,487	2,926	4,500
New Brunswick	2,448	1,415	2,200
Quebec	13,578	16,797	13,720
Ontario	58,000	67,765	50,946
Manitoba	1,364	2,020	1,776
Saskatchewan	3,183	3,964	3,477
Alberta	13,200	15,308	12,251
British Columbia	10,387	8,000	4,965
Total Canada	108,453	119,116	94,656
Production[1] from domestic sources, by products			
Brick - soft and stiff mud process and dry press	77,427	89,578	69,382
Drain tile	4,869	3,227	3,408
Sewer pipe	(2)	(2)	(2)
Flue linings	3,328	3,124	2,698
Pottery glazed or unglazed (including coarse earthenware, stoneware and all pottery)	(2)	(2)	(2)
Other products	11,787	16,956	11,880
Small establishments not reporting detail	11,042	6,231	7,288
Total	108,453	119,116	94,656

Source: Statistics Canada.
[1] Producers' shipments. Distribution for 1982 estimated by Energy, Mines and Resources Canada. (2) Included in "Other products".
P Preliminary.

rocks that have been hydrothermally altered. Commercial china clays are beneficiated to improve their whiteness when used as fillers and their whitefiring characteristics when used in ceramics. None of the crude kaolins known to exist in Canada have been developed, primarily because of beneficiation problems and the small size of some deposits.

China clay is used primarily as a filler and coater in the paper industry, a raw material in ceramic products, and a filler in rubber and in other products. In the ceramic industry china clay is used as a refractory raw material. In prepared whiteware bodies such as wall tile, sanitaryware, dinnerware, pottery and electrical porcelain, quantities of nepheline syenite, silica, feldspar and talc are used as well.

In southern Saskatchewan, deposits of sandy kaolin occur near Wood Mountain, Fir Mountain, Knollys, Flintoft and other localities. Despite considerable work, no satisfactory method of producing a good commercial china clay from these deposits has been developed.

A deposit of clay, which is very plastic to very sandy and is similar to a secondary kaolin, occurs along the Fraser River near Prince George, British Columbia. This material has been investigated as a source of china clay, as a fire clay and as a raw material for facing brick.

Various kaolinitic-rock deposits have been investigated in Manitoba. The reported deposits are principally in the northwest at Cross Lake and Pine River, on Deer Island (Punk Island) and Black Island in Lake Winnipeg, and at Arborg.

Several companies have shown considerable interest in Quebec's kaolin-

TABLE 2. CANADA, IMPORTS AND EXPORTS OF CLAYS, CLAY PRODUCTS AND REFRACTORIES, 1981 and 1982

	1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)
Imports				
Clays				
China clay, ground or unground	231 755	23,198	205 952	22,254
Fire clay, ground or unground	49 172	3,781	33 574	2,782
Clays, ground or unground nes	132 113	8,937	105 856	7,803
Bentonite	311 250	13,277	238 069	12,340
Fuller's Earth	784	56	1 081	75
Drilling mud	29 332	7,930	11 355	3,095
Clays and earth, activated	14 422	8,755	13 369	9,714
Subtotal, clays	768 828	65,934	609 256	58,063
Clay Products	(M)		(M)	
Brick-building, glazed	2 658	413	1 224	190
Brick-building, nes	18 976	3,333	13 818	2,544
Building blocks and hollow tiles	..	3,453	..	1,541
Brick acid-proof	..	154	..	131
Clay bricks, blocks and tiles, nes	..	5,777	..	3,150
Ceramic tiles	(m^2)		(m^2)	
under 2 1/2" x 2 1/2"	887 195	7,403	705 566	5,492
over 2 1/2" x 2 1/2"	7 080 438	54,321	5 651 402	38,217
Subtotal, bricks, blocks, tiles	..	74,854	..	51,265
Tableware, ceramics	..	113,374	..	92,679
Sanitaryware	..	116	..	166
Artware	..	30,903	..	24,233
Porcelain, insulating, fitting	..	23,123	..	31,666
Chemical stoneware, exc. laboratory	..	1,767	..	1,166
Pottery settings and firing supplies	..	1,054	..	975
Pottery basic products, nes	..	1,721	..	1,705
Clay end-products, nes	..	1,323	..	668
Subtotal, ceramics	..	173,381	..	153,258
Refractories	(tonnes)		(tonnes)	
Fire brick and shapes				
Alumina	20 932	16,852	14 050	13,007
Chrome	367	701	190	222
Magnesite	16 973	16,253	12 461	11,174
Silica	13 762	7,087	2 984	2,406
nes	134 981	46,543	102 916	35,240
Refractory cements and mortars	..	16,352	..	13,264
Plastic fire brick and ramming mixture	..	1,367	..	1,342
Crude refractory materials, nes	10 124	1,788	9 457	1,831
Grog (refractory scrap)	13 540	1,615	5 339	778
Foundry facings	..	913	..	1,012
Refractories, nes	..	8,396	..	6,978
Subtotal, refractories	..	117,867	..	87,254
Total clays, clay products and refractories	..	432,036	..	349,840
Imports				
By main countries				
United States	..	195,408	..	173,461
United Kingdom	..	72,797	..	48,746
Japan	..	51,440	..	40,751
Italy	..	34,940	..	24,726
West Germany	..	16,874	..	11,691
Spain	..	10,695	..	8,081
Greece	..	5,565	..	4,341
South Korea	..	5,004	..	3,904
France	..	4,627	..	6,090
Philippines	..	2,654	..	811
Taiwan	..	6,581	..	6,342
Brazil	..	2,348	..	1,818
China	..	4,239	..	5,215
Other	..	18,864	..	13,863
Total	..	432,036	..	349,840

TABLE 2. (cont'd)

	1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)
Exports				
Clays, ground and unground	1 298	184	557	40
Clay products	(M)		(M)	
Building brick, clay	3 593	708	2 138	467
Clay bricks, blocks, tiles, nes	..	1,648	..	2,085
Subtotal, bricks, blocks, tiles	..	2,356	..	2,552
High-tension insulators and fittings	..	4,842	..	4,392
Tableware, nes	..	10,725	..	9,718
Subtotal, porcelain, tableware	..	15,567	..	14,110
Refractories	(tonnes)		(tonnes)	
Fire brick and shapes	47 187	28,079	33 038	20,287
Crude refractory materials	629 770	1,319	40 840	150
Refractory nes	..	18,230	..	13,388
Subtotal refractories	..	47,628	..	33,825
Total clays, clay products and refractories	..	65,735	..	50,527
Exports				
By main countries				
United States	..	32,057	..	30,606
Venezuela	..	4,255	..	378
Indonesia	..	1,488	..	1,060
Mexico	..	2,000	..	544
Dominican Republic	..	1,912	..	645
Zambia	..	1,129	..	66
United Kingdom	..	1,018	..	723
Australia	..	1,283	..	955
Colombia	..	1,072	..	913
South Africa	..	2,166	..	875
Saudi Arabia	..	90	..	2,831
Ecuador	..	362	..	28
Other countries	..	16,903	..	10,903
Total	..	65,735	..	50,527

Source: Statistics Canada.

P Preliminary; .. Not available; nes not elsewhere specified; M = thousands; m^2 = square metres.

bearing deposits although the deposits, in general, contain an excessive amount of quartz and iron minerals. Kaolin-bearing rock occurs at St-Rémi-d'Amherst, Papineau County; Brébeuf, Terrebonne County; Point Comfort, near Thirty-one Mile Lake, Gatineau County; and Chateau-Richer, Montmorency County.

Extensive deposits of kaolin-silica sand mixtures occur in northern Ontario along the Missinaibi and Mattagami rivers. Distance from markets and the difficult terrain and climate of the area have hindered development, although some encouraging results were obtained.

Ball Clay. Ball clay is defined as a fine grained, highly plastic and mainly kaolinitic sedimentary clay. Natural colours range from white to brown, blue, grey and black, usually related to carbonaceous material. Fired colours may be white to offwhite. They are extremely refractory materials and have less alumina and more silica than kaolin. Ball clay occurs in bed, lenticular with complex sequential and rapid lateral variation.

Ball clays occurring in Canada are mineralogically similar to high-grade, plastic fire clay and are composed principally of fine-particle kaolinite, quartz and mica. These clays are known to occur in the Whitemud Formation of southern Saskatchewan. Good-quality deposits are present at Willows, Readlyn, Big Muddy Valley, Blue Hills, Willow Bunch, Flintoft and in other areas. Clay from the Willows area was used for many years in potteries at Medicine Hat and Vancouver; however, the lack of proper quality control, the distance from large markets and lack of reserves have been the principal disadvantages affecting the widespread use of this material. Some ball clays from the Flintoft area are used for white-to-buff facing brick.

Fire Clay (Refractory Clay). Fire clay is a detrital clay mainly composed of kaolinite with a high content of alumina and silica. It usually occurs in sedimentary rocks as lenticular bodies. These clays may range in plasticity from essentially that of ball clay to nonplastic varieties such as flint clay. They are formed by alteration of aluminous sediments deposited in a swampy environment or following transportation and concentration of clayey material.

Fire clay is used in the manufacture of products requiring high resistance to heat such as fire brick, insulating brick and refractory mortar. The refractory suitability is determined by the pyrometric cone equivalent (PCE test). Canadian fire clays are used principally for the manufacture of medium- and high-duty fire brick and refractory specialties. Known Canadian fire clays are not sufficiently refractory for the manufacture of superduty refractories without the addition of some very refractory material such as alumina.

Various grades of good-quality fire clay occur in the Whitemud Formation in southern Saskatchewan and on Sumas Mountain in British Columbia. Fire clay, associated with lignite as well as with kaolin-silica sand mixtures, occurs in the James Bay watershed of northern Ontario along the Missinaibi, Abitibi, Moose and Mattagami rivers.

At Shubenacadie, Nova Scotia, some seams of clay are sufficiently refractory for medium-duty fire clay. Clay from Musquodoboit, Nova Scotia, has been used by few foundries in the Atlantic provinces, and the properties and extent of this clay were investigated by the Nova Scotia Department of Mines. Ontario and Quebec have no producing domestic sources of fire clay and import most of their requirements from the United States.

Stoneware Clay. Stoneware clays are intermediary between low-grade common clays and the high-grade kaolinitic clays. They are typically a mixture of kaolinitic clay minerals and micaceous clay minerals. Stoneware clays must be capable of being fully vitrified at relatively low temperature.

Stoneware clays are used extensively in the manufacture of sewer pipe, flue liners, facing brick. They are widely used by amateur and studio potters.

The principal source of stoneware clay in Canada is the Whitemud Formation in southern Saskatchewan and southeastern Alberta. The Eastend area in Saskatchewan was formerly the source of much of the clay used at Medicine Hat. Stoneware clay pits are presently located in the Alberta Cypress Hills, southeast of Medicine Hat, and at Avonlea, Saskatchewan. Stoneware clays occur on Sumas Mountain, near Abbotsford, British Columbia.

In Nova Scotia, stoneware clays occur at Shubenacadie and Musquodoboit. The Shubenacadie clays are used principally for the manufacture of buff facing brick. Other similar deposits occur at Swan River, Manitoba, where some buff brick has been manufactured in Kergwenan, Manitoba and in British Columbia at Chimney Creek Bridge, Williams Lake, Quesnel and near the Alaska Highway at Coal River. Quebec and Ontario import some stoneware clay from the United States for manufacture of facing brick and sewer pipe respectively.

Bentonite and Fuller's Earth. Bentonite consists primarily of montmorillonite clay, and is formed from volcanic ash, tuff or glass, other igneous rocks, or from rocks of sedimentary origin. Sodium bentonite has strong swelling properties and possesses a high dry-bonding strength. Calcium bentonite of the non-swelling type, exhibits adsorptive characteristics. Fuller's earth contains mainly smectite-group clay minerals and is very similar to non-swelling bentonite. It is formed by alteration of volcanic ash or by direct chemical precipitation of montmorillonite in shallow marine basins. Fuller's earth is characterized by absorptives properties, catalytic action, bonding power and cation-exchange capacities.

TABLE 3. CANADA, SHIPMENTS OF REFRACTORIES, 1979-81

	1979		1980		1981	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Monolithics	36 879	14,983	42 852	19,555	25 103	14,026
Fire brick and shapes	141 517	74,790	134 671	73,664	122 413	66,034
Cement and mortars	32 827	9,751	39 402	13,842	56 558	18,026
All other products	...	40,208	...	28,596	...	34,002
Total	...	139,732	...	135,657	...	132,088

Source: Statistics Canada.
... Figures not appropriate or not applicable.

Drilling mud and Activated Clays. Drilling mud contains about 10 per cent swelling bentonite. Synthetic bentonites may also be used for special muds. The swelling properties of a bentonite used as a drilling mud may be improved by adding soda ash in a drying process to substitute calcium cations by sodium cations. Activated clays are non-swelling bentonites that are acid leached to remove impurities and to increase reactive surface and bleaching power. They are used for decolouring mineral oils and as catalysts.

Bentonite, Fuller's earth and Activated clays are covered at intervals in a separate mineral review.

CANADIAN INDUSTRY AND DEVELOPMENTS

Production and shipment of clay products depends on the level of construction activity in various sectors such as housing, non-residential and heavy construction. Housing starts decreased substantially in 1981 and in 1982: 13 per cent and 30 per cent respectively. In 1982, clay products manufacturers operated at an average capacity rate of 55 per cent. The value of clay products produced from domestic clays declined about 30 per cent in 1982, when inflation is taken into account. In terms of constant dollars, the value of materials produced from imported clays remained constant from 1979 to 1981. The trend in values of imported

TABLE 4. CANADA, CLAYS, CLAY PRODUCTS AND REFRACTORIES, PRODUCTION AND TRADE, 1970, 1975, 1978-82

	Production					
Year	Domestic Clays	Imported Clays[2]	Total	Refractory Shipments[1]	Imports	Exports
			($ million)			
1970	51.8	33.6	85.4	42.3	81.2	15.6
1975	78.4	59.1	137.5	65.0	177.4	25.1
1978	109.6	64.8	174.4	97.3	252.0	43.0
1979	121.5	71.4	192.9	139.7	323.1	61.2
1980	108.5	83.4	191.9	135.7	386.2	63.8
1981	119.1	85.1	204.2	132.1	432.0	65.7
1982P	94.6	..	..	..	349.8	50.5

Source: Statistics Canada.

[1] Includes fire brick and shapes, refractory cements, mortars, and monolithics, plus all other products shipped. [2] Includes electrical porcelains, glazed floor and wall tile, sanitaryware, pottery, art and decorative ware plus all other products.
P Preliminary; .. Not available.

TABLE 5. CANADA, CONSUMPTION (AVAILABLE DATA) OF CLAYS, BY INDUSTRIES, 1980 AND 1981

	1980	1981P
	(tonnes)	
China Clay		
Paper and paper products[1]	111 883	85 555
Ceramic products	8 742	9 764
Paint and varnish	8 197	5 955
Rubber and linoleum	3 504	3 873
Other products[2]	20 835	22 077
Total	153 161	127 224
Ball Clay		
Ceramic products misc.	11 247	10 619
Refractories	2 583	2 743
Other[3]	3 740	4 943
Total	17 570	18 305
Fire Clay		
Foundries	13 615	11 731
Refractories	15 213	14 929
Other[4]	389	2 467
Total	29 217	29 127

[1] Includes paper and paper products and paper pulp. [2] Includes refractory brick mixes, cements, glass fibre and wools, adhesives, foundry, wire and cable and other miscellaneous products. [3] Includes adhesives, miscellaneous chemicals, petroleum refining, paint and varnish and other miscellaneous products. [4] Includes abrasives, ceramic products, concrete products, paint and varnish, petroleum refining, and rubber products.
P Preliminary.

products is likely similar to those of domestic clay products for the 1980-1982 period. The value of exports dropped substantially in 1982 in comparison with the previous three years.

I.XL Industries Ltd. has new expansion plans in Alberta with an anticipated production of 40 million modular bricks annually, scheduled to start up by Fall, 1982. Clayburn Refractories Ltd., B.C., intensified its activities in the refractory sector producing more than 860 different products, mainly castables, in 1981 and in 1982.

Maritime Clay Company, a branch of Pottery Supply House Limited, began construction in the fall of 1981 to provide red fire clay from Musquodoboit, Nova Scotia. Raw material is available for tiles, dinnerware and brick plants.

WORLD REVIEW

United States mine production of clays was about 44.6 million short tons valued at $950 million in 1981, and 37 million short tons valued at $800 million in 1982. The clay producers operated at capacities between 50 and 60 per cent in 1982. Demand for clays is expected to increase, from a 1982 basis, at an annual rate of 2 to 4 per cent through 1990.

In Sweden, a high-quality kaolin deposit of several million t was found and offers potential for paper coating. In France, the refractory interests of LaFarge and Saint-Gobain-Pont-à-Mousson merged under the name Société LaFarge-Réfractaires, now the largest refractories producers in the country with an annual production of around 370 000 t. English China Clays of England has consolidated its position as the world's largest producer of china clay by scheduling new projects for coating, filler and ceramic clays in Spain, Portugal and Belgium.

The Indian government has reiterated that it does not intend to permit export of refractory grade minerals such as magnesite, kyanite and sillimanite. Brazil developed kaolin deposits in 1981, and now produces coating quality clays.

OUTLOOK

Trends in the demand for refractories are tied to changes in advanced technologies such as in steelmaking and in areas requiring special materials. Traditional fire bricks such as low-duty fire clay and silica, as well as basic refractories, are giving way to special refractories made with silicon carbide, carbon and alumina, and to monolithics. Demand is toward materials of improved quality and reliability requiring less maintenance. The steel and iron industries will maintain their larger share of the market. New products and designs are dictated by changes in reducing atmospheres in the chemical and petrochemical industry, by increased demand for high-purity glass and by need for more economical production of ceramics.

The clays and clay products industry will continue to place increasing emphasis on improving energy efficiencies. The Canadian brick and tile industry made a commitment to reduce energy consumption by 23 per cent between 1973-1974 and 1985. Clays and clay products, like other low-cost construction materials, must be strategically located near the populated areas since transportation costs are a major factor influencing demand. Increasing unit value, rising land costs, environmental control and land rehabilitation bring complexity to the structure of this industry. Closures or consolidation have been the major responses to difficult economic situations.

PRICES

United States clay prices, according to Chemical Marketing Reporter, December 27, 1982.

	($US per short ton)
Ball clay	
Domestic, crushed, moisture-repellent, bulk carloads, fob Tennessee	8-11.25
Imported lump, bulk, fob Great Lakes ports	40.50
Imported, airfloated, bags, carloads Atlantic ports	70
China clay (kaolin)	
Water washed, fully calcined, bags, carloads, fob Georgia	218
Uncalcined, No. 1 to No. 4 coating, same basis, bulk	94-70
Dry-ground, airfloated soft, same basis	60

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
29500-1	Clays, including china clay, fire clay and pipe clay not further manufactured than ground	free	free	free	free
29525-1	China clay	free	free	25	free
28100-1	Firebrick containing not less than 90 per cent silica; magnesite firebrick or chrome firebrick; other firebrick valued at not less than $100 per 1,000, rectangular shaped, not to exceed 100 x 25 in.^{3} for use in kiln repair or other equipment of a manufacturing establishment	free	free	free	free
28105-1	Firebrick, nop, of a class or kind not made in Canada, for use in construction or repair of a furnace, kiln, etc.	free	free	15	free
28110-1	Firebrick, nop	5	8.8	22.5	5
28200-1	Building brick and paving brick	8.1	8.1	22.5	5
28205-1	Manufactures of clay or cement, nop	10.8	10.8	22.5	7
28210-1	Saggars, hillers, bats and plate setters, when used in the manufacture of ceramic products	free	free	free	free
28300-1	Drain tiles, not glazed	free	14.8	20	free

CANADA (cont'd)

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
28400-1	Drain pipes, sewer pipes and earthenware fittings therefor; chimney linings or vents, chimney tops and inverted blocks glazed or unglazed, nop	15	16.7	35	11
28405-1	Earthenware tiles, for roofing purposes	free	14.8	35	free
28415-1	Earthenware tiles, nop	12.5	17.2	35	11
28500-1	Tiles or blocks of earthenware or of stone prepared for mosaic flooring	15	17.2	30	11
28600-1	Earthenware and stoneware, viz: demijohns, churns or crocks, nop	16.7	16.7	35	11
28700-1	All tableware of china, porcelain, semi-porcelain or white granite, excluding earthenware articles	free	15	35	free
28705-1	Articles of chinaware, for mounting by silverware manufacturers	12.5	14.8	22.5	9.5
28710-1	Undecorated tableware of china, porcelain, semi-porcelain for use in the manufacture of decorated tableware	free	8.8	35	free
28800-1	Stoneware and Rockinghamware and earthenware, nop	15.7	16.7	35	11
28805-1	Chemical stoneware	free	8.8	35	free
28810-1	Hand forms of porcelain for manufacture of rubber gloves	free	free	35	free
28900-1	Baths, bathtubs, basins, closets, closet seats and covers, closet tanks, lavatories, urinals, sinks and laundry tubs of earthenware, stone, or cement, clay or other material, nop	12.5	15	35	10
28215-1	Grog, crushed or ground, but not further manufactured for use exclusively as refractory material	free	free	1.15	free
28416-1	Biscuits larger than 135 cm^2 in dimension containing not less than 50 per cent by weight of silica, kaolin and limestone for use in the manufacture of ceramic wall tiles (expires June 30, 1982)	free	free	35	free
28715-1	Undecorated whiteware not less than 1/8 inch in thickness for use in the manufacture of decorated heavy duty tableware (expires June 30, 1982)	free	free	35	free
30000-1	Crucibles and covers, nop	free	8.8	15	free

CANADA (cont'd)

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
44515-1	Porcelains all of one piece, over eighty-six inches in length or having an outside diameter greater than twenty-four inches, for use in the manufacture of electric instrument and power transformers	free	free	37.5	free
44518-1	Electric insulators of all kinds, nop (expires June 30, 1982)	12.8	12.8	27.5	8.5
44518-2	Ceramic insulator spark plug cores not further manufactured than burned and blazed		free		free
44518-3	Porcelain or ceramic insulators, nop and complete parts thereof	15	15	27.5	10
44519-1	Porcelain or ceramic bushings for use in the manufacture of hermetically sealed power capacitors (expires June 30, 1982)	free	free	27.5	free
49203-1	Ceramic discs for use in the manufacture of carrier assemblies for multi-orifice valves (expires June 30, 1982)	free	free	20	free
62430-1	Statues and statuettes of porcelain or earthenware	free	14.8	30	free

MFN Reductions under GATT (effective January 1 of year given)		1982	1983	1984	1985	1986	1987
					(%)		
28110-1	Firebrick, nop	8.8	8.4	8.0	7.6	7.2	6.8
28200-1	Building brick and paving brick	8.1	7.5	6.9	6.3	5.6	5.0
28205-1	Manufactures of clay or cement, nop	10.8	10.3	9.7	9.1	8.6	8.0
28300-1	Drain tiles, not glazed	14.8	13.9	12.9	12.0	11.1	10.2
28400-1	Drain pipes, sewer pipes and earthenware fittings therefor; chimney linings or vents, chimney tops and inverted blocks glazed or unglazed, nop	16.7	15.7	14.6	13.5	12.4	11.3
28405-1	Earthenware tiles, for roofing purposes	14.8	13.9	12.9	12.0	11.1	10.2
28415-1	Earthenware tiles, nop	17.2	16.3	15.3	14.4	13.4	12.5
28500-1	Tiles or blocks of earthenware or of stone prepared for mosaic flooring	17.2	16.3	15.3	14.4	13.4	12.5

CANADA (cont'd)

Item No.		1982	1983	1984	1985	1986	1987
				(%)			
28600-1	Earthenware and stoneware, viz: demijohns, churns or crocks, nop	16.7	15.7	14.6	13.5	12.4	11.3
28700-1	All tableware of china, porcelain, semi-porcelain or white granite, excluding earthenware articles	15.0	15.0	14.6	13.5	12.4	11.3
28705-1	Articles of chinaware, for mounting by silverware manufacturers	14.8	13.9	12.9	12.0	11.1	10.2
28710-1	Undecorated tableware of china, porcelain, semi-porcelain for use in the manufacture of decorated tableware	8.8	8.4	8.0	7.6	7.2	6.8
28800-1	Stoneware and Rockinghamware and earthenware, nop	16.7	15.7	14.6	13.5	12.4	11.3
28805-1	Chemical stoneware	8.8	8.4	8.0	7.6	7.2	6.8
28900-1	Baths, bathtubs, basins, closets, closet seats and covers, closet tanks, lavatories, urinals, sinks and laundry tubs of earthenware, stone, or cement, clay or other material, nop	15.0	15.0	14.6	13.5	12.4	11.3

UNITED STATES (MFN)

		(¢ per long ton)
521.41	China clay or kaolin	33.0
521.81	Other clays, not beneficiated	free
521.84	Other clays, wholly or partly beneficiated	50.0

		1982	1983	1984	1985	1986	1987
				(¢ per long ton)			
521.71	Common blue clay and other ball clays, not beneficiated	40.5	40.0	39.5	39.0	38.5	38.0
521.74	Common blue clay and other ball clays wholly or partly beneficiated	82.0	81.0	80.0	79.0	78.0	77.0

Sources: The Customs Tariff and Commodities Index, January 1982, Revenue Canada; Tariff Schedules of the United States Annotated 1982, USITC Publication 1200, U.S. Federal Register, Vol. 44, No. 241.

Note: In addition to the above tariffs various duties are in existence on manufactured clay products, viz., brick pottery, artware, etc., nop not otherwise provided for.

Coal and Coke

J. AYLSWORTH

The Canadian coal industry continued to set new records for production, consumption and exports in 1982 in spite of the serious global recession. Overall coal production grew by 7 per cent to reach a record level of 42.8 million t, exports were up 2 per cent reaching the 16 million t level, and imports increased 6 per cent to 15.8 million t. The values for each of these categories registered much larger increases with production growing by 21 per cent, exports by 15 per cent and imports by 14 per cent. Domestic coal utilization rose by 8 per cent to 41.5 million t based on a record consumption of thermal coal by provincial utilities of 33.7 million t. The export sector experienced some problems later in the year as the Japanese steel industry was obliged to reduce imports from all of its major suppliers. While final figures indicate that Canadian coal exports to Japan were up by 3 per cent in 1982 over 1981, this was due to an increase in thermal coal exports. Coking coal sales to Japan in 1982 were equal to those in 1981 in spite of a slowdown in deliveries in the last quarter. This slowdown necessitated some temporary mine closures in western Canada.

In spite of the current short term problems, the future of the Canadian coal industry remains promising. The most visible symbols of this future development are the new and expanding mines now under construction in British Columbia and Alberta. The largest project under development is in northeastern British Columbia where the new coal mines, upgraded railway facilities, a new coal port and related townsite and other social infrastructure will involve nearly $3 billion in public and private funds and result in the annual production of over 8 million t of coking and thermal coal for export.

Other new mines and expansions to existing mines along with related infrastructure expansions will see nearly $4 billion in total committed to coal export projects in western Canada by the mid-1980s. Another $4 billion will be spent in the 1980s on domestic coal projects including several new thermal power stations and related coal mines in western, central and eastern Canada. The magnitude and timing of these projects is expected to carry the coal industry over the current recession and provide the basis for expansion throughout the 1980s.

Despite the worldwide recession, the Canadian export coal industry recorded several important events in 1982 including the initial shipment from a new mine in southeastern British Columbia, the negotiation of a number of small but significant thermal and coking coal contracts with Asian, European and Latin American buyers and the beginning of construction on the first Canadian thermal coal mine entirely dedicated to the export market.

COAL PRODUCTION AND DEVELOPMENTS

Coal production increased by 20 per cent in Nova Scotia in 1982 as domestic and foreign coal demand for the generation of electricity increased. Approximately 90 per cent of the province's coal production comes from the three mines of the Cape Breton Development Corporation (DEVCO) near Sydney on Cape Breton Island. Clean (saleable) coal production from these mines totalled 2.7 million t in 1982. The major and fastest growing market for this coal is the provincially owned Nova Scotia Power Corporation. Additional markets include overseas utilities and steel industries, and residential/industrial consumers in eastern Canada. Throughout 1982, work was under way by DEVCO on two tunnels which will form part of the new Donkin-Morien mine now targeted to be in operation in 1985 or 1986 and on feasibility and marketing studies for the proposed Lingan-Phalen mine.

Production in New Brunswick remained unchanged in 1982 at just under 500 000 t. The main market for coal in this province is the provincial utility, which generated about 13 per cent of its electricity from coal.

TABLE 1. SUMMARY OF COAL SUPPLY BY TYPE AND VALUES, 1978-82

	1978		1979		1980		1981		1982	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
DOMESTIC[1]										
Bituminous										
Nova Scotia	2 650	116,322	2 157	103,279	2 726	132,750	2 539	133,226	3 052	174,474
New Brunswick	395	10,042	310	10,260	439	17,269	524	23,308	499	24,450
Alberta	5 115	212,616	5 349	190,059	6 830	246,771	6 895	272,238	6 978	337,742
British Columbia	9 061	379,489	10 616	466,801	10 156	457,959	11 781	590,935	11 768	654,130
Total	17 142	718,469	18 432	770,399	20 151	854,749	21 739	1,019,707	22 396	1,190,796
Sub-bituminous										
Alberta	8 278	36,135	9 569	43,562	10 542	55,402	11 551	42,559	13 021	88,022
Lignite										
Saskatchewan	5 058	21,520	5 012	21,770	5 971	32,381	6 798	55,305	7 494	73,520
Total	30 477	776,124	33 013	835,731	36 664	942,532	40 088	1,117,571	42 811	1,352,398
IMPORTED[2]										
Bituminous & Anthracite Briquettes	14 119	789,704	17 524	1,033,703	15 860	953,998	14 836	991,994	15 773	1,132,000
Total Coal Supply	44 596	1,565,828	50 537	1,869,434	52 524	1,896,530	54 924	2,109,565	58 584	2,484,338

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] fob mines; [2] Value at U.S. ports of exit.
(Figures refer to clean or saleable coal).

TABLE 2. CANADA, COAL PRODUCTION BY TYPES AND PROVINCES 1981 AND 1982

	1981			1982		
	Surface	Underground	Total	Surface	Underground	Total
	(000 tonnes)					
Bituminous						
Nova Scotia	294	2 245	2 539	399	2 652	3 051
New Brunswick	524	-	524	499	-	499
Alberta	6 206	689	6 895	6 371	607	6 978
British Columbia	11 015	766	11 781	11 038	730	11 768
Sub-Total	18 039	3 700	21 739	18 307	3 989	22 296
Sub-bituminous						
Alberta	11 551	-	11 551	13 021	-	13 021
Lignite						
Saskatchewan	6 798	-	6 798	7 494	-	7 494
Total production	36 388	3 700	40 088	38 822	3 989	42 811

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

Coal production in Saskatchewan increased by a significant amount in response to increased provincial consumption and growing sales to Ontario Hydro. Lignite production was a record 7.5 million t during 1982, up 10 per cent from 1981. Provincial markets account for 82 per cent of this output with the remainder exported to Ontario Hydro (13 per cent) and Manitoba Hydro (4 per cent).

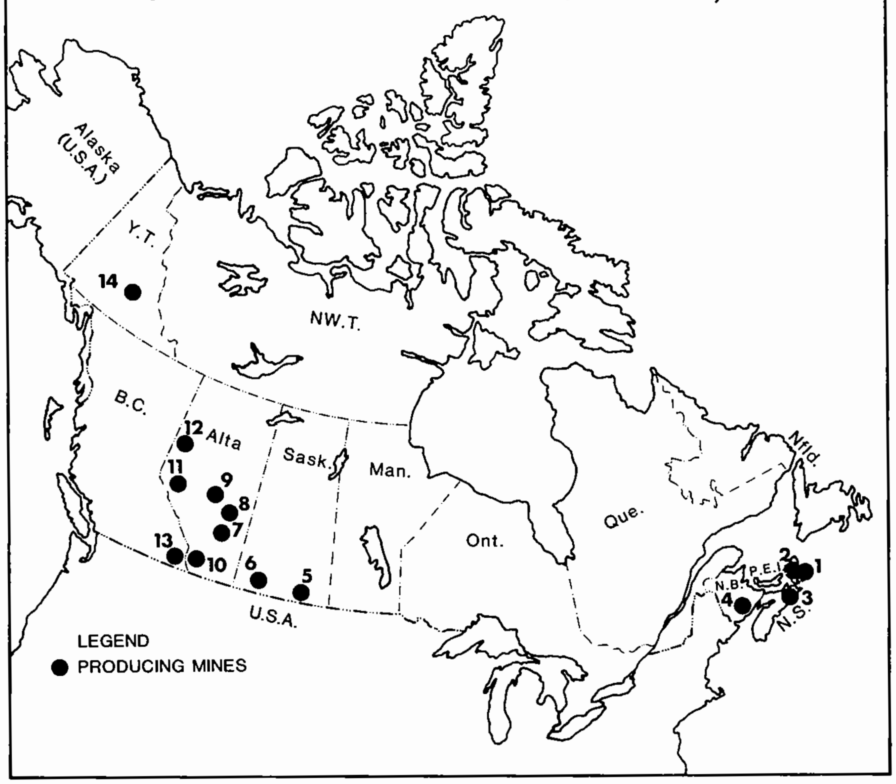
Alberta's record coal production of 20 million t in 1982 primarily reflected the increased electrical demand of provincial utilities. Production of sub-bituminous coal for this market increased as did the production of bituminous coking and thermal coal for export. Thermal coal output totalled 16.5 million t in 1982, while clean (saleable) coking coal production was 3.5 million t. The slump in coking coal demand in 1982 resulted in the short-term closures of the McIntyre Mines Limited Grande Cache mine and Luscar Ltd.'s Cardinal River Coals Ltd. mine. Both these mines were back into production at year-end.

Coal mines in British Columbia also felt the effects of world recession and resulting downturn in the Japanese and other steel industries. These market pressures forced B.C. Coal Ltd. to shut down its Balmer mine for 12 weeks with the result that total clean coal output only totalled 5.6 million t in 1982, down 1.9 million t from 1981. However, B.C. Coal remains Canada's largest exporter and completed several new agreements in 1982 with thermal and coking coal customers in Asia, Europe and Latin America. Work on the Greenhills mine expansion continued during the year with the first train of thermal coal loaded late in the year. Production of coking coal from this mine is expected to begin in September 1983.

The Fording Coal Limited operations at Elkford also felt the effects of the world recession in 1982, although clean coal production was up by 7 per cent due to increased productivity. Mining operations were shut down in the latter half of December due to market conditions. However, Fording finalized new agreements during 1982 and continued to work on a mine expansion that will see 2 million t of new clean coal productive capacity added in 1983.

Production at a third British Columbia producer was up significantly in 1982, as Byron Creek Collieries Limited more than doubled its 1981 production, when operations were curtailed because of a strike. Markets for this thermal coal include Ontario Hydro and customers in Asia and the United States. British Columbia's fourth and newest

PRINCIPAL COAL MINES in CANADA, 1982



mine, the Line Creek mine of Crows Nest Resources Limited shipped its first trainload of thermal coal to a South Korean cement plant in February. Coking coal production for the export market will begin in 1983 at this mine.

CANADIAN COAL UTILIZATION

Domestic coal utilization totalled 41.5 million t in 1982 up 8 per cent over 1982. The major market for coal in Canada is the utility sector which uses coal for the generation of electricity. Coal consumption in this market totalled 33.7 million t in 1982 up nearly 4 million t over the previous year. Utility thermal coal use was up in Nova Scotia, New Brunswick, Ontario, Saskatchewan and Alberta and down in Manitoba.

Thermal coal utilization in Nova Scotia in 1982 was up 15 per cent over 1981 with consumption at the four Nova Scotia Power Corporation's generation stations totalling 1.3 million t. Coal is now Nova Scotia's major fuel providing 48 per cent of the utility generated electricity in 1982 compared to only 37 per cent for oil. This represents a significant reduction in the use of imported oil for electricity generation, reflecting the federal and provincial objectives of increasing the use of indigenous coal in the province's energy balance. Coal will become even more important as two new 150 MW coal-fired plants come on-stream at Lingan on Cape Breton Island in 1983 and 1984.

Thermal coal utilization in New Brunswick increased by 6 per cent in 1982

TABLE 3. PRINCIPAL COAL PRODUCERS IN 1982

Company and Mine Location (Numbers refer to locations Figure 1)	1982 Raw Coal Production (000 tonnes)	Coal Rank	Chief Markets	Remarks
Nova Scotia				
1. Cape Breton Development Corporation (DEVCO)				
Lingan Mine, Lingan	1 847	Hvb A	Power generation	Underground
No. 26, Glace Bay Colliery	891	Hvb A	Metallurgical, Industrial, Domestic	Underground
Prince Mine, Point Aconi	498	Hvb A	Power generation	Underground
Novaco Limited, Point Aconi	242	Hvb A	Power generation	Surface
Thomas Brogan Limited Florence	45		Power generation Residential	Surface
Selminco Inc. Sydney	86	Hvb A	Power generation Residential	Surface
2. Evans Coal Mines Limited St. Rose	49	Hvb B	Power generation Residential	Underground
3. Thorburn Mining Limited Stellarton	23		Power generation Residential	Underground
New Brunswick				
4. N.B. Coal Limited Minto, Chipman areas	499	Hvb A	Power generation Paper mills	Surface
Saskatchewan				
5. Manitoba and Saskatchewan Coal Company (Limited) M&S Mine, Bienfait	1 428	Lig A	Power generation Industrial	Surface
5. Boundary Dam Mine, Estevan	1 134	Lig A	Power generation	Surface
5. Manalta Coal Ltd. Costello Mine, Estevan	557	Lig A	Power generation Industrial	Surface, formerly the Klimax mine
5. Manalta Coal Ltd. Utility Mine, Estevan	2 197	Lig A	Power generation	Surface
5. Saskatchewan Power Corporation Souris Valley Coal Mine, Estevan	274	Lig A	Power generation	Surface
6. Saskatchewan Power Corporation Poplar River Mine, Coronach	1 905	Lig A	Power generation	Surface

TABLE 3 (cont'd)

Company and Mine Location	1981 Raw Coal Production (000 tonnes)	Coal Rank	Chief Markets	Remarks
Alberta				
Sub-bituminous Mines				
7. Manalta Coal Ltd. Montgomery Mine, Sheerness	33	Sub C	Power generation	Surface, formerly the Roselyn Mine
8. Manalta Coal Ltd. Vesta Mine, Halkirk	899	Sub C	Power generation Residential	Surface
8. Forestburg Collieries Limited				
Diplomat Mine, Forestburg	367	Sub C	Power generation	Surface
Paintearth Mines	1 200	Sub C	Power generation	Surface, new mine
9. Manalta Coal Ltd. Whitewood Mine, Wabamun	1 893	Sub A & B	Power generation	Surface
Highvale Mine, Sundance	8 550	Sub C	Power generation	Surface
Bituminous Mines				
10. Coleman Collieries Limited Tent Mountain, Coleman	282		Japan for coke-making	Surface, re-processing waste material
11. Cardinal River Coals Ltd. Cardinal River Mine, Hinton	2 766	Mvb	Japan for coke-making	Surface
11. Luscar Sterco Ltd. Coal Valley Mine, Hinton	5 276	Mvb	Ontario Hydro and West Germany	Surface mine opened in 1978
12. McIntyre Mines Limited Smoky River Mines, Grand Cache	2 090	Lvb	Japan for coke-making	Surface and underground
British Columbia				
13. B.C. Coal Ltd.				
Michel Colliery, Natal	1 076	Lvb	Japan for coke-making	Surface and underground (hydraulic mining)
Harmer Ridge, Sparwood	6 409			
Greenhills Mine	708			
13. Fording Coal Limited Fording Mine, Fording Valley	6 369	Lvb	Japan for coke-making	Surface
13. Byron Creek Collieries Limited, Corbin Coal Mountain	1 225	Mvb	Ontario and Europe for steam generating	Surface
13. Crows Nest Resources Limited Line Creek Mine	1 466	Mvb	South Korea and Japan	Surface, new mine
Yukon				
14. Cyprus Anvil Mining Corporation, Carmacks Coal Mine, Carmacks		Hvb B	Anvil lead-zinc mine for heating and concentrate drying	Underground

Sources: Statistics Canada; Energy, Mines and Resources Canada.
Note: An - Semi-anthracite; Lvb - Low volatile bituminous ; Mvb - Medium volatile bituminous; Sub - Sub-bituminous; Lig - Lignite; Hvb - High volatile bituminous.

to 548 000 t and is expected to remain at about this level throughout the 1980s.

Ontario's use of thermal coal reached a record level of 12.5 million t in 1982 up 9 per cent over 1981. About one quarter or 2.9 million t of this coal came from British Columbia, Alberta and Saskatchewan while the remaining three quarters or 9.6 million t was imported from the United States. Ontario's coal utilization capacity increased in 1982 as one new 149 MW coal-fired unit was brought into service at Thunder Bay in July fuelled with Saskatchewan lignite coal. Work was also under way during the year on a 206 MW station at Atikokan, west of Thunder Bay, now scheduled to be in service in October 1984. This station will also be fuelled with coal from Saskatchewan raising the annual 1985 Ontario demand for this lignite coal to over 2 million t and the total Ontario Hydro requirement for Canadian coal to between 4 and 5 million t annually.

Coal utilization in Manitoba fell to 184 000 t in 1982, down 45 per cent from 1981. This decrease reflected better weather conditions and greater use of hydro facilities.

Consumption of coal for electricity generation in Saskatchewan grew by 20 per cent in 1982 to 5.9 million t. This increase reflected the first full year's operation of the first of two 300 MW units of the Poplar River generating station. The second 300 MW unit at this station is scheduled to begin operations in mid-1983 increasing coal requirements by another million t. Coal demand for electricity generation in Saskatchewan is forecast to approach 8 million t by 1984.

For the first time, Alberta's thermal coal consumption exceeded that of Ontario. Final statistics show a coal utilization level of 13.2 million t reflecting a 16 per cent increase over 1981 when coal demand was 11.4 million t. About 70 per cent of Alberta's electricity is generated from coal. Coal use at TransAlta Utilities Corporation's two-coal fired stations totalled 10.2 million t while consumption at Alberta Power Limited's coal stations approached the 3 million t level. Approximately 95 per cent of the thermal coal used in Alberta is sub-bituminous, mined in the plains region with the remaining 5 per cent a bituminous byproduct from McIntyre Mines Limited's Grande Cache operation located in the Rocky Mountains.

TABLE 4. PRODUCER'S DISPOSITION OF CANADIAN COAL[1], 1981

	Originating Province					
Destination	Nova Scotia	New Brunswick	Saskat-chewan	Alberta	British Columbia	Canada
			(000 tonnes)			
Newfoundland	2	-	-	-	-	2
Prince Edward Island	16	-	-	-	-	16
Nova Scotia	1 856	-	-	-	-	1 856
New Brunswick	29	499	-	-	-	528
Quebec	-	-	-	-	-	-
Ontario	-	-	999	1 495	587	3 081
Manitoba	-	-	325	9	50	384
Saskatchewan	-	-	6 170	25	-	6 195
Alberta	-	-	-	13 287	1	13 288
British Columbia	-	-	-	5	66	71
Total Canada	1 903	499	7 494	14 821	704	25 421
Japan	-	-	-	4 165	6 592	10 757
Others	1 050	-	-	848	3 349	5 247
Total shipments	2 953	499	7 494	19 834	10 645	41 425

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Saleable coal (raw coal, clean coal and middling sales).
- Nil.

TABLE 5. SUMMARY OF COAL SUPPLY-DEMAND, 1972-82

Year	CANADA PRODUCTION Bituminous	Sub-Bituminous	Lignite	Total	IMPORTS Anthracite	Bituminous	Total Available	Domestic Consumption	Exports
			(million tonnes)						
1972	11.3	4.4	3.0	18.7	0.4	16.4	35.5	24.2	8.5
1973	12.3	4.5	3.6	20.4	0.4	14.6	35.4	25.0	10.3
1974	12.5	5.1	3.5	21.1	0.4	12.0	33.5	24.9	10.5
1975	15.8	6.0	3.5	25.3	0.4	15.4	41.1	25.5	11.4
1976	14.4	6.4	4.7	25.5	0.3	14.3	40.1	28.2	11.9
1977	15.3	7.9	5.5	28.7	0.4	15.0	44.1	30.8	12.4
1978	17.1	8.3	5.1	30.5	0.3	13.8	44.6	31.7	14.0
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

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

TABLE 6. CANADA, COAL PRODUCTION, IMPORTS, EXPORTS AND CONSUMPTION, 1977-82

	Production	Imports	Exports	Domestic Consumption
	(000 tonnes)			
1977	28 681	15 439	12 387	30 896
1978	30 477	14 119	14 000	31 738
1979	33 013	17 524	13 698	34 764
1980	36 664	15 829	15 269	37 333
1981	40 088	14 836	15 705	38 367
1982	41 811	15 773	16 004	41 478

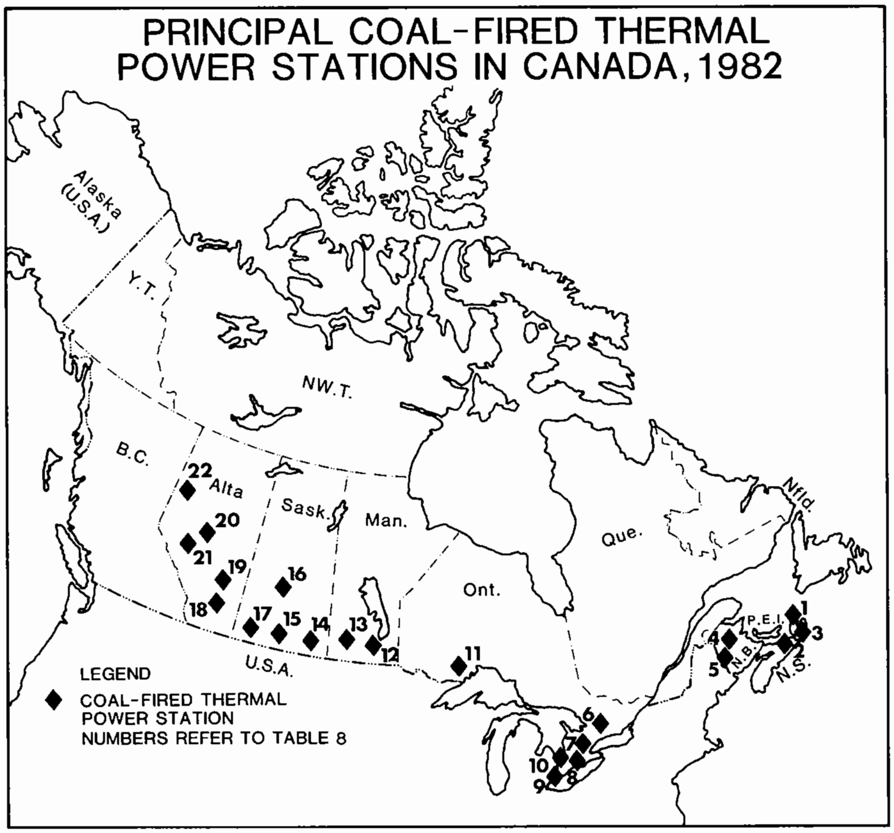
Sources: Statistics Canada; Energy, Mines and Resources Canada.

Several major new thermal coal-fired thermal power stations are in various stages of construction in Alberta. The 800 MW Keephills station of TransAlta Utilities is the most advanced, scheduled to come on-stream in 400 MW units in 1983 and 1984. The 750 MW Sheerness station, owned jointly by TransAlta Utilities and Alberta Power Limited, will be placed in service in 375 MW units in 1985 and 1986 while the 800 MW Genesee station, owned by Edmonton Power, is scheduled to be in service in 1986 and 1987. Total annual coal requirement for these three stations when operating at full capacity will be approximately 9 million t raising Alberta's thermal coal requirements to over 22 million t by the late-1980s. Capital investment in these power stations, coal mines and related facilities will exceed $3 billion.

TABLE 7. SUMMARY OF COAL DEMAND, 1978-82

	1978	1979	1980	1981	1982
			(000 tonnes)		
DEMAND					
Thermal Electric					
Canadian Coal	13 931	16 104	19 314	20 998	24 033
Imported Coal	8 984	8 857	8 468	8 815	9 623
Total	22 915	24 961	27 782	29 813	33 656
Metallurgical					
Canadian Coal	1 195	1 272	961	784	229
Imported Coal	5 714	6 593	6 279	5 593	5 347
Total	6 909	7 865	7 240	6 377	5 576
General Industry					
Canadian Coal	766	963	1 190	962	1 075
Imported Coal	922	751	955	1 044	986
Total	1 688	1 714	2 145	2 006	2 061
Space Heating					
Canadian Coal	199	200	166	171	185
Imported Coal	27	24	-	-	-
Total	226	224	166	171	185
Exports					
Canadian Coal	14 000	13 698	15 269	15 705	16 004
Total					
Canadian Coal	30 091	32 237	36 900	38 620	41 526
Imported Coal	15 647	16 225	15 702	15 452	15 956
Total Coal Demand	45 738	48 462	52 602	54 072	57 482

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



The possibility of large scale use of coal for electricity generation in the near term in British Columbia received a setback in 1982. Lower than expected economic growth along with lower electricity demand forecasts, the availability of hydro alternatives and rising costs brought about the indefinite postponement by British Columbia Hydro and Power Authority of its proposed 2000 MW Hat Creek coal-fired electric generating station. The project had previously been put back until 1992 because of a decline in electricity growth rates brought about by a slumping forest industry and industrial sector.

Consumption of coking coal in Canada declined by 13 per cent in 1982, and crude steel production fell by 19 per cent, reflecting difficult market conditions in Canada and elsewhere brought on by the global recession. Coal consumption was down 66 per cent to 200 000 t at the Sydney Steel Corporation facility in Sydney, Nova Scotia while smaller decreases in coal requirements at The Algoma Steel Corporation, Limited and Dofasco Inc. facilities saw coal feed total 1.4 and 1.7 million t respectively. The only major steel company to register a gain in coal utilization was Stelco Inc. where coal requirements increased by 30 per cent to nearly 2.3 million t. Most of the increase was attributed to the first full year's operation of the Lake Erie Nanticoke complex which began operations in November 1981. Coal consumption at Canada's other coke oven-carbonization facilities was down from 1981, bringing overall domestic coking coal consumption to 5.9 million t, down from 6.5 million t in 1981.

TABLE 8. PRINCIPAL COAL-FIRED THERMAL POWER STATIONS IN CANADA, 1982

Utilities (numbers refer to locations on Figure 2)	Station	Capacity (KW)	Coal Consumption (000 tonnes)	Remarks
Nova Scotia				
1. Nova Scotia Power Corporation	Seaboard	111 000	74 221	
2. Nova Scotia Power Corporation	Maccan	25 000	5 558	
2. Nova Scotia Power Corporation	Trenton	210 000	400 864	
3. Nova Scotia Power Corporation	Lingan	300 000	819 551	Two new 150-MW units to come on-stream in 1983 and 1984.
New Brunswick				
4. New Brunswick Electric Power Commission	Dalhousie	200 000	323 202	
5. New Brunswick Electric Power Commission	Grand Lake	85 000	224 436	
Ontario				
6. Ontario Hydro	Richard L. Hearn	1 222 500	191 560	
7. Ontario Hydro	Lakeview	2 422 500	1 841 763	
8. Ontario Hydro	Nanticoke	4 022 500	6 137 214	
9. Ontario Hydro	J. Clark Keith	271 500	203 112	
10. Ontario Hydro	Lambton	2 022 500	3 283 160	
11. Ontario Hydro	Thunder Bay	277 300	826 996	One new 149-MW unit began operation in 1981, second unit in 1982.
Manitoba				
12. Manitoba Hydro	Selkirk	155 800	21 259	
13. Manitoba Hydro	Brandon	237 000	163 045	
Saskatchewan				
14. Saskatchewan Power Corporation	Estevan	70 000	339 230	
15. Saskatchewan Power Corporation	Boundary Dam	875 000	3 838 259	
16. Saskatchewan Power Corporation	Queen Elizabeth	232 000	40 363	
17. Saskatchewan Power Corporation	Poplar River	300 000	1 679 278	One new 300-MW unit came on-stream in 1982, second scheduled for 1983.
Alberta				
18. Alberta Power Limited	Drumheller	15 000	1 924 580	Standby.
19. Alberta Power Limited	Battle River	737 000	2 452 143	
20. TransAlta Utilities Corp.	Wabamun	582 000	1 840 022	
21. TransAlta Utilities Corp.	Sundance	2 100 000	8 339 531	
22. Alberta Power Limited	H.R. Milner	150 000	610 190	

Coal utilization in the industrial/residential/space heating sector in 1982 was 2.1 million t, up 3 per cent from 1981.

COAL RESEARCH AND DEVELOPMENT

A wide range of activities are under way in Canada looking at the many aspects influencing the future use of coal in Canada. This ongoing work includes activities centred on coal mining; special investigations of health and safety issues; strata mechanics technology for the improvement of ground control in underground mines; studies of new and modified mining technologies; studies of coal reserve and resource assessment and other activities.

Much of the R&D work is concentrated on investigating the oppportunities for introducing new technologies to replace conventional fuel utilization in existing or future boiler equipment. The majority of this work is concentrated in eastern Canada where the opportunities for replacing imported oil with domestic energy alternatives is most urgent. Examples of such activities include the work under way at the new research facilities near Sydney, Nova Scotia which will produce a coal-water fuel to replace oil in boilers originally designed to burn only oil. If successful, this would reduce fuel costs, allow the utilization of a fuel readily available in this region and because of the technology involved, would have important environmental advantages. Another program involves the first demonstration of fluidized bed combustion technology in Canada at a heating plant in Summerside, Prince Edward Island. Other coal related activities included the development of a 7.6 meter diameter Tunnel Boring Machine which is now being used to drive access tunnels at the Donkin-Morien mine near Sydney, Nova Scotia, research into various aspects of coal liquefaction and studies of conventional combustion technology.

WORLD SCENE

International coal trade experienced a dramatic turnaround during 1982 brought on by the global recession. A buoyant market early in the year gave way to production cutbacks and falling market prices in the final quarter. The impact was most noticeable in the Japanese and European coking coal markets as imports fell by 1 and 4 per cent, respectively.

TABLE 9. COAL USED BY THERMAL POWER STATIONS IN CANADA, BY PROVINCES, 1964-82

	Nova Scotia	New Brunswick	Ontario	Manitoba	Saskatchewan	Alberta	Total Canada
				(000 tonnes)			
1964	530	222	2 795	132	1 006	999	5 684
1965	633	334	3 567	175	1 085	1 211	7 005
1966	799	294	3 500	79	1 116	1 360	7 148
1967	758	275	4 435	38	1 334	1 427	8 267
1968	646	240	5 523	179	1 354	2 128	10 070
1969	676	150	6 424	51	1 123	2 378	10 802
1970	548	113	7 696	503	1 969	2 951	13 780
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

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

Production and trade in Canada and elsewhere grew throughout the early months of the year as a consequence of events in 1981. Prior to the beginning of 1982, the Japanese steel industry completed an unusual number of agreements in the United States spot market to purchase extra quantities of coal. This coal was to replace production expected to be lost from Australia suppliers due to predicted labour and transportation-port difficulties. A combination of a rapid downturn in the world's economies and unexpected deliveries from Australian and other exporters led to a growing stockpile of coking coal by Japanese steel mills. As a result, Japanese crude steel production fell below the 100 million t level for the first time in 10 years. Steel industries in Europe, Latin America and other Pacific Rim countries also felt the effects of the recession and sought to reduce coal imports.

Coking coal exporters in many countries reduced production and all of Canada's four major coking coal producers shut down production at some time during 1982. Overall Canadian coking coal output fell by 7 per cent in 1982 and this was reflected in lower exports. However, because of increased shipments early in the year, total coking coal exports to Japan were only down by about 1 per cent. Coking coal exports to other countries were down 19 per cent.

This problem in the world's steel industry has highlighted serious long-term structural problems. Steel production capacity is now thought to be in excess of likely demand level for much of the 1980s and rationalization will be required especially in the older industries, some of which are producing at low levels of capacity. This trend will have a long term impact on growth prospects for world coking coal trade.

The thermal coal trade has also been adversely affected by the current recession and the resulting decline in energy requirements and longer term commitments to thermal coal projects have been delayed in many countries. Several potential coal projects which were near agreement in western Canada have been set back pending improved economic conditions although construction activity did begin one project in Alberta in 1982.

Coal prices have been influenced by the changing conditions of 1982. Earlier in the year the larger Canadian coking coal exporters completed agreements with Japanese steel mills to increase coal prices for FY 1982/83 by 20 to 25 per cent. Prices for the two largest exporters rose from the $Cdn. 65 to $70 range to the $Cdn. 80 to $85 range per long ton fob Vancouver. As the year progressed and the recession deepened spot market prices for coals exported through eastern United States ports fell 20 per cent and more.

TABLE 10. EXPORT DEMAND FOR CANADIAN COAL, 1981 AND 1982

Country	1981		1982	
	(000 t)	($000)[1]	(000 t)	($000)[1]
Japan	10 486	680,953	10 757	807,651
United States	67	4,344	71	3,956
Denmark	319	20,281	333	22,037
Chile	248	16,169	76	5,563
Korea	1 733	113,999	2 276	159,972
Germany	608	32,276	952	64,948
Sweden	261	17,091	285	23,473
Mexico	272	19,186	32	2,668
Pakistan	73	4,832	146	11,528
Belgium	56	5,699	4	299
Brazil	874	62,534	230	17,999
Argentina	76	5,817	-	-
Italy	71	5,022	64	4,925
Taiwan	315	20,782	510	41,425
Spain	54	4,204	-	-
India	117	7,675	63	4,968
China	-	-	177	10,561
Netherlands	75	5,010	28	2,121
Total	15 705	1,025,874	16 004	1,184,114

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] fob Port of Export Canadian dollars.
- Nil.

OUTLOOK

In spite of the present difficulties, the long-term outlook for the Canadian coal industry remains promising. The domestic industry has several major coal related projects under way which have not been influenced by the current recession. The export sector is expected to experience a doubling of exports in the next few years primarily based on new coking coal contracts signed in 1980 and 1981.

The expansion of the domestic thermal coal sector is assured in Nova Scotia, Saskatchewan and Alberta as several new

TABLE 11. CANADA, COKE PRODUCTION AND TRADE, 1972-82

	Production		Imports		Exports	
	Coal Coke	Petroleum Coke	Coal Coke	Petroleum Coke	Coal Coke	Petroleum Coke
	(tonnes)					
1972	4 675 866	242 370	481 816	555 710	238 478	881
1973	5 369 861	286 530	357 815	637 664	367 916	1 960
1974	5 443 427	274 412	509 058	746 033	260 892	24 940
1975	5 277 837	270 685	546 456	572 557	96 081	161 576
1976	5 289 185	678 432	287 249	591 859	169 895	136 970
1977	4 845 066	921 363	382 827	986 678	198 727	157 191
1978	4 967 664	1 014 076	553 349	973 985	217 595	134 762
1979	5 775 141	1 105 433	520 534	980 657	228 601	125 416
1980	5 249 744	1 156 444	626 923	908 322	319 554	150 200
1981	4 659 007	1 098 397	653 645	935 929	190 879	200 149
1982	3 999 117	1 083 129	453 915	650 810	129 793	104 897

coal-fired thermal generating stations are in various stages of construction. Provincial thermal coal production will increase in 1983 to supply coal for the third 150 MW Lingan coal-fired station on Cape Breton Island, scheduled to become operational late in the year; the 300 MW Poplar River No. 2 unit scheduled to start-up in July 1983 in southern Saskatchewan; and the first 400 MW unit of the Keephills generating station, west of Edmonton scheduled for an April 1983 start-up. Overall Canadian thermal coal consumption is forecast to reach 37 million t in 1983 up 10 per cent from 1982.

Assuming a recovery in the world economy, Canadian coking coal exports should again exceed 16 million t in 1983. Several new mines and expansions to existing operations are under way in western Canada which will assure a continued growth in exports throughout the 1980s. On the basis of contracts already signed exports will double in the next few years. About half of this expanded production will come from the new Quintette Coal Limited (Denison Mines Limited) and Bullmoose (Teck Corporation) mines in British Columbia scheduled to export their first shiploads of coal in December 1983.

Other new projects include Manalta Coal Ltd.'s new Gregg River mine in north central Alberta scheduled to begin production of coking coal for export to the Japanese steel industry in mid-1983. Initial production of coking coal for Pacific Rim and other markets is also scheduled to begin at the Crows Nest Resources mine (Shell Canada Resources Limited), the Greenhills mine (B.C. Coal Ltd.), and at the Fording Coal Limited expanded operations near Elkford, British Columbia in 1983.

Several new thermal coal projects are under investigation in western Canada to serve the export coal market. However some of these projects have now been delayed or put back because of the current world recession and the resulting slowdown in electricity growth rates. Canadian coal exporters did however complete negotiations on several smaller thermal coal contracts with utility and cement concerns in Hong Kong, South Korea and other markets during the year. In addition, construction did begin on Canada's first thermal coal mine entirely dedicated to the export market. The Obed Marsh Thermal Coal Project (Union Oil Company of Canada Limited) is scheduled to being the initial coal deliveries towards the end of 1984.

Increased coking and thermal coal exports will be handled by an expanded western Canadian rail system and new coal exporting facilities. A major rail upgrading program is expected to be accelerated on the western rail systems of both Canadian Pacific and Canadian National Railways. British Columbia Railways is building western Canada's first electrified rail link to service the new northeastern British Columbia mines. Coal from these mines will be exported through a new coal terminal at Ridley Island near Prince Rupert.

TABLE 12. COKE OVEN AND OTHER CARBONIZATION PLANTS IN CANADA, 1982

Company	Operating Batteries and No. of Ovens	Oven Type	Year Built	1982 Coal Feed	1982 Coke Production	Byproduct
				(000 tonnes/year)		
The Algoma Steel Corporation, Limited Sault Ste. Marie, Ontario	No. 5-86	Koppers-Becker	1943	1 362	980	Tars, light oil, gas
	No. 6-57	Koppers-Becker	1953			
	No. 7-57	Wilputte Underjet	1958			
	No. 8-60	Wilputte Underjet	1967			
	No. 9-60	Wilputte Underjet	1978			
Stelco Inc. Hamilton, Ontario	No. 3-61	Wilputte Underjet	1947	1 814	1 387	Tars, gas, light oil, anhydrous ammonia
	No. 4-83	Wilputte Underjet	1952			
	No. 5-47	Wilputte Underjet	1953			
	No. 6-73	Otto Underjet	1967			
	No. 7-83	Otto Underjet	1972			
Stelco Inc. Nanticoke, Ontario	No. 1-45	Otto Underjet	Began operation in Nov. 1981	520	398	Tars, gas, light oil
Dofasco Inc. Hamilton, Ontario	No. 1-25	Koppers-Becker Gun Type Comb.	1951	1 736	1 303	Tars, light oil, gas sulphur, ammonium, sulphate
	No. 2-35	Koppers-Becker Gun Type Comb.	1956			
	No. 3-45	Koppers-Becker Gun Type Comb.	1958			
	No. 4-53	Koppers-Becker Gun Type Comb.	1967			
	No. 5-53	Koppers-Becker Gun Type Comb.	1971			
	No. 6-35	Koppers-Becker Gun Type Comb.	1978			
Sydney Steel Corporation Sydney, Nova Scotia	No. 6-61	Koppers-Becker Underjet	1953	191	143	Tars, light oil, gas
B.C. Coal Ltd. Natal, British Columbia	16 Units	Curran-Knowles	1949	19	15	Crude tar, gas, coke breeze (ceased operation April/83).
	16 Units	Curran-Knowles	1952			
Manitoba and Saskatchewan Coal Company (Limited)	2 Units	Lurgi Carbonizing Retort	1925	76	40)	All coal char
	2 Units	Salem Rotary Hearth Calciners	1974	224	89)	
Char Briquetting Div. Bienfait, Saskatchewan						

This $300 million Ridley Island coal terminal, 90 per cent owned by the federal government through Canada Ports Corporation (formerly the National Harbours Board) and 10 per cent by Federal Commerce and Navigation Co. Ltd. of Montreal, will have an initial throughput capacity of 12 million t and a capability for handling ships of up to 250 000 tons deadweight. It can be expanded to handle up to 24 million t of coal annually when required. The coal exporting capacity of the Westshore Terminals Ltd. facility at Roberts Bank south of Vancouver is also being expanded to facilitate increased coal exports. Beginning in 1983 this terminal will be capable of handling up to 22 million t of coal exports annually almost double its current capacity of 12 million t.

Expansion and upgrading of coal terminal and related transportation facilities is under way at Standard Aero Limited, North Vancouver and at Cape Breton Development Corporation, Sydney, Nova Scotia.

Cobalt

D.G. FONG

SUMMARY

Canadian production of cobalt in 1982, amounting to 1 458 t, was down by 30 per cent from 1981. The decrease was primarily due to prolonged shutdowns at nickel-copper operations where cobalt was produced as a byproduct. Canadian refineries that toll-refined cobalt materials also showed a significant decline in output because of a shortage of feedstocks.

Western world cobalt production in 1982, estimated at 14 509 t, dropped by 32 per cent while consumption continued to decline. In the United States, cobalt consumption declined for the fourth consecutive year; markets were especially weak in superalloys, cutting and wear resisting materials, driers and catalysts.

The price of cobalt dropped sharply during the second half of the year when it reached a post-war low in constant dollars. The principal reasons for this decrease were lower demand caused by slow economic activity and large inventories held by the major producers.

CANADA AND OFF-SHORE OPERATIONS OF CANADIAN PRODUCERS

Canadian cobalt production in 1982 declined by 30 per cent to 1 458 t, compared with 2 080 t in 1981. Two companies, Inco Limited and Falconbridge Limited recovered cobalt as a byproduct from their nickel-copper production while a third, Sherritt Gordon Mines Limited, recovered cobalt from nickeliferous materials refined on a toll basis and from purchased nickel feedstocks.

Inco produced crude cobalt oxide at its Port Colborne, Ontario and Thompson, Manitoba plants. This product was further processed at the company's Clydach, Wales, refinery to obtain various oxide and salt compounds.

Inco's output in 1982 was severely affected by a month-long strike which began May 31 and prolonged shutdowns immediately after; the Sudbury and Port Colborne operations remained closed after May 31. The production of cobalt salts at the Clydach refinery was permanently terminated in the fourth quarter of the year.

Work on Inco's electrolytic cobalt plant at Port Colborne progressed as planned. The $25 million plant, expected to come on-stream before the middle of 1983, will have a production capacity of 907 tpy of cobalt metal. Feedstock for the new plant, which will replace the cobalt oxide production line, will be supplied from an existing cobalt treatment facility at Port Colborne. Cobalt oxide will continue to be produced at the Thompson nickel refinery.

Falconbridge's cobalt production was significantly lower in 1982 due to the 11-week summer shutdown at its Norwegian operations, beginning July 9, and a prolonged shutdown at its Canadian operations starting June 27. The company had planned to resume operations in the Sudbury area on September 26, 1982, but extended the shutdown by 14 weeks until January 2, 1983 because of continuing weak economic conditions. At Kristiansand, Norway, the company's nickel refinery recovered electrolytic cobalt from nickel-copper matte produced in Canada and from materials that were either purchased or processed on a toll basis from various sources.

Sherritt Gordon's output of refined cobalt declined to 784 t in 1982 from 914 t in 1981 due to a shortage of cobalt feedstocks. The company has expanded its cobalt refining capacity at its Fort Saskatchewan, Alberta, facility in recent years, with the intention of using the enlarged facilities for toll refining arrangements. Current nominal capacity at the plant is 907 tpy of cobalt.

Diamond drilling during 1981-82 located a major copper-cobalt deposit in northwestern British Columbia. The property, known as Windy Craggy, is being explored

TABLE 1. CANADA, COBALT PRODUCTION TRADE 1981 AND 1982 AND CONSUMPTION 1980 AND 1981

	1981		1982P	
	(kilograms)	($)	(kilograms)	($)
Production[1] (all forms)				
Ontario	1 831 320	94,392,728	1 188 000	36,976,000
Manitoba	249 075	13,990,393	270 000	8,403,000
Total	2 080 395	108,383,121	1 458 000	45,379,000
Exports				
Cobalt metal				
United States	624 726	25,428,000	526 670	14,206,000
South Africa	250	7,000	8 321	606,000
Japan	-	-	17 599	304,000
Netherlands	26 989	919,000	9 979	237,000
Mexico	3 729	250,000	12 320	200,000
Other countries	20 881	1,156,000	10 112	346,000
Total	676 575	27,760,000	585 001	15,899,000
Cobalt oxides and hydroxides[2]				
United Kingdom	600 874	27,532,000	230 000	8,521,000
Total	600 874	27,532,000	230 000	8,521,000
Consumption[3]	1980		1981	
Cobalt contained in:				
Cobalt metal	80 981		87 583	
Cobalt oxide	14 766		6 979	
Cobalt salts	9 478		6 772	
Total	105 225	..	101 334	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Production (cobalt content) from domestic ores. [2] Gross weight. [3] Available data reported by consumers.
P Preliminary; - Nil; .. Not available.

TABLE 2. CANADA, COBALT PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975 AND 1978-82

		Exports		Imports		
	Production[1]	Cobalt metal	Cobalt oxides and hydroxides	Cobalt ores[2]	Cobalt oxides and hydroxides[3]	Consumption[4]
	(tonnes)					
1970	2 069	381	837	..	..	148
1975	1 354	431	561	..	..	123
1978	1 233	716	748	85	83	145
1979	1 640	296	445	190	46	115
1980	2 118	325	1 091	2	26	105
1981	2 080	676	601	24	20	101
1982P	1 458	585	230	2	30	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Production from domestic ores, cobalt content including cobalt content of Inco Limited and of Falconbridge Limited shipments to overseas refineries. [2] Cobalt content. [3] Gross weight.
[4] Consumption of cobalt in metal, oxides and salts.
P Preliminary; .. Not available.

under a joint venture agreement between Geddes Resources Limited and Falconbridge Limited. Geddes can earn a 49 per cent interest in the property through expenditures of $1.5 million. Preliminary results based on 12 holes indicate reserves of over 83 million t grading 3.04 per cent copper and 0.9 per cent cobalt. Total inferred reserves are estimated at over 300 million t of 1.52 per cent copper and 0.08 per cent cobalt.

WESTERN WORLD

Western world cobalt production in 1982, estimated at 14 509 t, was down by 32 per cent from 1981. The decline in output was largely a result of voluntary cutbacks by major byproduct producers who were confronted with depressed metal markets and high inventories. Zaire, the world's leading cobalt producer, reduced production markedly and Zambia experienced operating problems. The extended shutdowns at Canada's nickel operations and a shortage of cobalt feedstocks at a number of major refineries in the world also contributed to the lower level of output.

Cobalt consumption in the western world declined to 13 000 t in 1982 from 15 500 t in 1981 and prices dropped to a post-war low in constant dollars. As a result, producer inventories were at a record high. The reduction in demand was most pronounced in the aerospace industry in the United States and the magnet manufacturing industry in Japan.

Zaire produced about 5 800 t of cobalt in 1982 compared with 11 124 t in 1981. Producers were reported to be holding about 20 000 t of cobalt in stocks at year-end. In September, Zaire switched from its producer price policy of the past to a competitive pricing policy in an effort to reduce its inventory level and to recapture its market share.

The decline in Zambia's production was largely due to problems related to equipment availability and a shortage of skilled manpower and spare parts. It was also partly due to a power interruption at Kitwe where three transformers exploded in November, causing a one-month shutdown of the smelter and refinery at Rokana.

The state-controlled byproduct cobalt producers, Roan Consolidated Mines Limited (RCM) and Nchanga Consolidated Copper Mines Ltd. (NCCM) were merged into Zambia Consolidated Copper Mines Ltd. (ZCCM) in March, 1982. The merger, completed in March 1982 was undertaken for the purpose of reducing costs by rationalizing common activities and eliminating competition between the two companies.

TABLE 3. PRODUCER SHIPMENTS OF COBALT BY MAJOR CANADIAN PRODUCERS 1980-82

	1980	1981	1982
	(tonnes)		
Inco	885	1 642r	1 148
Falconbridge	632	622	377
Sherritt Gordon	196	379	342
Total	1 713	2 643r	1 867

Source: Company annual reports.
r Revised.

Cobalt production in Zambia will increase significantly in the future as major investment projects are completed and achieve planned operating rates. The cobalt vacuum refinery at the Chambishi plant began operations in October. At Rokana, the old cobalt plant was being expanded and modernized, and a new roast-leach-electrowinning cobalt plant was completed toward year-end. In addition, a number of mine developments and expansions were underway.

Noranda Mining Inc., a U.S. subsidiary of Noranda Mines Limited, Toronto, completed feasibility studies on its Blackbird deposit in Idaho. Drilling has indicated an ore reserve of 6.4 million t grading 0.71 per cent Co and 1.2 per cent Cu, and U.S. authorities have approved an environment protection program submitted by the company. However, the project has been deferred because of the current depressed market situation.

Construction work has started on India's first cobalt plant, located near a large copper mine at Ghatshila in Bihar State. The plant is to be operating within three years and will be capable of recovering about 60 tpy of cobalt from slags. Extraction technology will be supplied by a Finnish firm. This plant will make India, which has been relying on Zambia for its supply of cobalt, self-sufficient in the metal.

Major world cobalt producers have formed the Cobalt Development Institute to promote the use of cobalt. This institute, with headquarters in Brussels, Belgium was created following a two-day meeting of its founding members in March 1982 in Casablanca, Morocco. Participating members include producers from France, Japan, Belgium, Canada, Morocco, Zaire and Finland.

A study by the United States Congressional Budget Office on policy options for strategic minerals concluded that the National Defence Stockpile represents the least expensive solution to safeguard against a disruption in cobalt supplies. The report noted that the current stockpile goal of 38 740 t of cobalt is significantly above the level required to meet three years consumption for strategic purposes at projected 1985 levels of demand. The United States government increased its stockpile to 19 050 t following the purchase of 2 359 t of cobalt from Zaire in 1981.

USES

Cobalt is used in superalloys because it improves high strength, and wear and corrosion resistance characteristics of the alloy at elevated temperatures. The major use of cobalt-base superalloys is in turbine blades for aircraft jet engines and gas turbines for gas pipelines. Cobalt-base superalloys normally contain 45 per cent or more cobalt, while nickel- and iron-based superalloys contain 8 to 20 per cent cobalt.

Cobalt-base alloys are used in applications where difficult cutting is involved and high abrasion resistance qualities are required. The most important group of cobalt-base alloys is the stellite group, containing cobalt, tungsten, chromium, and molybdenum as principal constituents. Hardfacing or coating of tools with cobalt alloys provides greater resistance to abrasion, heat, impact and corrosion.

Cobalt metal powder is used as a binder in making cemented tungsten carbides for heavy-duty and high-speed cutting tools.

As a chemical product, cobalt oxide is an important additive in paint, glass, and ceramics. Cobalt is also used to promote the adherence of enamel to steel for applications such as appliances, and steel to rubber for the construction of steel-belted tires. A cobalt-molybdenum-alumina compound is used as a catalyst in hydrogenation and in petroleum desulphurization.

TABLE 4. WORLD PRODUCTION OF RECOVERABLE COBALT[e] 1980-1982

	1980	1981	1982
	(tonnes)		
Zaire	14 482	11 124[r]	5 800
Zambia	3 309	2 570[r]	2 446
Canada	2 118	2 080[r]	1 458
Finland	1 152[r]	1 229[r]	1 455
Morocco	998	1 000	600
Philippines	1 270	1 400	1 000
Australia	1 596	1 500	1 300
Other Western	580	450	450
Subtotal	25 505[r]	21 353[r]	14 509
U.S.S.R.	2 040	4 000[1]	4 000[1]
Cuba	1 700		
Total	29 245[r]	25 353[r]	18 509

[1] U.S.S.R. and Cuba.
[e] Estimated; [r] Revised.

PRICES

Reduced demand and large inventories have resulted in progressive price-cutting in both dealer markets and producer quotations. Zaire, a dominant influence on the cobalt market, lowered its official price to $US 27.56 per kg from $US 38.58 on February 1, and abandoned the fixed price policy in September by offering competitive prices. Zambia, on the other hand, was undercutting other producers by offering its contract customers lower prices. At the beginning of July, Zambia was selling at $US 19.40 a kg for Chambishi cobalt and $US 19.78 for Rokana cobalt; in September, these prices were lowered to $US 16.53 and $US 17.20 respectively.

Dealers reacted swiftly to Zaire's large price cut in February, with spot prices in the United States dropping to $US 24.80-25.90 from $US 26.46-28.66 a kg. The price continued to fall and toward the end of June, it was quoted at $US 20.39-$US 20.94 a kg. Strong competition in an already weak market forced the price to drop further to $US 8.82-10.14 a kg in October before improving slightly during the last two months of 1982 to $US 10.14-$10.69 a kg.

PRICES

	Aug. 1981	Dec. 1982
	($)	
Cobalt metal, per kg.		
fob New York		
Shot, 99.5%, 250-kg drum	20.00[1]	12.50
Powder, 99%+		
300 and 400 mesh, 50-kg drums	22.92[1]	6.20
extra fine, 125-kg drums	27.26[1]	9.81

Source: Metals Week.
fob Free on board.
[1] Due to suspension of producer list price, last quotation week for the year 1981 ended August 14, 1981.

OUTLOOK

The depressed state of the cobalt market is expected to persist throughout 1983. With Zaire still holding a very large inventory, supplies will continue to exceed consumption. Some improvement in consumption is expected from the superalloy sector, especially in the United States, but this is unlikely to have a major impact on the cobalt market. Prices will remain weak until total consumption improves and consumers begin to rebuild their inventories.

TARIFFS

CANADA Item No.		British Preferential	General Preferential	Most Favoured Nation	General
			(%)		
33200-1	Ore of cobalt	free	free	free	free
35103-1	Cobalt metal, excluding alloys, in lumps, powders, ingots or blocks	free	free	free	25
35110-1	Cobalt metal, in bars	free	free	8.8	25
92824-1	Cobalt hydroxides	9.4	6	9.4	25
	Temporary reduction June 3, 1980 to December 31, 1986	free	free		
92824-2	Cobalt oxides	free	free	10	20

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
				(%)		
35110-1	8.8	8.4	8.0	7.6	7.2	6.8
92824-1	9.4	7.5	5.6	3.8	1.9	free
92824-2	10	10	10	10	9.9	9.2

UNITED STATES		1982	1983	1984	1985	1986	1987
					(%)		
418.60	Cobalt oxide		1.2¢/lb				
418.62	Cobalt sulphate		1.4%				
601.18	Cobalt ore		free				
632.20	Cobalt metal, unwrought waste and scrap		free				
418.68	Cobalt compounds other than cobalt oxide and cobalt sulphate	5.3	5.1	4.9	4.7	4.4	4.2
426.24	Cobalt salts, resinate	5.3	5.1	4.9	4.7	4.4	4.2
426.26	Cobalt salts, other	5.3	5.1	4.9	4.7	4.4	4.2
632.88	Cobalt metal alloys unwrought	7.7	7.3	6.8	6.4	5.9	5.5
633.00	Cobalt metal wrought	7.7	7.3	6.8	6.4	5.9	5.5

Sources: The Customs Tariff and Commodities Index, Revenue Canada; Tariff Schedules of the United States Annotated (1982), USITC Publication 1200; U.S. Federal Register, Vol. 44, No. 241.

Columbium (Niobium) and Tantalum

D.G. FONG

SUMMARY

Western world columbium production, estimated at 16 600 t of columbium pentoxide (Cb_2O_5) was about 6 per cent lower than that of 1981. The consumption of columbium was substantially lower in the United States because of the significant drop in production of carbon steels, high-strength-low-alloy (HSLA) steels and superalloys. However, the consumption of these columbium-bearing metals was sustained in Japan and Europe due to increased uses in energy and defense-related applications and also in Japanese automobile production. Prices of most columbium products were lower during 1982, except for pyrochlore concentrates which remained unchanged from 1981.

Western world mine output of tantalum pentoxide (Ta_2O_5) in 1982 declined substantially because of production cutbacks by the major tantalite* producers and reduced output of byproduct production from tin mining. The consumption of tantalum, estimated at 630 t was about 20 per cent lower than 1981. World stocks increased to about 2 560 t of Ta_2O_5 and prices dropped to a five-year low.

COLUMBIUM

Canadian Developments

Columbium is produced in Canada by Niobec Inc., a company owned by Société québécoise d'exploration minière (SOQUEM) and Teck Corporation. Niobec produced about 3 080 t of contained Cb_2O_5 in 1982 at its pyrochlore deposit near St. Honore, Quebec, a 10 per cent increase over 1981. The increase resulted from mining higher-grade ore zones.

Despite reduced demand for columbium in the United States, one of its three major markets, Niobec increased shipments during 1982. This was mainly due to the increase in demand from its long-term customers in Japan and Europe. Niobec continued to carry out engineering studies on a high-purity oxide plant, and is expected to make a decision in 1983 on proceeding with the project. High-purity oxides are used for making vacuum-grade ferrocolumbium for superalloys.

Iron Ore Company of Canada carried out metallurgical tests during 1982 on the Strange Lake deposit, located near Lac Brisson which straddles the boundary between Québec and Labrador. Significant mineralization at the property includes columbium, tantalum, zirconium, beryllium, yttrium, and rare earths. The deposit was discovered in 1979 in a follow-up of a geochemical survey of the region by the Geological Survey of Canada (GSC).

World Developments

Cia Brasileira Metalurgia e Mineracão S.A. (CBMM), the world's largest columbium producer, completed its 25 000 tpy pyrochlore plant in late-1981 to replace the old 14 500 tpy facility. Production at the new plant during 1982 was substantially below capacity because of weak demand from the U.S. steel industry. The company had planned for a second mill which would result in doubling the output capacity. However, due to the surplus situation, the project was postponed.

CBMM put its first shipments of high-purity ferrocolumbium and nickel-columbium on the U.S. market in July 1982. The commercial production of these high-purity products had been scheduled for October 1981, but marketing was delayed because of unexpected technical problems in the plant.

* Tantalite and columbite ((Fe, Mn) $(Ta,Cb)_2O_6$) are important sources of tantalum and columbium. These minerals form an almost continuous Ta-Cb solid solution series. Tantalite is sold on the basis of tantalum pentoxide (Ta_2O_5) in concentrates while columbite is sold on the basis of 65 per cent combined pentoxides in specific ratios of Cb_2O_5 to Ta_2O_5, generally 10 to 1 or 8½ to 1.

Operations at the 1 360 tpy high-purity oxide plant, which were suspended in December 1980 after one year of production, remained closed during 1982 because of large inventories. The company was holding 300 t of columbium oxide at year-end. CBMM also started a pilot plant which produces ultra-pure crystal-grade columbium oxides for optical and electronic applications. Full scale production of 100 tpy is targeted for 1983.

USES

The steel industry is the largest consumer of columbium, which is used in the form of ferrocolumbium as an additive agent in high-strength-low-alloy (HSLA) steels, carbon steels, low-alloy steels, stainless steels and tool steels. Although the quantity of the metal added to steel may be as low as 0.02 per cent, the mechanical properties and tensile strength of the steel are significantly improved. These characteristics are particularly important in applications such as pipeline steels, automotive components and structural steels where the strength-to-weight ratio is critical.

High-purity columbium pentoxide is used mainly in superalloys for aircraft and turbine engines. A columbium addition to the cobalt- and nickel-based superalloys improves the high-temperature characteristics of these alloys. In the manufacture of high-alloy and stainless steels, columbium is used to impart resistance to corrosion at elevated temperatures, a property of particular importance in coal gasification, and sour natural gas and smelter gas processing.

One of the important properties of columbium is its superior conductivity compared with other pure metals. Superconductivity is the loss of all resistance to direct electrical current at temperatures near absolute zero. This special property of columbium allows the construction of extremely powerful magnets for electrical generators, which are much more efficient than conventional generators with copper wire windings. Also, because of the powerful magnetic field created by the superconductors, many potential applications in electrical devices are being developed, including new types of motors and ship engines.

TABLE 1. CANADA, COLUMBIUM (NIOBIUM) AND TANTALUM PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975 AND 1978-82

	Production[1]		Imports					Consumption
			Primary forms and fabricated metals				Exports[2] Columbium Ores and Concentrates to U.S.	Ferrocolumbium and ferro-tantalum-columbium, Cb and Ta-Cb Content
	Cb_2O_5 Content	Ta_2O_5 Content	Columbium	Columbium Alloys	Tantalum	Tantalum Alloys		
	(kilograms)							
1970	2 129 271	143 800	..	..	..	..	576 227	132 449
1975	1 661 567	178 304	..	..	..	..	9 682	215 910
1978	2 473 045	158 776	1 705	-	7 655	1 535	552 657	163 293
1979	2 512 667	158 845	855	W	6 901	2 503	509 953	360 152r
1980	2 462 798	115 261	877	156	21 280	12 112	655 721	486 251r
1981	2 740 736	103 949	913	303	2 769	5 152	419 865	455 407
1982P	3 126 000	60 000	805	59	1 759	1 146	291 193	..

Sources: Energy, Mines and Resources Canada; Statistics Canada; U.S. Department of Commerce.

[1] Producers' shipments of columbium and tantalum ores and concentrates and primary products, Cb_2O_5 and Ta_2O_5 content. [2] From U.S. Department of Commerce, Imports of Merchandise for Consumption, Report FT 135. Quantities in gross weight of material.
P Preliminary; - Nil; .. Not available; W Withheld to avoid disclosing confidential company data; r Revised.

Special high-purity columbium pentoxide is produced for optical applications. Additions of columbium pentoxide to optical glass give a high refractive index and thereby allow production of thin lenses for eyeglasses. This characteristic, along with others, such as lightweight and durability, enable such lenses to be competitive with plastic lenses.

PRICES

Niobec, the sole major supplier of columbium concentrate in the world, quoted the price for concentrate at $US 7.17 a kg (contained Cb_2O_5) throughout 1982. CBMM lowered its prices for standard-grade ferrocolumbium on July 23 to $US 13.10 per kg (contained Cb) from $US 13.67 for bulk shipments, and to $US 13.23 from $US 13.80 for packaged materials. The U.S. producers, Foote Mineral Company and Shieldalloy Corp., matched the Brazilian prices and made their quotations effective July 16 and August 1, respectively. In July, CBMM began marketing high-purity products in the United States, with prices listed at $US 46.30 per kg for high-purity ferrocolumbium and $US 49.05 per kg for nickel columbium, about $US 5.51 per kg below U.S. market quotations. The U.S. producers, Reading Alloys, Inc., KBI Division of Cabot Corporation and Shieldalloy, immediately followed suit.

OUTLOOK

Western world columbium production and demand in 1983 are expected to be about the same as in 1982. Depressed steel production in the United States and a continuing contraction in the steel industries of western Europe and Japan will likely result in some stock accumulation in the first half of 1983. However, a partial recovery of the steel industry during the second half of the year could offset earlier losses in consumption.

In the long term, demand is expected to grow between 5 and 6 per cent a year; the development of new applications and a growing acceptance worldwide of columbium steels will provide a strong growth base for columbium. Mine production capacity will continue to increase, especially in Canada and Brazil where new projects are in the planning stage.

TANTALUM

Canadian Developments

In 1982, Canada produced about 125 t of tantalum pentoxide (Ta_2O_5) contained in concentrate, a decrease of some 7 per cent from 1981 and 20 per cent from the record production of 1979. Tantalum concentrate was produced at the Bernic Lake mine in Manitoba by Tantalum Mining Corporation of Canada Limited (Tanco), a company jointly owned by the Hudson Bay Mining and Smelting Co., Limited, the KBI Division of Cabot Corporation and the Manitoba government. About 60 per cent of Tanco's production of concentrate is committed by a long-term contract to KBI at Reading, Pennsylvania.

Tanco announced in November that its Bernic Lake operations would be closed for at least one year, starting December 31, 1982, due to reduced demand and inventory liquidation by processors and consumers. The company also shut down the mine and mill from June 23 to July 31 in an attempt to bring inventories in line with reduced sales.

Placer Development Limited allowed its option on the Thor Lake tantalum-columbium deposit to expire in May 1982 because of the poor recovery rate achieved in metallurgical tests. The property, located about 40 km southeast of Yellowknife, Northwest Territories, was optioned in 1980 from Highwood Resources Ltd.

World Developments

Greenbushes Tin N.L. produced tantalite as a byproduct of tin mining in Western Australia. Production at the 81 650 kg per year operation was cut back in 1982 to about one-third of this amount because of tin export restrictions imposed by the International Tin Council and a drop in demand for tantalum.

Greenbushes continued with the development of its underground mine on a large tin-tantalum-columbium deposit discovered in 1980. The new mine, located adjacent to the company's open-pit mine, was originally designed for an annual mining capacity of 1 million t of ore but, because of market conditions during the last two years, has been scaled down to 250 000 tpy. The deposit contains an ore reserve of 30 million t grading 0.15 per cent tin, 0.06 per cent Ta_2O_5 and 0.04 per cent Cb_2O_5. Metallurgical tests have indicated a recovery rate of 75 per cent for tin and 70 per cent for tantalite by the gravity method. However, roasting will be required for the removal of arsenic and sulphur contained in the ore as arsenopyrite.

USES AND CONSUMPTION

Tantalum, being a high-melting-point refractory material and a good conductor of electricity and heat, is used primarily in the manufacture of electric capacitors and cemented carbide cutting tools. Also, because of its high resistance to corrosion by most acids, it is being used increasingly in chemical plants.

As a result of the continuing recession, consumption in the western world in 1982 decreased by 20 per cent to about 630 t. In the United States, where end-uses normally account for about 60 per cent of the total world market for tantalum, consumption was reported at 430 t, a decline of about 25 per cent. Demand for tantalum in cemented carbides showed the largest drop. Deep recession in the automotive, farm machinery, steel, and construction machinery industries has resulted in the sharp decline in the demand for carbide cutting tools. In Japan, tantalum consumption was equally affected by the weak world economy. The 1982 consumption in Japan was down 7.4 per cent to 124.6 t, with the major part of the decline being experienced in the capacitor segment.

OUTLOOK

The outlook for tantalum is for continuing weak markets and high inventories, with little likelihood of a major upswing in prices during 1983. World production is expected to decline further as a result of the shutdown by Tanco and continuing production cutbacks by other major producers. Readily available supplies of tantalum at low prices has influenced a major jet engine manufacturer to use tantalum superalloys in turbine engine blades. Although high-temperature alloys normally account for about 5 per cent of total tantalum consumption, this market sector has been in a decline for the last two years. The inclusion of tantalum in the new superalloy could boost tantalum consumption in this area in future years.

PRICES

Depressed demand and accumulating inventories resulted in a large price drop during 1982. Tanco reduced its tantalite price from $US 187.39 a kg to $US 110.23 in February, and again to $US 99.21 a kg on July 1. The lower price quotation was maintained for the remainder of 1982. Merchant prices remained essentially unchanged at $US 77-88 a kg during the first seven months but began to decline thereafter to $US 44-55 a kg in the fourth quarter.

PRICES

Prices as quoted in Metals Week in December 1981 and 1982 and American Metal Market in January 1982 and 1983, U.S. currency.

	1981	1982
	($)	
Columbium ore		
Columbite, per kilogram of pentoxide, cif US ports	17.64 - 22.04	11.02 - 15.43
Brazilian pyrochlore, per kilogram Cb_2O_5 fob shipping point, contract only	(1)	(1)
Canadian pyrochlore, per kilogram, fob mine	7.17	7.17
Ferrocolumbium, per kilogram Cb, fob shipping port		
Low alloy	13.71 - 14.00	13.23
High purity alloy	54.67	46.30
Columbium metal, per kilogram 99.5-99.8%, fas shipping point		
Reactor ingot	77.16 - 88.18	72.75 - 88.18
Reactor powder	83.78 - 105.82	79.37 -105.82
Tantalum ore		
Tantalite, per kilogram of pentoxide, Tanco price	187.39	99.21
Tantalum metal, per kilogram, fob shipping point depending on size of lot		
U.S. powder	308.65 - 418.88	286.60 - 308.65
U.S. rod 99.9% Ta	315.26 - 473.99	308.65 - 374.79

(1) Last quote $5.62 per kilogram, Metals Week, February 9, 1981.
cif - cost, insurance and freight; fob - free on board; fas - free alongside ship.

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
32900-1	Columbium and tantalum ores and concentrates	free	free	free	free
35120-1	Columbium (niobium) and tantalum metal and alloys in powder, pellets, scrap, ingots, sheets, plates, strips, bars, rods, tubing or wire for use in Canadian manufactures (expires June 30, 1983)	free	free	25	free
37506-1	Ferrocolumbium, ferrotantalum, ferro-tantalum-columbium	free	4.8	5	free

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
				(%)		
37506-1	4.8	4.7	4.5	4.3	4.2	4.0

UNITED STATES

601.21	Columbium ore	free
601.42	Tantalum ore	free

		1982	1983	1984	1985	1986	1987
					(%)		
628.15	Columbium metal, unwrought, and waste and scrap (duty on waste and scrap suspended to June 30, 1982)	4.5	4.4	4.2	4.0	3.9	3.7
628.17	Columbium, unwrought alloys	6.5	6.2	5.9	5.6	5.2	4.9
628.20	Columbium metal, wrought	7.7	7.3	6.8	6.4	5.9	5.5
629.05	Tantalum metal, unwrought and waste and scrap (duty on waste and scrap suspended to June 30, 1982)	4.5	4.4	4.2	4.0	3.9	3.7
629.07	Tantalum, unwrought alloys	6.5	6.2	5.9	5.6	5.2	4.9
629.10	Tantalum metal, wrought	7.7	7.3	6.8	6.4	5.9	5.5

Sources: The Customs Tariff and Commodities Index, Revenue Canada; Tariff Schedules of the United States Annotated 1982, USITC Publication 1200; U.S. Federal Register, Vol. 44, No. 241.

Copper

D. CRANSTONE

The year 1982 was a poor one for copper producers. Non-communist world copper consumption declined by 6.6 per cent instead of increasing by the 1.5 per cent average of the previous 8 years. As a result, copper prices dropped (in constant dollar terms) to their lowest levels since the 1930s. This led to copper production cutbacks in various parts of the world, but especially in the United States and Canada. With costs well above the world average, the U.S. copper industry was particularly hard hit by the depressed prices and was operating at only about 50 per cent of installed capacity at year-end, when Canadian mines were operating at nearly 80 per cent of capacity.

CANADA

With prices below production costs for nearly all Canadian copper producers, a number of mines were closed for some weeks or months during 1982. Other mines closed for an indefinite period, some of them unlikely to reopen until copper prices increase significantly. Some mines were operating at a cash loss and others at a positive cash flow only because higher than normal-grade ore was being produced or because capital equipment or mine development investments were not being made. More mines are likely to close unless demand and price for copper improve considerably.

Canadian primary copper production in 1982, 606 202 t, was 12 per cent lower than the 691 328 t produced in 1981. Bv December, Canadian mine production was at an annual rate of only about 450 000 tpy, or about 60 per cent of normal.

Atlantic provinces

Consolidated Rambler Mines Limited had announced that it would close its Baie Verte, Newfoundland copper mine on November 30, 1981, but was able to continue operating until April 30, 1982. Although a significant tonnage of low-grade copper-bearing mineralization remains, a much higher copper price would be required to justify reopening the mine. At the Buchans mine of ASARCO Incorporated, underground exploration and development was carried out on the extension of the orebody discovered in 1981, but mining of this material has been postponed until prices improve.

Heath Steele Mines Limited announced that its mine near Newcastle, New Brunswick, would close October 4 for an indefinite period because operations were losing $1 million a month. However, the mine remained open because the New Brunswick government is prepared to spend up to $3 million to maintain production until April 30, 1983. The financial situation of the operation was being monitored to determine how much assistance is justified to ensure production for another six months beyond April 1983.

Quebec

Ore reserves were exhausted at Madeleine Mines Ltd. at Ste. Anne des Monts, Quebec, which closed on June 30. Ore reserves were expected to be depleted in September at the Lemoine mine of Northgate Patino Mines Inc., near Chibougamau, but underground drilling intersected encouraging copper-gold-zinc-silver mineralization to the east of the mine area and was continuing at year-end. Mining of ore also continued through the end of the year. Noranda Mines Limited closed the Orchan mine at its Matagami Division because the orebody is exhausted, after production of 4.5 million t of zinc-copper ore since 1963. Corporation Falconbridge Copper closed its Lake Dufault operation at the end of June because of low metal prices. The property was being maintained on a standby basis until conditions improve. The company undertook a feasibility study and engineering and design studies for the new Ansil deposit at Lake Dufault, but suspended this work in September to preserve working capital. The Ansil deposit contains more than 1 800 000 t that average 7 per cent copper, 0.5 per cent

TABLE 1. CANADA, COPPER PRODUCTION, TRADE AND CONSUMPTION, 1981 AND 1982

	1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)
Production[1]				
British Columbia	288 085	637,474	267 513	520,419
Ontario	225 837	499,733	172 873	336,307
Quebec	89 908	198,949	90 572	176,660
Manitoba	55 983	123,878	47 972	93,325
New Brunswick	12 034	26,629	12 851	25,000
Yukon	9 094	20,123	7 236	14,077
Saskatchewan	4 956	10,967	4 460	8,677
Newfoundland	5 154	11,404	2 474	4,813
Northwest Territories	277	613	251	489
Total	691 328	1,529,770	606 202	1,179,767
Refined	476 655	..	312 411	..
Exports				
Copper in ores, concentrates and matte				
Japan	198 396	297,969	182 919	236,366
United States	2 175	2,670	19 509	21,602
Norway	24 987	55,086	15 018	21,523
South Korea	19 818	27,382	14 882	17,427
West Germany	5 923	6,985	8 418	10,345
Taiwan	11 117	19,724	5 672	6,658
Spain	4 904	7,063	2 944	3,645
Belgium-Luxembourg	2 779	4,091	1 984	2,691
Portugal	-	-	663	584
United Kingdom	691	1,651	747	567
Turkey	2 915	6,334	-	-
Romania	2 786	4,426	-	-
Other countries	319	103	-	-
Total	276 810	433,484	252 756	321,408
Copper in slag, skimmings and sludge				
Spain	339	523	247	228
United States	763	189	1 105	215
United Kingdom	-	-	4	13
Total	1 102	712	1 356	456
Copper scrap (gross weight)				
United States	17 604	31,300	21 613	30,089
Turkey	-	-	5 341	9,530
Japan	597	989	4 788	5,705
Spain	230	425	1 675	2,203
South Korea	495	897	1 400	1,996
Belgium-Luxembourg	81	124	649	703
West Germany	115	143	356	446
Netherlands	541	1,048	149	255
India	118	239	109	128
Other countries	632	1,072	285	213
Total	20 413	36,237	36 365	51,268
Brass and bronze scrap (gross weight)				
United States	9 545	13,972	6 948	8,370
Belgium-Luxembourg	1 221	1,781	2 951	3,710
India	1 888	2,684	2 224	2,645
West Germany	165	237	949	1,335

TABLE 1. (cont'd.)

	1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)
Brass and bronze scrap (gross weight) (cont'd)				
South Korea	528	746	596	741
Japan	360	559	452	582
Denmark	54	111	207	335
Taiwan	390	518	214	255
France	-	-	306	254
Italy	-	-	190	232
Spain	122	182	148	170
Other countries	498	651	195	225
Total	14 771	21,441	15 380	18,854
Copper alloy scrap, nes (gross weight)				
United States	3 420	4,510	3 038	3,031
Belgium-Luxembourg	879	1,262	1 079	1,348
South Korea	143	209	375	445
West Germany	-	-	88	138
Taiwan	1 143	270	207	84
Japan	76	102	19	22
Other countries	40	56	66	55
Total	5 701	6,409	4 872	5,123
Copper refinery shapes				
United States	84 137	188,903	93 220	170,781
United Kingdom	74 377	155,756	65 882	132,659
West Germany	31 756	68,630	22 194	42,291
Belgium-Luxembourg	17 786	38,199	14 595	32,907
France	17 766	37,711	10 741	20,573
Sweden	9 275	19,714	9 578	18,391
Netherlands	3 751	7,821	9 040	17,302
Italy	11 895	25,718	4 129	7,990
Brazil	4 278	9,290	989	1,938
Portugal	1 378	2,899	1 008	1,872
Greece	2 325	4,906	840	1,559
Japan	2 780	4,919	3	6
Other countries	1 138	2,546	404	723
Total	262 642	567,012	232 623	448,992
Copper bars, rods and shapes, nes				
United States	6 517	18,961	8 084	16,571
Venezuela	2 455	6,275	1 451	3,356
Cuba	700	1,789	750	1,705
Bangladesh	1 525	3,763	567	1,188
Dominican Republic	453	1,093	416	881
Nigeria	600	1,958	305	831
West Germany	-	-	200	366
Pakistan	1 235	2,745	137	289
United Kingdom	121	449	121	252
Other countries	1 215	3,006	296	645
Total	14 821	40,039	12 327	26,084
Copper plates, sheet and flat products				
United States	4 883	15,942	3 707	11,612
United Kingdom	12	7	125	404
Venezuela	51	210	50	202
Australia	47	173	14	45
Other countries	1	45	11	49
Total	4 994	16,377	3 907	12,312

TABLE 1. (cont'd.)

	1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)
Copper pipe and tubing				
United States	2 447	8,505	2 327	7,288
West Germany	182	579	1 058	2,600
Israel	421	1,409	826	2,238
United Kingdom	80	359	536	1,634
Saudi Arabia	4	2	38	146
Sweden	11	7	35	78
Costa Rica	-	-	1	31
Netherlands	525	1,658	5	19
Netherland Antilles	165	642	5	18
Spain	714	2,428	-	-
Other countries	28	283	11	63
Total	4 577	15,872	4 842	14,115
Copper wire and cable (not insulated)				
United States	142	523	100	350
Saudi Arabia	-	-	38	125
South Africa	6	31	9	46
New Zealand	8	43	5	29
Other countries	49	166	28	56
Total	205	763	180	606
Copper alloy shapes and sections				
United States	10 352	32,727	7 873	24,264
United Kingdom	60	145	71	230
Belgium-Luxembourg	88	189	53	94
Venezuela	64	234	25	81
Chile	-	-	36	66
New Zealand	-	-	9	45
Other countries	73	214	19	48
Total	10 637	33,509	8 086	24,828
Copper alloy pipe and tubing				
United States	2 080	7,615	1 616	6 038
Netherlands	17	90	14	71
Saudi Arabia	-	-	8	43
Greenland	-	-	19	40
Mexico	2	13	1	13
Other countries	19	108	--	10
Total	2 118	7,826	1 658	6,215
Copper alloy wire and cable, not insulated				
United States	141	689	102	529
South Africa	4	26	18	156
New Zealand	14	87	17	113
Chile	11	71	10	70
Other countries	15	70	5	37
Total	185	943	152	905
Copper and alloy fabricated materials, nes				
United States	1 402	5,775	658	3,183
Taiwan	18	105	29	211
United Kingdom	148	483	53	186
West Germany	2	11	16	129

TABLE 1. (cont'd.)

	1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)
Copper and alloy fabricated materials, nes (cont'd)				
Puerto Rico	24	126	4	84
Australia	12	60	6	56
Belgium-Luxembourg	70	157	-	-
Other countries	33	250	38	242
Total	1 709	6,967	804	4,091
Insulated wire and cable[2]				
United States	15 240	60,600	14 315	54,717
Saudi Arabia	6 538	21,353	7 805	24,736
Egyptian A.R.	493	1,654	1 201	3,789
Singapore	414	1,252	660	2,408
Trinidad-Tobago	525	2,716	324	1,063
Kenya	1 681	3,409	178	673
Indonesia	257	1,159	108	450
United Kingdom	155	988	90	447
Cameroon	306	1,596	--	1
Pakistan	1 320	3,664	-	-
Other countries	1 959	10,017	3 441	15,134
Total	28 888	108,408	28 122	103,418
Total exports of copper and products	..	1,295,999	..	1,038,675
Imports				
Copper in ores and concentrates	19 551	24,083	12 362	13,742
Copper scrap	26 428	33,242	33 230	34,553
Copper refinery shapes	24 778	56,325	28 028	52,760
Copper bars, rods and shapes, nes	3 676	8,772	6 061	12,406
Copper plates, sheet strip and flat products	1 593	6,022	977	3,533
Copper pipe and tubing	3 301	12,772	2 519	9,170
Copper wire and cable, not insulated	1 597	6,157	1 952	5,702
Copper alloy scrap (gross weight)	11 546	10,921	7 883	8,266
Copper powder	306	880	540	1,245
Copper alloy refinery shapes, bars and sections	9 835	24,911	6 732	16,449
Brass plates, sheet and flat products	3 782	11,575	2 767	8,663
Copper alloy plates, sheets, strip and flat products	6 560	35,627	773	4,397
Copper alloy pipe and tubing	2 557	11,808	1 884	8,978
Copper alloy wire and cable, not insulated	909	3,529	774	2,837
Copper and alloy fabricated material, nes	2 483	12,877	2 386	11,813
Insulated wire and cable	..	65,986	..	133,634
Copper oxides and hydroxides	277	799	288	767
Copper sulphate	339	329	4 536	2,751
Copper alloy castings	453	2,408	228	1,395
Total imports of copper and products	..	329,023	..	333,061
Consumption[3]				
Refined	216 759	..	120 946	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Blister copper plus recoverable copper in matte and concentrate exported. [2] Includes small quantities of non-copper wire and cable, insulated. [3] Producers' domestic shipments, refined copper.
- Nil; P Preliminary; .. Not available or not applicable; nes Not elsewhere specified; -- Amount too small to be expressed.

zinc, 27 g/t Ag and 1.7 g/t Au, at a depth of between 1 190 and 1 465 m. Camchib Resources Inc. closed its Chibougamau area mines on August 26 following unsuccessful talks with its workers for a reduction in wage benefits. Camchib had wanted to suspend cost of living raises and change the bonus payment system provided for in existing contracts in return for job guarantees. The company resumed production at its Gwillim gold mine on October 25, and the other mines returned to full production on November 15 after an agreement was reached with the union. The company continued with its program of exploration of various deposits in the Chibougamau area, with the objective of attempting to increase and improve reserves to allow the concentrator to operate at close to its full capacity of 3 200 t/d.

Noranda Mines Limited closed its Gaspé Division for a "vacation shutdown" on June 30, then resumed production on August 15 at one-third of the normal mining rate. On December 15, mining of ore ceased for "at least six months". The Gaspé copper smelter will continue to operate provided that an adequate supply of concentrates can be maintained. The company hopes to continue with underground development work at the Needle Mountain mine and with exploration and development at the new Murdochville deposit.

Ontario

Hourly-rated workers at the Sudbury operations of Inco Limited voted to reject a company contract offer and strike action started at the end of May. Although the strike was settled at the end of June, the company, which has large nickel inventories, is not scheduled to reopen its Ontario operations until April 1983. Future long-term nickel and copper production will be at a reduced rate. Falconbridge Limited commenced a 10-week summer shutdown on June 27; this was subsequently extended to January 3, 1983. Falconbridge will resume production with only 2,600 employees, compared to the previous 4,000, the remainder to be laid off permanently.

Early in the year, Pamour Porcupine Mines, Limited suspended production from the copper zone at its Schumacher mine at Timmins.

Umex Inc. closed its Thierry mine in April, leaving it on a care and maintenance basis, after experiencing losses of $20 million in 1981. The mine, where production began in 1976 from an open-pit, had subsequently switched to underground mining. In 1981 the company was preparing the nearby Kapichi copper-nickel deposit for production from an open-pit.

The Mattabi and Lyon Lake mines at Sturgeon Lake were closed for ten weeks during the summer, commencing July 12. Deepening of the Lyon Lake shaft was deferred until 1983. There was no mining from the "F" Group open-pit mine, although some 148 000 t of previously stockpiled ore was processed at the Mattabi concentrator. The remaining 182 000 t of ore is to be mined in 1983 and processed in 1984.

Manitoba

Sherritt Gordon Mines Limited laid off 342 employees early in the year. The grade of the ore being mined at the Fox and Ruttan mines was increased to maintain concentrate output and to lower unit costs. Subsequently, Sherritt closed both mines for a 15-week period beginning June 19.

Hudson Bay Mining and Smelting Co., Limited suspended production at its Manitoba-Saskatchewan mining operations for an 8-week period ending August 23. Earlier in the year the company had deferred all possible capital expenditures, major repairs and mine development. The Trout Lake mine near Flin Flon and the Spruce Point mine at Reed Lake both commenced production in 1982. The Rod mine at Snow Lake which was being developed for production, is to be put on standby when shaft work is completed.

Inco Limited closed its Thompson district mines on November 1, with production scheduled to resume in February 1983.

British Columbia

Craigmont Mines Limited ceased milling of copper ore at its mine near Merritt in February, and then converted the mill to process a stockpile of magnetite-rich tailings into concentrates used in the cleaning of metallurgical coal. Operations were permanently closed when the magnetite upgrading program was completed in December. A 580 000 t stockpile of the heavy media grade iron concentrate remains to be sold and represents about 10 years of Canadian requirements. The company is attempting to sell the entire stockpile and other assets.

TABLE 2. CANADA, COPPER PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975 AND 1978-82

	Production		Exports			Imports	Consumption[2]
	All Forms[1]	Refined	Ore and Matte	Refined	Total	Refined	Refined
				(tonnes)			
1970	610 279	493 261	161 377	265 264	426 641	13 192	215 834
1975	733 826	529 197	314 518	320 705	635 223	10 908	185 198
1978	659 380	446 278	282 159	247 727	529 886	21 441	228 694
1979	636 383	397 263	315 211	191 122	506 333	32 540	210 689
1980	716 363	505 238	286 076	335 022	621 098	13 466	195 124
1981	691 328	476 655	276 810	262 642	539 452	24 778	216 759
1982P	606 202	312 411	252 756	232 623	485 379	28 028	120 946

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Blister copper plus recoverable copper in matte and concentrate exported. [2] Producers' domestic shipments of refined copper.
P Preliminary.

A strike that had closed the Afton mine of Teck Corporation and Metallgesellschaft Canada Limited in November 1981 was settled in March, but the operation was again closed for economic reasons on June 22 and had not reopened by year-end.

Noranda Mines Limited closed its Granisle copper mine at Babine Lake, reportedly for one year, on July 2. The company cited substantial losses over the previous year as a reason for the closure. Subsequently, the company's nearby Bell Copper mine was closed for a six-week period starting July 30, then closed again for an indefinite period beginning October 29.

Cominco Ltd. ceased production at the Jersey mine of wholly-owned Bethlehem Copper Corporation on July 1 because the mine is uneconomic at present copper prices. Cominco is spending $18 million to develop the nearby Lake Zone copper orebody, with 18 000 tpd of ore to be milled at the existing Bethlehem concentrator beginning in March 1983.

In June, Gibraltar Mines Limited ceased development of ore intended for 1984 production and then ceased mining ore in July, when about half of the company's 600 mine employees were laid off. The mill continued operating on stockpiled low-grade ore, but copper output was reduced by only about 20 per cent despite the lower grade and higher metallurgical losses, because this softer material permits more grinding throughput. The low-grade ore stockpile is sufficient to last until about mid-1983.

Brenda Mines Ltd. suspended operations at its mining operation near Peachland for a six-week period beginning on July 26. The company had experienced a net loss of $10.6 million and an operating loss of $5.1 million during the first nine months of 1982.

Canada Wide Mines Ltd., a unit of Esso Resources Canada Limited, kept its Granduc copper mine near Stewart open, but is reducing the number of employees from 460 to 375 through attrition. Ore production is being limited to 1 800 tpd rather than increasing it to the scheduled 3 600 tpd. In December, the company announced that it would write down the book value of the mine by $40 million, but continue to mine ore already developed.

The Buttle Lake mine of Westmin Resources Limited was one of the few profitable Canadian copper producers. The company continued with exploration and development of the new H-W orebody, where ore reserves are now over 12 million t, and has a project under way to replace the existing 900 tpd concentrator with triple the existing capacity by 1984. The present concentrator is to be dismantled.

Yukon Territory

At the Whitehorse Copper Division of Hudson Bay Mining and Smelting Co., Limited, near

TABLE 3. PRINCIPAL COPPER MINES IN CANADA, 1982 AND (1981)

Company and Location	Mill or Mine Capacity	Grade of Ore Mined or Milled: Copper	Zinc	Lead	Nickel	Silver	Gold	Ore Mined or Milled	Copper Concentrates Produced	Grade of Copper in Concentrate	Contained Copper Produced[1] In All Concentrates	Destination of Copper Concentrate[2]
	(tonnes)	(%)	(%)	(%)	(%)	(grams/ tonne)	(grams/ tonne)	(tonnes)	(tonnes)	(%)	(tonnes)	
Newfoundland												
ASARCO Incorporated	1 100	-	-	-	-	-	-	-	-	-	-	-
Buchans	(1 100)	(0.80)	(8.95)	(5.31)	(-)	(92.91)	(0.72)	(68 946)	(1 145)	(25.76)	(295)	(10)
Consolidated Rambler	1 100	3.84	-	-	-	..	..	59 783	8 490	23.36	1 984	1
Mines Limited, Ming mine, Baie Verte	(1 100)	(3.82)	(-)	(-)	(-)	(17.85)	(2.06)	(143 244)	(20 851)	(25.13)	(5 240)	(1)
New Brunswick												
Brunswick Mining and	10 000	0.30	8.90	3.55	-	100.01	-	3 633 499	26 653	21.22	8 559	1
Smelting Corporation Limited, No. 6 and No. 12 mines, Bathurst	(10 000)	(0.35)	(8.74)	(3.51)	(-)	(98)	(-)	(3 423 000)	(21 121)	(22.37)	(7 844)	(1)
Heath Steele Mines	3 650	0.99	3.97	1.45	-	57.60	0.82	1 399 078	39 864	20.01	9 854	1,2
Limited, Newcastle	(3 650)	(0.91)	(3.94)	(1.45)	(-)	(51.43)	(0.69)	(1 249 984)	(32 895)	(20.54)	(8 119)	(1)
Quebec												
Camchib Resources	3 600	0.99	-	-	-	6.82	2.61	341 768	17 770	18.07	3 211	2
Inc., Cedar Bay, Henderson and Main and Gwillim mines Chibougamau	(3 600)	(0.96)	(-)	(-)	(-)	(6.24)	(2.50)	(330 791)	(16 204)	(18.66)	(3 024)	(2)
Corporation Falcon-	1 400	2.90	0.70	-	-	13.37	0.62	324 129	36 714	24.74	9 102	2
bridge Copper Millenbach and Corbet mines Noranda	(1 400)	(2.78)	(1.19)	(-)	(-)	(19.51)	(0.69)	(449 366)	(50 137)	(24.35)	(12 245)	(2)
Corporation Falcon-	2 900	1.59	-	-	-	10.63	1.30	954 463	56 805	23.94	13 599	2
bridge Copper Perry, Springer, Cooke mines, Chapais	(2 900)	(1.64)	(-)	(-)	(-)	(12.72)	(1.13)	(843 300)	(57 853)	(22.70)	(13 133)	(2)
Les Mines Selbaie	1 500	3.36	0.86	-	-	34.29	1.71	470 351	55 004	27.61	15 186	2
Brouillan Twp.	(1 500)	(3.24)	(0.77)	(-)	(-)	(26.81)	(1.30)	(94 917)	(11 373)	(25.79)	(2 933)	(2)

Louvem Mining	910	-	-	-	-	-	-	-	-	-	-	-
Company Inc.,	(910)	(0.19)	(4.03)	(0.19)	(-)	(29.49)	(0.96)	(32 276)	(95)	(15.90)	(15)	(10)
(SOQUEM),												
Louvicourt												
Madeleine Mines	2 250	0.88	-	-	-	5.14	-	414 144	11 246	30.00	3 374	1
Ltd.,	(2 250)	(0.94)	(-)	(-)	(-)	(5.14)	(-)	(577 639)	(16 225)	(30.61)	(4 966)	(1)
Ste. Anne des												
Monts												
Noranda Mines Limited	30 800	0.51	-	-	-	3.75	0.06	5 878 696	80 712	21.59	17 432	1
Mines Gaspé	(30 800)	(0.46)	(-)	(-)	(-)	(3.62)	(0.06)	(11 533 642)	(177 148)	(25.09)	(44 454)	(1)
Division, Copper												
Mountain and Needle												
Mountain mines												
Murdochville												
Molybdenum grade of ore milled: 1982, 0.021% Mo; 1981, 0.018% Mo												
Noranda Mines Limited	4 100	0.99	6.10	0.05	-	20.91	0.51	1 178 041	42 728	21.26	10 137	2
Matagami Division	(4 100)	(0.75)	(4.85)	(-)	(-)	(19.58)	(0.62)	(1 203 722)	(30 304)	(22.68)	(7 651)	(2)
Mattagami, Orchan,												
Norita and Radior												
No. 2 mines												
Northgate Patino Mines	300	2.34	5.93	-	-	42.51	2.23	111 117	10 141	24.00	2 483	2
Inc.	(300)	(3.70)	(8.47)	(-)	(-)	(69.60)	(4.08)	(84 967)	(12 124)	(24.59)	(3 025)	(2)
Lemoine mine												
Copper Rand,	3 085	1.60	-	-	-	8.85	2.81	663 262	50 593	20.41	10 326	2
Copper Cliff	(3 085)	(1.64)	(-)	(-)	(-)	(9.12)	(2.54)	(670 753)	(54 018)	(19.90)	(10 750)	(2)
Portage mines												
Chibougamau												
Ontario												
Falconbridge Limited	10 300	1.02	-	-	1.26	6.86	0.14	1 559 178	..	..	15 047	3,4,5
Falconbridge,	(10 300)	(1.01)	(-)	(-)	(1.25)	(3.43)	(0.07)	(2 754 690)	(..)	(..)	(26 247)	(3,4,5)
East Onaping,												
Lockerby and Fraser												
Strathcona mines,												
Sudbury												
Inco Metals Company,	49 400[3]	1.33	-	-	1.35	5.14	0.17	3 991 571	..	..	49 804	3
(Inco Limited)	(49 400)[3]	(1.28)	(-)	(-)	(1.35)	(4.46[e])	(0.17[e])	(9 220 048)	(..)	(..)	(112 416)	(3)
Copper Cliff												
South, Creighton,												
Frood, Garson,												
Levack, Little												
Stobie, Stobie and												
McCreedy West and												
Shebandowan mines												

TABLE 3. (cont'd)

Company and Location	Mill or Mine Capacity (tonnes)	Grade of Ore Mined or Milled: Copper (%)	Zinc (%)	Lead (%)	Nickel (%)	Silver (grams/ tonne)	Gold (grams/ tonne)	Ore Mined or Milled (tonnes)	Copper Concentrates Produced (tonnes)	Grade of Copper in Concentrate (%)	Contained Copper Produced[1] In All Concentrates (tonnes)	Destination of Copper Concentrate[2]
Ontario (cont'd)												
Kidd Creek Mines Ltd. Kidd Creek mine Timmins	13 500 (13 500)	2.05 (1.90)	5.60 (5.35)	0.19 (0.16)	- (-)	77.19 (64.86)	- (-)	4 320 446 (4 076 776)	319 361 (273 007)	25.24 (25.82)	84 505 (74 113)	2,6 (2,6))
Mattabi Mines Limited Sturgeon Lake	2 700 (2 700)	0.44 (0.56)	6.50 (6.50)	0.73 (0.57)	- (-)	98.05 (86.40)	0.27 (-)	359 342 (471 600)	13 307[4] (15 933)[4]	20.11[4] (19.82)[4]	4 177[4] (4 241)[4]	2 (2)
Noranda Mines Limited Geco Division Manitouwadge	4 500 (4 500)	1.59 (1.83)	3.51 (3.16)	0.13 (0.10)	- (-)	45.60 (46.63)	0.10 (0.10)	1 350 734 (1 329 489)	68 052 (77 825)	28.95 (29.18)	20 445 (23 357)	2 (2)
Lyon Lake mine Sturgeon Lake	- (-)	0.85 (0.95)	7.56 (6.83)	0.89 (0.72)	- (-)	139.87 (118.62)	0.38 (..)	242 948 (352 649)	..[5] (..)[5]	..[5] (..)[5]	..[5] (..)[5]	- (-)
"F" Group mine Sturgeon Lake	- (-)	0.77 (0.42)	9.37 (8.18)	0.53 (0.59)	- (-)	69.25 (58.97)	0.38 (-)	150 641 (107 499)	..[5] (..)[5]	..[5] (..)[5]	..[5] (..)[5]	(-)
Pamour Porcupine Mines, Limited Schumacher Division mill Timmins	2 700 (2 700)	.. (0.23)	- (-)	- (-)	- (-)	4.56 (4.46)	3.43 (2.29)	765 746 (808 923)	6 813 (6 735)	4.67 (23.24)	318 (1 565)	2 (2)
Selco Inc. South Bay mine, Uchi Lake	- (450)	- (1.42)	- (8.81)	- (-)	- (-)	- (79.54)	- (-)	- (38 698)	- (1 958)	- (23.98)	- (508)	- (2)
Teck Corporation Silverfields Division, Cobalt	250 (250)	0.60 (0.60)	- (-)	- (-)	0.24 (0.25)	274.29 (240.00)	- (-)	71 837 (78 397)	- (-)	- (-)	23 (21)	- (-)
Umex Inc. Thiery mine Pickle Lake	3 600 (3 600)	0.85 (1.16)	- (-)	- (-)	0.12 (0.12)	7.89 (7.89)	0.17 (0.17)	217 166 (1 088 622)	9 807 (40 049)	17.31 (28.38)	1 700 (11 366)	2 (2)
Manitoba-Saskatchewan												
Hudson Bay Mining and Smelting Co., Limited Anderson, Chisel, Flin Flon (including Saskatchewan portion), Ghost, Osborne, Stall, Spruce Point, Centennial, Trout Lake, Westarm and White Lake mines, Flin Flon and Snow Lake	10 700 (10 700)	2.13 (2.01)	2.76 (2.34)	- (0.14)	- (-)	18.07 (16.66)	1.46 (1.17)	1 722 023 (1 754 032)	169 497 (173 774)	19.77 (18.58)	33 510 (32 285)	7 (7)

Inco Metals Company,	12 700	0.14	-	-	1.89	5.14[e]	0.10[e]	1 764 267	..	..	2 214[6]	3
Pipe and Thompson	(12 700)	(0.13)	(-)	(-)	(1.77)	(2.74[e])	(0.10[e])	(1 801 223)	(..)	(..)	(2 035)[6]	(3)
mines												
Thompson district												
Sherritt Gordon	2 700	1.65	1.77	-	-	14.06	0.48	427 695	26 103	26.53	7 036	7
Mines Limited,	(2 700)	(1.42)	(1.73)	(-)	(-)	(7.57)	(0.28)	(733 844)	(36 991)	(25.12)	(9 509)	(7)
Fox mine												
Lynn Lake area												
Ruttan mine	9 100	2.16	0.14	-	-	8.17	0.31	784 363	59 761	27.17	16 237	2,7
Leaf Rapids area	(9 100)	(1.30)	(1.25)	(-)	(-)	(7.31)	(0.25)	(1 702 627)	(76 903)	(26.27)	(20 202)	(2,7)
British Columbia												
Afton Operating	7 800	0.58	-	-	-	3.60	0.34	1 025 025	10 008	49.33	4 937	8
Corporation	(7 800)	(0.89)	(-)	(-)	(-)	(4.90)	(0.62)	(2 324 121)	(30 486)	(57.47)	(17 521)	(8)
Afton mine												
Kamloops												
Cominco Ltd.	18 000	0.38	-	-	-	2.40	0.03	3 112 829	23 712	42.93	10 180	11
Bethlehem Copper	(18 000)	(0.39)	(-)	(-)	(-)	(2.40)	(0.03)	(6 496 183)	(60 129)	(34.60)	(20 800)	(..)
Division												
Highland Valley												
Molybdenum grades of ore milled: 1982, 0.004% Mo; 1981, 0.004% Mo.												
Brenda Mines Ltd.,	27 900	0.14	-	-	-	1.20	0.02	9 484 562	37 227	29.10	10 833	11
Peachland	(27 900)	(0.137)	(-)	(-)	(-)	(1.20)	(0.02)	(10 199 300)	(38 160)	(29.95)	(11 429)	(10,11,14)
Molybdenum grades of ore milled: 1982, 0.032% Mo; 1981, 0.033% Mo.												
Canada Wide Mines	3 600	1.24	-	-	-	10.29	0.17	510 229	21 087	28.42	5 993	11
Ltd.	(3 600)	(1.44)	(-)	(-)	(-)	(10.29)	(0.17)	(544 576)	(27 129)	(28.37)	(7(697)	(11)
Granduc mine												
Stewart												
Craigmont Mines	5 300	0.97	-	-	-	-	-	268 128	5 477	27.07	2 461	11,14
Limited	(5 300)	(0.70)	(-)	(-)	(-)	(-)	(-)	(1 263 590)	(32 500)	(27.84)	(9 048)	(11,13)
Merritt												
DeKalb Mining	-	-	-	-	-	-	-	-	-	-	-	..
Corporation	(635)	(2.06)	(-)	(-)	(-)	(17.38)	(0.34)	(80 800)	(3 852)	(41.41)	(1 595)	(..)
Highland Valley												
Equity Silver Mines	5 700	0.39	-	-	-	121.71	1.44	2 073 000	32 795	18.47	6 057	7,10,11,14
Limited	(5 200)	(0.39)	(-)	(-)	(-)	(102.9)	(0.96)	(1 910 000)	(35 200)	(16.19)	(5 700)	(11,14))
Houston												
Falconbridge Limited	7 300	0.38	-	-	-	2.98	0.07	1 108 115	16 264	23.10	3 773	11
Tasu (Wesfrob) mine	(7 300)	(0.32)	(-)	(-)	(-)	(3.09)	(0.08)	(1(008 695)	(13 607)	(20.69)	(2 815)	(11)
Tasu Harbour, Queen												
Charlotte Islands												
Iron grade of ore milled: 1981, 49.75% Fe												

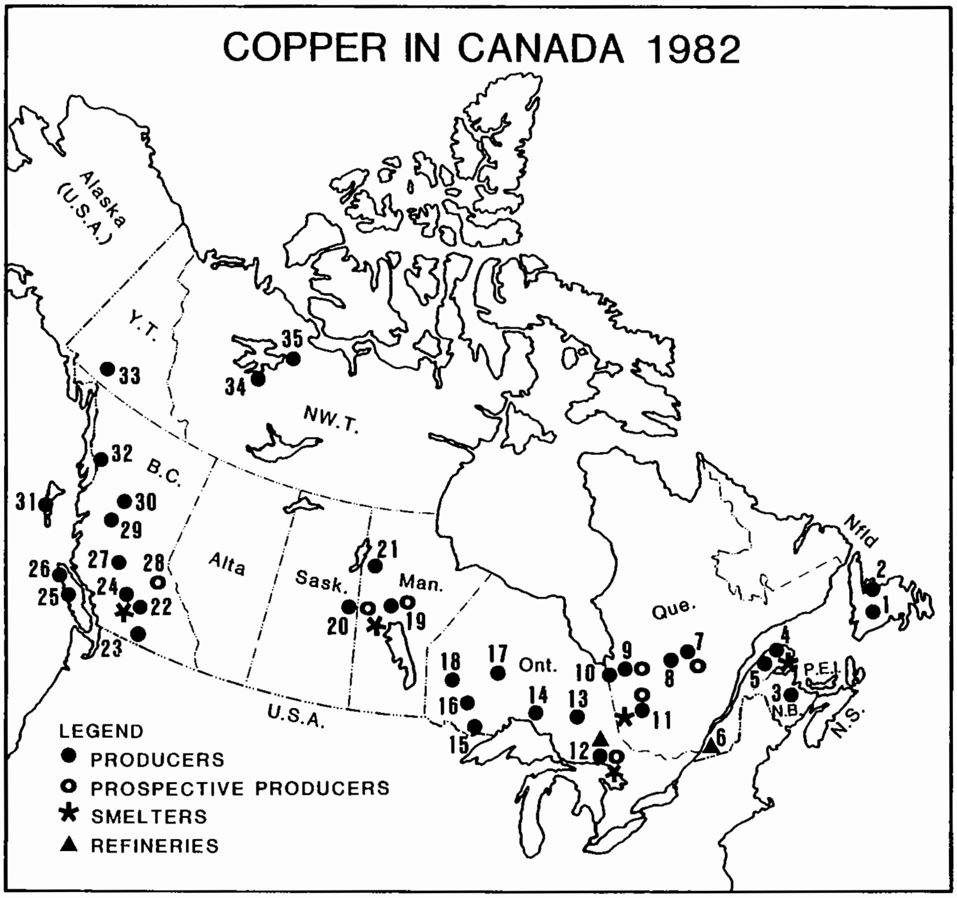
TABLE 3. (cont'd)

Company and Location	Mill or Mine Capacity (tonnes)	Grade of Ore Mined or Milled: Copper (%)	Zinc (%)	Lead (%)	Nickel (%)	Silver (grams/tonne)	Gold (grams/tonne)	Ore Mined or Milled (tonnes)	Copper Concentrates Produced (tonnes)	Grade of Copper in Concentrate (%)	Contained Copper Produced[1] In All Concentrates (tonnes)	Destination of Copper Concentrate[2]
British Columbia (cont'd)												
Gibraltar Mines Ltd.	37 300	0.30	-	-	-	0.69	-	13 378 535	123 472	25.35	31 300	7,10,11,13,14
McLeese Lake,	(37 300)	(0.38)	(-)	(-)	(-)	(0.69)	(-)	(12 258 000)	(155 200)	(26.36)	(40 909)	(11,13,14)
Caribou District												
Molybdenum grade of ore milled: 1982, 0.012% Mo; 1981, 0.014% Mo												
Highmont Operating	25 000	0.17	-	-	-	..	..	8 887 325	41 609	30.69	12 827	12
Corporation	(22 700)	(0.15)	(-)	(-)	(-)	(-)	(-)	6 397 689	(27 060)	(28.11)	(7 795)	(2)
Molybdenum grade of ore milled: 1982, 0.030% Mo; 1981, 0.032% Mo.												
Lornex Mining	80 000	0.364	-	-	-	2.06	-	27 842 549	326 733	28.15	91 975	11
Corporation Ltd.	(72 600)	(0.415)	(-)	(-)	(-)	(1.89)	(-)	(20 737 213)	(248 998)	(31.69)	(78 907)	(11)
Lornex mine												
Highland Valley												
Molybdenum grade of ore milled: 1982, 0.015% Mo; 1981, 0.015% Mo												
Newmont Mines Limited	22 000	0.38	-	-	-	1.37	0.34	6 742 833	75 023	29.66	22 248	11
Similkameen	(22 000)	(0.40)	(-)	(-)	(-)	(1.37)	(0.34)	(6 863 214)	(80 673)	(28.91)	(23 323)	(11)
Division												
Princeton												
Noranda Mines Limited												
(Babine Division)	16 400	0.37	-	-	-	0.62	0.19	3 374 727	39 021	26.62	10 387	2
Bell Copper mine	(16 400)	(0.48)	(-)	(-)	(-)	(..)	0.28	(5 428 994)	(80 737)	(26.62)	(21 492)	(2)
Granisle mine	12 700	0.42	-	-	-	1.71	0.21	1 880 953	22 514	30.70	6 769	2,11,12,14
Babine Lake	(12 700)	(0.37)	(-)	(-)	(-)	(2.98)	(0.29)	(3 832 498)	(38 609)	(30.44)	(11 758)	(2,11,12,14)
Northair Mines Ltd.	270	0.19	2.32	1.32	-	35.86	7.99	33 104	-	-	44	-
Brandywine Mine	(270)	(0.15)	(2.09)	(1.15)	(-)	(28.63)	(7.92)	(62 548)	(-)	(-)	(67)	(-)
Utah Mines Ltd.,	37 200	0.43	-	-	-	1.37	0.21	15 291 656	245 705	23.04	56 627	11,14
Island Copper mine	(37 200)	(0.43)	(-)	(-)	(-)	(1.37)	(0.21)	(14 157 525)	(223 260)	(22.90)	(51 115)	(11,14)
Coal Harbour												
Vancouver Island												
Molybdenum grade of ore milled: 1982, 0.017% Mo; 1981, 0.017% Mo												
Westmin Resources	900	1.06	7.28	1.11	-	127.9	2.74	287 579	9 077	26.58	2 880	11
Limited	(900)	(1.13)	(7.37)	(1.22)	(-)	(127.2)	(2.67)	(246 150)	(7 977)	(27.25)	(2 580)	(11)
Lynx and Myra mines,												
Buttle Lake												
Yukon Territory												
Hudson Bay Mining	2 300	1.39	-	-	-	..	..	898 000	..	..	..	7
and Smelting Co.,	(2 300)	(1.42)	(-)	(-)	(-)	(10.08)	(0.82)	(726 091)	(20 085)	(45.15)	(9 068)	(7)
Limited												
Whitehorse Copper												
Division												
Little Chief Mine												
Whitehorse												

Northwest Territories

Echo Bay Mines Ltd.	-	-	-	-	-	-	-	-	-	-	-	-
Port Radium	(130)	(0.81)	(-)	(-)	(-)	(923.1))	(-)	(38 338)	(2 861)	(10.7)	(317)	(10)
Great Bear Lake												
Terra Mines Ltd.	140	0.39	0.25	0.32	0.03	760.5	-	36 627	-	-	124	-
Camsell River	(140)	(0.66)	(-)	(-)	(-)	(1159.0)	(0.34)	(1 565)	(181)	(5.8)	(10)	(10)
Great Bear Lake												

Sources: Company responses to Energy, Mines and Resources Canada questionnaires, company reports and technical press.
[1] Total copper in concentrates of all metals. [2] Destination of concentrates: (1) Canadian Copper Refiners Limited, Mines Gaspé Division; (2) Noranda Mines Limited; (3) Inco Limited, Sudbury. (4) Falconbridge Limited, Sudbury. (5) Falconbridge Nikkelverk A/S, Norway. (6) Kidd Creek Mines Ltd. (7) Hudson Bay Mining and Smelting Co., Limited. (8) Sherritt Gordon Mines Limited (9) Afton Mines Ltd. (10) United States. (11) Japan. (12) Germany. (13) Korea. (14) Un-specified, and other countries. [3] Capacity limited by Ontario SO_2 emission regulations. [4] Includes copper produced from Lyon Lake and "F" Group mines of Noranda Mines Limited. [5] Included in copper concentrate and copper output of Mattabi Mines Limited. [6] Included in the Inco copper production for Ontario.
- Nil; .. Not available; [e] Estimated.



PRODUCERS

(numbers correspond to those in map above)

1. ASARCO Incorporated (Buchans Unit)
2. Consolidated Rambler Mines Limited (Ming mine)
3. Brunswick Mining and Smelting Corporation Limited (Nos. 6 and 12 mines)
   Heath Steele Mines Limited
4. Noranda Mines Limited, Division Mines Gaspé (Copper Mountain and Needle Mountain mines)
5. Madeleine Mines Ltd.
7. Camchib Resources Inc. (Cedar Bay, Henderson and Merrill mines)
   Northgate Patino Mines Inc. (Copper Rand, Lemoine and Portage mines)
8. Corporation Falconbridge Copper, Opemiska Division (Perry, Springer and Cooke mines)
9. Noranda Mines Limited, Mattagami Division (Mattagami, Orchan, Norita mines)
10. Selco Inc. - Hudson's Bay Oil and Gas Company Limited (Selbaie mine)
11. Corporation Falconbridge Copper, Lake Dufault Division (Millenbach and Corbet Mines)
    Louvem Mining Company Inc.
12. Falconbridge Limited (East, Falconbridge, Fraser, Lockerby, North Onaping, Strathcona mines)

Inco Metals Company
(Clarabelle, Coleman, Copper Cliff South, Creighton, Frood, Garson, Levack, Little Stobie, Stobie, McCreedy West)

13. Kidd Creek Mines Ltd.
Pamour Porcupine Mines, Limited (Schumacher, Ross mines)
14. Noranda Mines Limited, Geco Division
15. Inco Metals Company (Shebandowan mine)
16. Mattabi Mines Limited
Noranda Mines Limited, Lyon Lake and F group mines
17. Umex Inc. (Thierry mine)
18. Selco Inc. (South Bay mine)
19. Inco Metals Company (Pipe No. 2 and Thompson mines)
20. Hudson Bay Mining and Smelting Co., Limited (Anderson, Centennial, Chisel, Flin Flon, Ghost, Osborne, Stall, Trout Lake Westarm and White Lake mines), Spruce Point
21. Sherritt Gordon Mines Limited
Fox and Ruttan mines
22. Brenda Mines Ltd.
23. Newmont Mines Limited (Ingerbelle and Copper Mountain mines)
24. Cominco Limited (Jersey and Lake Zone mines)
Lornex Mining Corporation Ltd.
Craigmont Mines Limited
Afton Operating Corporation
Highmont Operating Corporation
25. Westmin Resources Limited (Lynx, Myrna, Price and HW mines)
26. Utah Mines Ltd. (Island Copper mine)
27. Gibraltar Mines Limited
29. Equity Silver Mines Limited
30. Noranda Mines Limited (Bell Copper, Granisle mines)
31. Falconbridge Limited (Wesfrob mine)
32. Canada Wide Mines Ltd. (Granduc mine)
33. Hudson Bay Mining and Smelting Co., Ltd. (Whitehorse Copper Division)
34. Terra Mines Ltd.
35. Echo Bay Mines Ltd.

PROSPECTIVE PRODUCERS[1]

9. Noranda Mines Limited (Phelps Dodge Corporation deposit)
11. Noranda Mines Limited (New Insco mine)
12. Falconbridge Limited
(Craig, Lindsley, North mines)
Inco Metals Company (Clarabelle, Copper Cliff North, Crean Hill, Fecunis, Levack East, Totten mines)
20. Hudson Bay Mining and Smelting Co., Limited (Rod mine)
28. Noranda Mines Limited (Goldstream mine)

OTHER DEPOSITS AND EXPLORATION PROJECTS[2]

SMELTERS

4. Canadian Copper Refiners Limited
Mines Gaspé Division
11. Noranda Mines Limited
12. Falconbridge Limited
Inco Limited
14. Kidd Creek Mines Ltd.
21. Hudson Bay Mining and Smelting Co., Limited
25. Afton Mines Ltd.

REFINERIES

6. Canadian Copper Refiners Limited
12. Inco Limited
13. Kidd Creek Mines Ltd.

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[1] Only mines with announced production plans and mines placed on standby.
[2] An inventory of undeveloped Canadian copper deposits is available in the publication Canadian Mineral Deposits Not Being Mined in 1980, Energy, Mines and Resources Canada, Mineral Policy Sector Internal Report MRI 80/7.

Whitehorse, production ceased at the end of 1982, when viable ore was depleted.

Smelting and Refining

Noranda Mines Limited and la Société nationale de l'amiante (SNA) undertook a pilot plant study at Noranda's Horne smelter to determine the technical and economic parameters for a sulphur dioxide recovery process using asbestos plant tailings. This would yield magnesium sulphate, which could be used as fertilizer and in the pulp and paper industry. The intent is that data gathered during this pilot experiment would permit the design of a processing plant that would substantially reduce sulphur dioxide emissions in northwestern Quebec.

A strike at Noranda's CCR copper refinery at Montreal East began on May 2 and lasted for 17 weeks. Refinery throughput was reduced by 109 000 t because of the strike, but as copper production at the smelters was unaffected, inventory of unrefined anodes rose to unprecedented levels. As a result, anode stocks were sufficient to permit capacity operation of the refinery until at least mid-1983 despite expected smelter cutbacks.

Kidd Creek Mines Ltd. placed its new Mitsubishi type copper smelter-refinery into commercial operation in November. The company closed its Timmins operations for a ten-day period in December, and is reducing its workforce by 200. As for nearly all other Canadian copper producing companies, Kidd Creek experienced substantial losses in 1982.

The Inco Limited copper smelter and refinery were closed from the end of May except for a period in September when the company recalled 500 workers to smelt a stockpile of copper concentrates. The Falconbridge Limited smelter was closed for the last six months of the year, and the smelter of Afton Operating Corporation operated only from March until June.

Studies continued on the feasibility of additional SO_2 containment at Canadian base metal smelters.

WORLD DEVELOPMENTS

Major copper production cutbacks have occurred in the United States because of low prices, with nearly all of the major companies having closed some or all of their mines for a temporary or indefinite period. Near year-end, the U.S. copper mining industry was operating about 50 per cent of installed capacity, even though some producers were apparently operating at a cash loss in an attempt to keep customers. U.S. monthly production in 1982, expressed as a percentage of production in the same month in 1981, dropped from 76 per cent in May to 52 per cent in August. U.S. production in December (79 200 t) was at a rate of only 62 per cent of average monthly production for all of 1981. Total U.S. mine production of copper in 1982 was only 1 139 600 t, compared to 1 538 200 t in 1981.

Western Mining Corporation Limited and BP Australia Ltd. have indicated that the Roxby Downs (Olympic Dam) deposit in Southern Australia, which has an area of 28 square km, contains an estimated 2 000 million t averaging 1.6 per cent copper, 0.64 kg/t uranium, 0.6 g/t gold plus some silver. These reserves are based on a 200 m drilling grid. Closely-spaced fill-in drilling has indicated significant tonnages of higher grade material. A large number of additional mineralized drill hole intersections have been made in the surrounding area, but have yet to be evaluated because the companies intend to concentrate first on proving up reserves in the immediate Olympic Dam area. Although a production decision has not been made, the companies are assuming initial annual production of 6.5 million tpy of ore (from an underground mine) which would yield 150 000 t of copper, 3 000 t of U_3O_8, 3 400 kg of gold and up to 23 000 kg of silver.

In Chile, the state-owned El Teniente copper mine of Corporacion Nacional del Cobre de Chile (Codelco-Chile) asked 2,000 workers to resign with special compensation, to reduce the company's labour costs. The other state-owned mining company, Empresa Nacional de Minera (ENAMI), called for bids from companies that may wish to develop the Andacolla copper deposit, then suspended the tender in late December "because of the international economic situation". Noranda Mines Limited decided in 1980 to drop the deposit because of low copper prices and difficulties in arranging suitable financing.

Limited trial production was reported from the Sar Chesmeh Copper Mining Co. complex in Iran. In May, the government stated that the operation was to go into partial production during the summer of 1982 and to reach 50 per cent capacity within six months, but this target was not attained. The complex has a reported capacity of 145 000 tpy of copper.

A $US 400 million loan to Cia Minera de Cananea S.A., by a syndicate of private banks was approved by the International Finance Corporation, then subsequently deferred because of the devaluation of the Mexican peso. The loan was to increase output of the company's copper mining operation at Cananea, Mexico from 50 000 tpy to 150 000 tpy of copper by the end of 1984.

Work remains suspended on the huge Empresa de Cobre Cerro Colorado SA copper project in Panama because conditions are not favourable. The Panamanian government and Rio Tinto Zinc Corporation Limited (RTZ) were negotiating whether a small pilot operation should be set up pending a recovery of world copper prices.

TABLE 4. PROSPECTIVE COPPER PRODUCERS, 1982

Company and Location	Mine or Mill Capacity tonnes/day and Ore Grade	Year Production Expected or Expansion Completed	Destination of Copper Concentrates	Remarks
Quebec				
Noranda Mines Limited, New Insco Mines Ltd. mine Noranda	330 Cu 2.6% Ag 0.6 g/t Au ..	..	Noranda	Development temporarily suspended.
Noranda Mines Limited, Phelps Dodge Corporation option La Gauchetière township	450 Cu 1.1% Zn 4.9%	..	Noranda	Development temporarily suspended.
Ontario				
Falconbridge Limited Craig mine, Sudbury area	Cu .. Ni ..	1987	Falconbridge	
Manitoba				
Hudson Bay Mining and Smelting Co., Limited, Rod mine, Snow Lake	450 Cu 5.38% Zn 2.28% Ag 13.7 Au 1.0	..	Flin Flon	Orebody leased from Falconbridge Limited and Stall Lake Mines Limited for a royalty of 7 per cent of the net realized value from the metals produced. Ore to be treated at the Snow Lake concentrator. Development temporarily suspended.
British Columbia				
Cominco Limited Lake Zone deposit Highland Valley	18 000	1983	Japan	Company developing Lake Zone for production, with ore to be treated at nearby Bethlehem concentrator.
Noranda Mines Limited, Goldstream mine, 80 km north of Kamloops	1 361 Cu 3.6% Zn 2.6% Ag 20 g/t	1983	Noranda	Mine and concentrator to be developed at a cost of $62 million. Mine development has been stretched out for May 1983 start-up.
Westmin Resources Limited, HW and Price mines, Buttle Lake, Vancouver Island	..	1984	Japan	Shaft sunk to 418 m to be deepened to 762 m in 1982. Ore reserves at HW now 11 741 000 t averaging 2.2% Cu, 5.1% Zn, 0.4% Pb, 34.3 g/t Ag and 2.4 g/t Au. New 2 720 tpd concentrator to be built to replace present smaller one.

.. Not available.

Company and Location	Product	Rated Annual Capacity (tonnes of ores and concentrates)	Ore and Concentrates Treated (tonnes)	Blister or Anode Copper Produced (tonnes)	Remarks
Afton Operating Corporation Kamloops, B.C.	Blister copper	22 500 (tonnes of blister copper)	..	3 908	The smelter commenced commercial operation on May 1, 1978. The uniquely low-sulphur concentrate, consisting chiefly of native copper, is smelted in a top-blown rotary converter. SO_2 produced is neutralized with limestone.
Falconbridge Limited Falconbridge, Ont.	Copper-nickel matte	570 000	..	14 924	A smelter modernization program begun in 1975 was completed in 1978 at a cost of $79 million. Fluid bed roasters and electric furnaces replaced older smelting equipment. A 1 800 tpd 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 market	3 630 000[1]	..	113 800[2]	Oxygen flash-smelting of copper concentrate; converters 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.
Kidd Creek Mines Ltd. Timmins, Ontario	Molten "blister" copper	59 000 t of copper	118 600	25 100	Mitsubishi-type smelting, separation and converting furnaces treat continuous copper concentrate feed stream to yield molten 99 per cent pure copper which is transported by ladles and overhead cranes to two 350 t anode furnaces.

Noranda Mines Limited, Horne smelter, Noranda, Que.	Copper anodes	838 000	791 000, of which 672 000 were custom concentrates	200 000	Three reverberatory furnaces, one of which is now considered to be permanently shut down; 5 converters; 1 continuous reactor; an 85 tpd oxygen plant to supply oxygen-enriched blast. Continuous reactor modified to produce matte instead of metal. A $35 million project to overhaul and modify the smelter, with electricity to become the plant's major energy source was completed in 1982. The new 450 tpd oxygen plant will decrease unit fuel requirements and increase capacity of the continuous reactor, and reduce fuel requirements for a reverberatory furnace.
Noranda Mines Limited, Gaspé smelter, Murdochville, Que.	Copper anodes	325 000	293 000, of which 78 000 were custom concentrates	62 600	Equipped with one fluid bed roaster, one reverberatory furnace and two converters plus an acid plant. Treats Gaspé and custom concentrates.
Hudson Bay Mining and Smelting Co., Limited, Flin Flon, Man.	Copper anodes	400 000		55 005	Five roasting furnaces, one reverberatory furnace and three converters. Company treats its own copper concentrates from mines at Flin Flon, Snow Lake and Whitehorse, as well as custom copper concentrates, zinc plant residues and stockpiled zinc-plant residues fed to reverberatory furnace.

[1] Includes copper and nickel-copper concentrates. This capacity cannot all be fully utilized owing to Ontario government sulphur dioxide emission regulations. [2] A small portion of this copper was from Inco's Manitoba ores.
.. Not available.

TABLE 6. COPPER REFINERIES IN CANADA, 1982

Company and Location	Rated Annual Capacity	Output in 1981	Remarks
	(tonnes)		
Noranda Mines Limited, CCR Division, Montreal East, Quebec	435 000	267 000	Refines anodes from Noranda's Horne and Gaspé smelters and from the Flin Flon smelter; also purchased scrap. Copper sulphate and nickel sulphate recovered by vacuum evaporation. Precious metals, selenium and tellurium recovered from slimes. Produces C.C.R. brand electrolytic copper wirebars, ingot bars, ingots, cathodes, cakes and billets.
Inco Limited Copper Refining Division Copper Cliff, Ont.	180 000	61 236	Casts and refines anodes from molten converter copper from the Copper Cliff smelter; also refines purchased scrap. Gold, silver, selenium and tellurium recovered from anode slimes, along with platinum metals concentrates. Recovers and electrowins copper from Copper Cliff nickel refinery residue. Produces ORC brand electrolytic copper cathodes, and wirebars.
Kidd Creek Mines Ltd. Timmins, Ontario	59 000	25 100	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 tankhouse. A decopperized precious metal slime is also marketed.

Some $US 850 million in financing has been obtained for the Ok Tedi gold-copper mine in Papua New Guinea. Canada's Export Development Corporation (EDC) will contribute $US 88 million for the purchase of Canadian-made equipment. Although some concern was expressed in Canada over the EDC loan because the mine would compete with Canadian copper producers, the Ok Tedi project, is viable with or without the EDC loan, and would have gone ahead in any case. The cap of the Ok Tedi deposit is gold ore, from which production will begin in 1984, with the underlying copper orebody to begin production in 1986 as mining progresses.

A $US 261 million expansion of the Cobriza copper mine of state-owned Corporacion de Desarrollo Minero Cerro Colorado (Codemin) in Peru is under way. The expansion project will increase copper production at Cobriza from 56 000 to 100 000 tpy by the end of 1983. At the Cerro Verde mine of Minero Peru, work was begun on the $US 300 million Stage II copper project which will yield 60 000 tpy of copper from sulphide ores, in addition to the present 33 000 tpy currently produced from oxide ores, when it comes on-stream in 1985.

The Philippine government announced that it would aid financially troubled

TABLE 7. WORLD MINE PRODUCTION OF COPPER, 1981 AND 1982

	1981	1982P
	(000 tonnes)	
United States	1 538.2	1 135.1
U.S.S.R.	1 140.0	1 140.3
Chile	1 081.1	1 240.7
Canada	691.4	606.2
Zambia	587.4	529.7
Zaire	504.8	498.7
Peru	327.6	361.0
Poland	294.6	314.8
Philippines	302.4	293.1
Mexico	230.4	230.0
Australia	231.3	244.7
Republic of South Africa	210.6	207.5
Papua New Guinea	165.4	167.8
Yugoslavia	111.0	110.0
Mongolia	71.8	71.7
Indonesia	62.6	72.6
Other communist countries	309.0	307.5
Other non-communist countries	432.3	491.2
Total	8 291.9	8 022.6

Sources: American Bureau of Metal Statistics, and Energy, Mines and Resources Canada.
P Preliminary.

TABLE 8. WORLD PRODUCTION OF REFINED COPPER, 1981 AND 1982

	1981	1982P
	(000 tonnes)	
United States	1 984.1	1 672.2
U.S.S.R.	1 460.0	1 460.6
Japan	1 050.2	1 075.0
Chile	775.6	851.6
Zambia	564.0	501.4
Canada	476.6	298.3
Belgium	417.7	408.2
West Germany	387.3	394.0
Poland	327.1	348.0
Peru	209.1	224.1
Australia	191.5	192.3
Spain	152.1	154.2
Zaire	156.1	158.8
Republic of South Africa	144.8	142.8
United Kingdom	136.2	124.2
Yugoslavia	132.6	126.9
South Korea	113.0	108.9
Other communist countries	519.9	520.8
Other non-communist countries	446.6	462.4
Total	9 644.5	9 224.7

Sources: American Bureau of Metal Statistics, and Energy, Mines and Resources Canada.
P Preliminary.

Philippine copper producers by purchasing copper produced between July and December 1982 at a fixed price of US 75 cents/lb, the average break-even point for Philippine copper mines. All major producers had threatened to close without some form of financial aid. Japan has reportedly agreed to provide an advance payment of $US 120 million to enable the Philippine government to subsidize this emergency aid program. As Japan purchases 95 per cent of the Philippine copper output (300 650 t in 1981) closure of the Philippine mine would have posed problems for Japanese smelters. A copper stabilization loan fund of $US 24.5 million, established earlier in 1982 by the Philippine government to assist the mines, had proved inadequate.

Zambia's two state-controlled copper companies, Nchanga Consolidated Copper Mines Ltd. and Roan Consolidated Mines Limited, merged in March to form Zambia Consolidated Copper Mines Ltd. The new company accounts for about one-third of Zambia's Gross Domestic Product and over 90 per cent of the country's foreign exchange earnings. The new company borrowed $US 250 million to finance a new tailings leach plant at the Nchanga operation, that will produce a total of over 520 000 t of copper metal from stockpiled mill tailings over the next 15 years and is scheduled for production in December 1984.

Smelting and Refining

Kennecott Minerals Company and Mitsubishi Corporation announced plans to modernize a copper smelter at their jointly-owned Chino Mines Company operation at Hurley, New Mexico. Construction on the $US 100 million project was to commence in December with completion targeted for early 1985. The project will enable the smelter to meet environmental regulations recently approved by the State of New Mexico and the United States Environmental Protection Agency, and will boost capacity to about 107 000 tpy of copper from the present 64 000 t. The existing reverberatory furnace is to be replaced with an Inco flash

TABLE 9. WORLD CONSUMPTION OF REFINED COPPER, 1981 AND 1982

	1981	1982P
	(000 tonnes)	
United States	2 032.6	1 664.1
U.S.S.R.	1 320.0	1 320.0
Japan	1 254.1	1 327.0
West Germany	744.2	743.9
France	429.6	438.1
Italy	366.0	362.9
United Kingdom	333.1	360.3
Belgium	260.0	272.0
Canada	241.6	181.4
Poland	185.6	206.8
Brazil	177.9	240.0
Yugoslavia	150.0	142.1
South Korea	144.0	129.9
Mexico	140.9	90.8
Australia	137.8	127.0
East Germany	122.0	122.5
Other communist countries	594.0	595.1
Other non-communist countries	854.7	863.9
Total	9 488.1	9 187.8

Source: American Bureau of Metal Statistics.
P Preliminary.

furnace. Mine and concentrator capacity have already been expanded to meet the feed requirements of the smelter.

Copper Range Company opened its new $78 million, 54 000 tpy electrolytic copper refinery at White Pine, Michigan. The refinery, which can produce copper cathodes and continuous cast wire rod, billets and cakes, was expected to be operating at 60 per cent of capacity by December. The refinery was treating only scrap and stockpiled semi-refined copper because the company's mine, concentrator and smelter were closed on October 1 due to depressed copper prices.

Production commenced at Brazil's first copper smelter, at Camarachi, Bahia, owned by Caraiba Metais S.A. Industria e Comércio. When it reaches full output the smelter will have a capacity of 150 000 tpy, about 25 per cent of Brazilian copper consumption. The viability of the plant is being questioned because of its high costs, which were more than 50 per cent above the world copper price in the second half of 1982. The government will require that Brazilian copper importers purchase a portion of their requirements from Caraiba Metais if they wish to be allowed future copper imports.

Sumitomo Metal Mining Co. Ltd. of Japan reached financial and technical agreement on a 90 000 tpy copper refinery in China's Guixi province of southern China. Construction started again in March, after a one year interruption because of changes in China's economic plans. The refinery is to be completed in the fall of 1983 and to begin operations toward the end of 1985 after construction of a 360 000 tpy sulphuric acid plant and other facilities.

The Italian government approved a plan for a 45 000 tpy copper refinery to be constructed by SAMIN S.p.A., the metals subsidiary of the state energy corporation Ente Nazionale Idrocarburl (ENI). The refinery, which will handle blister copper and copper scrap, will be built on the site of, and use some of the plant of a zinc refinery that closed in August 1981.

Mexicana de Cobre S.A., a Mexican copper mining firm, has signed agreements with Marubeni Corporation of Japan for supply of equipment and construction of a 180 000 tpy electrolytic copper refinery at Enpalma, in the State of Sonora, Mexico. Construction of the $US 100 million project was to start immediately, with production scheduled for the first quarter of 1985. The refinery will treat copper from the La Caridad mine after it is smelted at the flash smelter being constructed at El Tajo.

CONSUMPTION

Non-communist world consumption of refined copper dropped from 7 233 000 t in 1981 to only 6 759 000 t in 1982, a decline of 6.6 per cent, compared to an increase of 1.7 per cent in 1981 relative to 1980. Most of this decline in consumption occurred in North America and in some of the more highly industrialized nations of the European Community. North American housing starts were down sharply because of high interest rates and the depressed economy. General consumer demand was off and manufacturers were not ordering new or replacement machinery and equipment. At the same time, construction of new electrical generating capacity has been down for several years because of energy conservation measures and

TABLE 10. WORLD COPPER PRODUCTION AND CONSUMPTION, 1982P

	Mine Production	Refined Production	Refined Consumption
		(000 tonnes)	
United States	1 135.1	1 672.2	1 664.1
U.S.S.R.	1 140.3	1 460.6	1 320.0
Japan	51.0	1 075.0	1 327.0
CIPEC[1]	3 225.2	2 055.2	328.3
Europe	185.2	1 319.2	2 590.6
Canada	606.2	298.3	181.4
Other communist countries	694.0	868.8	924.4
Other non-communist countries	985.6	475.4	852.0
Total	8 022.6	9 224.7	9 187.8

Sources: American Bureau of Metal Statistics, and Energy, Mines and Resources Canada.
[1] Intergovernmental Council of Copper Exporting Countries includes: Australia, Chile, Indonesia, Papua New Guinea, Peru, Yugoslavia, Zaire and Zambia.
P Preliminary.

excess electrical generating capacity in many parts of the world.

STOCKS

Commercial Stocks

Total commercial stocks of refined copper held in the non-communist world, which were 1 086 900 t at the end of 1981, had risen by 38 per cent to 1 498 000 t by the end of 1982, according to the World Bureau of Metal Statistics. London Metal Exchange stocks were 253 000 t at the end of 1982 compared with 126 700 t at the end of 1981. New York Commodity Exchange Stocks were 249 000 t at the end of 1982, compared with 170 200 t at the end of 1981.

National Stockpiles

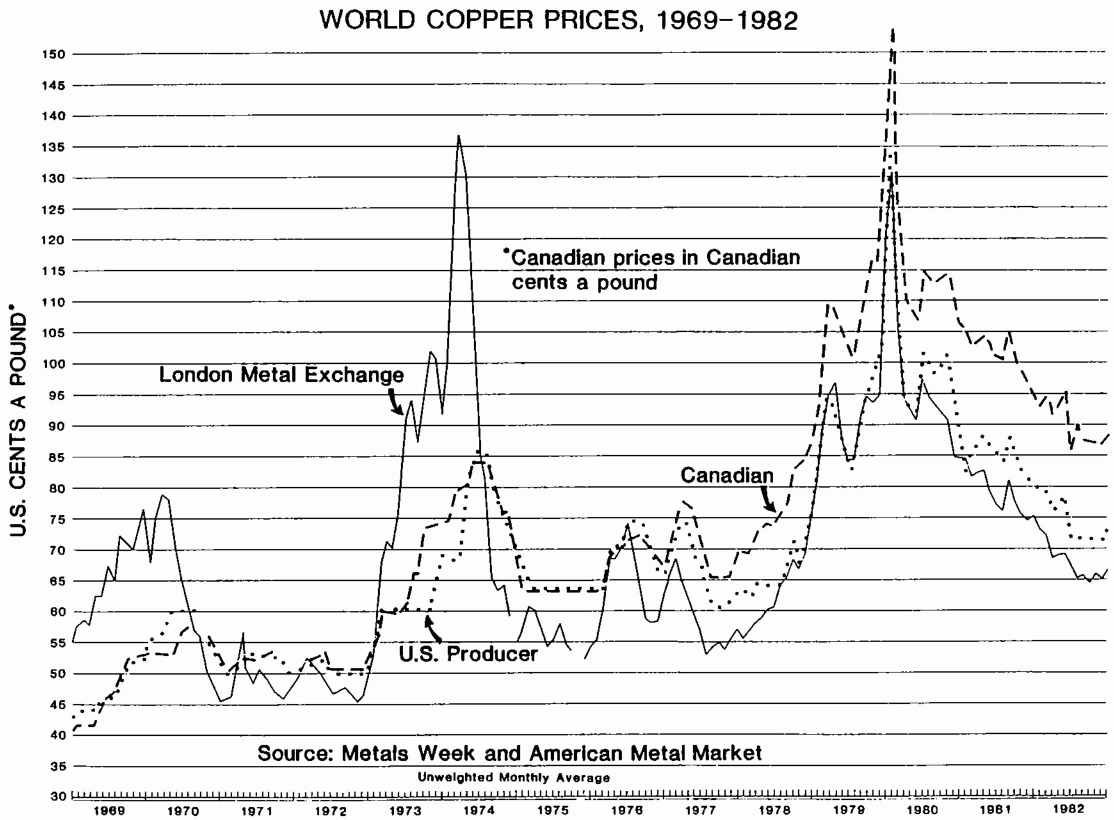
The United States strategic stockpile goal for copper remained at 907 184 t, with no change in holdings at the end of 1982 relative to the 20 200 t held at the end of 1981. Sales from the Japanese copper stockpile during 1982 of 4 800 t completely depleted it at the end of the year.

PRICES

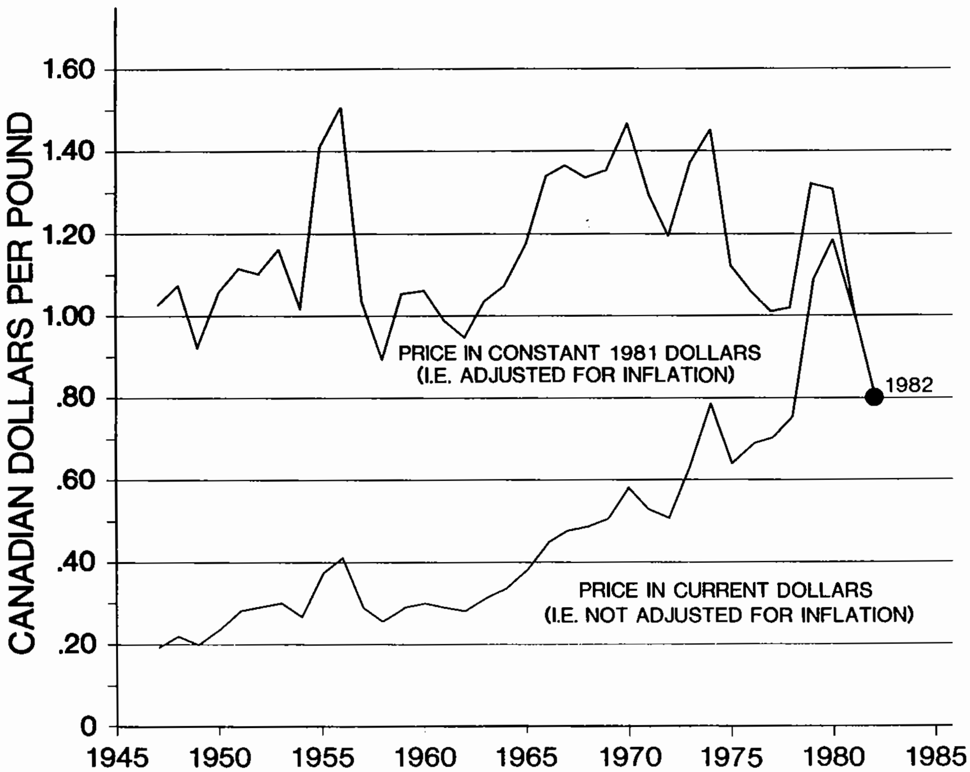
Copper prices dropped during 1982. The U.S. producer price for cathode, which was about 80 cents US/lb in early January, dropped as low as 62 cents in June and was about 73 cents US by year-end. The Canadian producer price was about 94 cents in early January, dropped to 82 cents on June 18 and was 90 cents at the end of December. The premium for wirebars was 1.75 cents/lb all year, except that Hudson Bay Mining and Smelting Co., Limited dropped its premium in Canada to 1.50 cents late in the year, but left the U.S. premium at 1.75 cents. Some Canadian producers indicated that effective January 1, 1983, their cathode price would be based on the COMEX price plus a 5 cents US/lb premium (North American producer prices include delivery to the nearest railroad siding, while commodity exchange prices do not). The wirebar premium is to be raised to 2 cents (Canadian) effective January 1, 1983. The LME cathode price, which was about 74 cents US/lb in early January, dropped to only 53.5 cents on June 21 and was 65.9 cents at the end of December.

The average Canadian producer price for full plate copper cathodes was 90.2 cents a pound with a premium of 1.50-1.75 cents a pound for wirebars. The average U.S. producer price for full plate cathodes was 74.6 cents US/lb. The average LME cash price for "copper-standard" cathodes was 65.56 cents US/lb and "copper-higher grade" 67.17 cents US/lb.

In constant dollar terms (i.e. after adjusting for inflation) the average copper price for 1982 was as low as any prices that have existed since the 1930s.


WORLD COPPER PRICES, 1969-1982
U.S. CENTS A POUND*
150
145
140
135
130
125
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
*Canadian prices in Canadian cents a pound
London Metal Exchange
Canadian
U.S. Producer
Source: Metals Week and American Metal Market
Unweighted Monthly Average
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982

COPPER WIREBAR
AVERAGE ANNUAL CANADIAN PRODUCER PRICE



CHARACTERISTICS AND USES OF COPPER

Most uses of copper are dependent on the metal's high electrical conductivity, durability and corrosion resistance. About half the copper consumed is for electrical uses, such as electrical and telecommunications wire and cable and electric motors. Other major uses are in industrial machinery, heat exchangers, turbines, locomotives and motor vehicles. Substantial quantities of the metal are used in building construction, primarily in plumbing and electrical wiring. The manufacture of brass and other copper alloys is a major consumer of copper, with scrap a common source of much of the copper required. Other significant uses for copper are copper chemicals, munitions, coinage, jewellery and numerous other applications.

OUTLOOK

Revival of the world economy and demand for copper is the single most important factor with respect to revival of the Canadian copper industry. When demand picks up, copper prices should improve sufficiently to enable most of the closed Canadian copper producers to reopen. However, more fundamental factors may also be involved. World mine production of copper, and world copper demand grew by about 4.5 per cent per annum from 1950 to 1973, but since 1973 the average annual growth rate has been only 1.5 per cent. Copper consumption in the industrialized countries (OECD countries) has been closely related to the index of industrial output of those countries. The annual rate of growth of this index has been much lower since about 1970. The probable reason is a structural change in the world economy, with the post-war rebuilding of Europe completed, the pent-up demand that resulted from a long depression and war period largely satisfied and the maturing of the Japanese economy. For whatever reasons, there seems to have been a basic change in the consumption pattern for copper, so that we cannot expect consumption and production of copper to grow in the future at rates as high as they have since World War II. This may be partially compensated for by a higher consumption growth rate in the Third World nations.

Copper is not in short supply, and many relatively high-grade copper deposits are known in various areas of the world. If put into production such known deposits could supply the total world demand for copper until beyond the end of this century, at prices (expressed in constant dollar terms) much lower than have existed over the past 35 years. Exploration for new copper deposits is going on in many parts of the world, so that new copper discoveries of economic grades seem likely to continue for many years into the future and to add to the potential supply of copper. In addition, a large number of other copper deposits are known in many parts of the world, including those in Canada, that are either in relatively remote locations that lack infrastructure or are of lower grade, or both. Therefore, there is enough copper already known to supply all that the world is likely to need over the foreseeable future.

The graph shows the annual average Canadian producer price for copper wirebars since prices were decontrolled after World War II. In constant dollars, the price has fluctuated over a fairly narrow range, with no sustained long-term tendency to rise or decline, but with boom periods of peak demand for copper driving prices to relatively high levels for short periods of time. Such shortages have tended to be self-correcting, both because high prices have led to development of new mines, and because excess demand has tended to decline again within a year or two. This pattern is expected to continue in the future.

However, the substantial potential for increased low-cost copper production in Chile, Australia and other countries, combined with the continued low 1.5 per cent per annum rate of increase in growth of world copper consumption, will likely result in low copper prices over the long term. The average copper price for the remainder of this century will be considerably below the average price of about $1.07 (1982 Canadian dollars) a pound that has prevailed since World War II.

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
32900-1	Copper in ores and concentrates	free	free	free	free
33503-1	Copper oxides	free	14.1	25.0	free
34800-1	Copper scrap, matte and blister and copper in pigs, blocks or ingots; cathode plates of electrolytic copper for melting, per lb	free	free	1.5¢	free
34820-1	Copper in bars or rods, for manufacture of trolley, telegraph and telephone wires, and electric wires and cables	free	4.6	10.0	free
34835-1	Electrolytic copper powder (expires June 30, 1982)	free	free	10.0	free
34845-1	Electrolytic copper wire bars, per lb (expires June 30, 1982)	free	free	1.5¢	free
35800-1	Anodes of copper	free	free	10.0	free

MFN Reductions under GATT (effective January 1 year given)	1982	1983	1984	1985	1986	1987
			(%)			
33503-1	14.1	13.8	13.4	13.1	12.8	12.5
34820-1	4.6	4.5	4.4	4.3	4.1	4.0

UNITED STATES (MFN)

		1982	1983	1984	1985	1986	1987
602.30	Copper, ores etc.	Remains free					
612.02	Unwrought copper, etc.		- no change -				1.7
612.08	Copper waste and scrap	4.7	4.2	3.8	3.3	2.9	2.4

EUROPEAN ECONOMIC COMMUNITY (MFN)

		1982	Base Rate	Concession Rate
26.01	Copper, ores and conc.	free	free	free
74.01	Copper in matte, unwrought copper, waste and scrap	free	free	free

JAPAN (MFN)

		1982	Base Rate	Concession Rate
26.01	Copper, ores and conc.	free	free	free
74.01	(1) Copper in matte etc.	free	free	free
	(2) Copper, unwrought			
	(a) containing not more than 99.8% by weight of copper etc.	8.1%	8.5%	7.3%
	(b) Other			
	(i) Containing by weight, not less than 25% of zinc and not less than 1% of lead.	20.63yen/kg	24yen/kg	15yen/kg
	(ii) Containing more than 95% by weight of copper			
	- blister copper in bar	8.1%	8.5%	7.3%
	- other	22.88yen/kg	24yen/kg	21yen/kg
	(iii) Containing not more than 95% by weight of copper	22.88yen/kg	24yen/kg	21yen/kg
	(3) Waste and scrap			
	(a) Unalloyed	1.6%	2.5%	free
	(b) Other: containing more than 10% by weight of nickel	14.1%	22.5%	free
	(c) Other	1.6%	2.5%	free

Sources: The Customs Tariff and Commodities Index, 1982, Revenue Canada; Tariff Schedules of the United States Annotated (1982), USITC Publication 1200; U.S. Federal Register Vol. 44, No. 241; Official Journal of the European Communities, Vol. 24, No. L335, 1981; Customs Tariff Schedules of Japan, 1982; GATT Documents, 1979.

Crude Oil and Natural Gas

R.L. THOMAS

At the close of 1981, the number of oil, gas and dry wells completed in Canada had declined by 22 per cent from the previous year and corresponding metrage fell by an equal amount. Well completions dropped to 7,186 wells from almost 9,200 completions and aggregate depth slid to 8.2 million m from 10.5 million m. Some of the reasons for Canada's rapid decline in drilling activity were due to the price of crude oil not rising as rapidly as forecasted; the domestic and export demand for Canadian natural gas did not increase as earlier projected thus failing to generate required cash flows; and, interest rates for borrowed capital increased too rapidly for some companies to remain operational. These major factors had created a climate of investment uncertainty in Canada that continues to be experienced, but now to a much lesser degree since federal/provincial amended agreements and incentives. Rig utilization has suffered from the decline in drilling activity, and been compounded by an oversupply of equipment constructed very early in 1980.

Year-end statistics indicating the industry's performance through this period, show that: purchases of Crown lands in western Canada have fallen by 40 per cent and revenues generated by these sales have dropped by 44 per cent; geophysical activity has declined by 5 per cent; the utilization of Canadian drilling rigs dipped by 14 points to an average of 52 per cent; and, the number of completed wells declined by 9 per cent to 6,561 from last year's total of 7,186 completions and the aggregate depth fell by 12 per cent to 7.2 million m from 8.2 million m.

Preliminary statistics for 1982 indicate that production of conventional crude oil and natural gas liquids from western Canada will decline by some 3 per cent to 229 999 cubic metres per day (m^3/d) from 236 210 m^3/d in 1981. There was a 13 per cent increase in the production of synthetic crude, to 22 284 m^3/d from 19 724 m^3/d. The total anticipated output of crude and liquids for this year will average 252 283 m^3/d, an estimated decline of some 1.5 per cent over the previous year.

The sales of Canadian natural gas, for both domestic consumption and export, are expected to increase slightly by 3 per cent to a daily average of 204 million m^3/d. Domestic consumption will rise by 4 million m^3/d to 143 million m^3/d and export volumes will increase to almost 61 million m^3/d from last year's average of 59 million m^3/d.

Revenue from the sales of crude oil, natural gas liquids and natural gas is expected to increase by 14 per cent, from $17.5 billion to almost $20.0 billion due to increased prices for petroleum. Expenditures by the industry shall show a marginal increase, to $14.2 billion this year from $14.1 billion in 1981.

As Canada's refining capacity continues to decline through the closure of some facilities and the decrease in demand resulting from conservation, the volumes of crude received at the plants during 1982 averaged some 236 000 m^3/d, down from 276 000 m^3/d in 1981.

OUTLOOK

In the first quarter of 1982, the petroleum industry experienced a downturn of drilling activity but is expected to return to normal levels in the latter part of 1982. The number of well licences, geophysical crews, revenues from sales of Crown lands, and active drilling rigs was reduced in mid-year to lower than historic levels causing uncertainty in forecasting the winter seasonal upturn in activity. The industry in the United States experienced similar problems in early 1982.

In the fourth quarter of the year Alberta, Saskatchewan and Manitoba recorded a marked increase in activity that resulted in several discoveries of crude oil. Discoveries

TABLE 1. CANADA, RESERVES OF LIQUID HYDROCARBONS AT END OF 1982

	Crude Oil	Pentanes Plus	Propane, Butane and Ethane	Total	Per cent of Total
			(000 cubic metres)		
Northern Canada	20 673	14 479	0	35 457	2.9
Alberta	682 518	76 639	99 655	858 812	70.4
Saskatchewan	109 707	246	875	110 828	9.1
British Columbia	24 180	2 918	2 861	29 959	2.5
Eastern Canada	9 055	0	0	9 055	0.7
Eastcoast offshore	175 000	0	0	175 000	14.4
Total	1 021 133	94 282	103 696	1 219 111	100.0

Source: Canadian Petroleum Association.

of crude oil made after December 31, 1980 qualify for a New Oil Reference Price (NORP) which is related, based on its quality, to the world price. In the frontier regions, exploration activity is expected to continue at high levels under new exploration agreements calling for multi-well programs, particularly in the Beaufort Sea and the eastcoast offshore.

The supply of natural gas continues to exceed domestic requirements. The National Energy Board, after studying the results from recent hearings, may in 1983 authorize additional gas exports.

TABLE 2. CANADA, ESTIMATED YEAR-END MARKETABLE RESERVES OF NATURAL GAS, 1981 AND 1982

	1981	1982
	(million cubic metres)	
Alberta	1 723 130	1 728 364
British Columbia	222 280	220 588
Saskatchewan	32 557	28 282
Eastern Canada	8 751	9 043
Northern Canada	576 255	604 773
Total	2 562 973	2 591 050

Source: Canadian Petroleum Association.

EXPLORATION

Exploration activity in Canada's frontier regions during the year continued at a record pace due to the drilling of untested prospects and delineation of earlier discoveries of oil and gas. The major operators in 1982 included: Panarctic Oils Ltd. (Arctic Islands), Dome Petroleum Limited, Gulf Canada Resources Inc., Esso Resources Canada Limited (Mackenzie Delta - Beaufort Sea), Petro-Canada (Labrador Shelf) and Mobil Oil Canada, Ltd. (eastcoast offshore).

In the Arctic Islands, Panarctic conducted its drilling operations from four ice platforms. Significant results in terms of the oil potential of the region were obtained from the Cisco C-42 delineation well located southeast of the B-66 oil and gas discovery of 1981. The well tested flow rates of some 160 m^3/d of oil and estimates of recoverable reserves of the field are 27-44 million m^3, down from earlier estimates. Other wells drilled by Panarctic, the Whitefish P-25, Cape Mamen F-24 and the Sculpin E-08 were dry.

In the Beaufort Sea region, Gulf encountered oil that tested a flow rate of 272 m^3/d at its Tarsiut N-44 delineation well, located 6 km east of the Tarsiut A-25 discovery. A follow-up well, N-44A, was disappointing in that some of the sands were water-bearing. The third delineation well,

TABLE 3. PRODUCTION OF LIQUID HYDROCARBONS BY PROVINCE, 1981 AND 1982

	1982P		1981r	
	(000 m^3)	(m^3/day)	(000 m^3)	(m^3/day)
Alberta				
Crude	62 508.6	171 256.4	64 178.7	175 832.1
Condensate	110.0	301.4	95.1	260.5
Propane	5 202.2	14 252.6	5 155.0	14 123.3
Butane	3 116.8	8 539.2	3 047.8	8 350.1
Pentanes plus	5 470.2	14 986.8	5 652.2	15 485.5
Ethane	4 248.0	11 638.4	4 670.7	12 796.4
Total	80 655.8	220 974.8	82 799.5	226 847.9
Saskatchewan				
Crude	8 055.9	22 071.0	7 392.8	20 254.2
Condensate	18.1	49.6	17.1	46.8
Propane	66.7	182.7	34.1	93.4
Butane	35.7	97.8	18.1	49.6
Pentanes plus	21.7	59.5	11.3	31.0
Total	8 198.1	22 460.5	7 473.4	20 475.1
British Columbia				
Crude	2 073.2	5 680.0	2 036.0	5 578.1
Condensate	21.2	58.1	27.9	76.4
Propane	68.9	188.8	64.1	175.6
Butane	89.4	244.9	84.6	231.8
Pentanes plus	135.3	370.7	124.9	342.2
Total	2 388.0	6 542.5	2 337.5	6 404.1
Canada				
Crude	73 479.0[1]	201 312.3	74 413.0[2]	203 871.2
Condensate	149.3	409.0	140.1	383.8
Propane	5 337.8	14 624.1	5 253.2	14 392.3
Butane	3 241.9	8 881.9	3 150.5	8 631.5
Pentanes plus	5 627.2	15 417.0	5 788.4	15 858.6
Ethane	4 248.0	11 638.4	4 670.7	12 796.4
Total	92 083.2	252 282.7	93 415.9	255 934.0

Source: Statistics Canada.
[1] Synthetic equals 8 133.6. [2] Synthetic equals 7 199.2.
P Preliminary; r Revised.

the Kiggavik A-43, tested gas and water indicating a probable lack of continuity in the reservoir zones across the Tarsiut field.

Dome's four drillships continued operations at several wells. Some of these wells are classified as re-entry wells whose purpose is to conduct various types of tests, or drilling to deeper depths. The Irkaluk B-35 and Kenalooak J-94 wells were re-entered and reached depths of 4 675 and 3 951 m respectively. A program of six tests were performed at the Nerlerk M-98 well and flow rates of 46 m^3/d of 22° API oil were obtained, making this well one of the larger discoveries. After Nerlerk, it is anticipated that the Orvilruk O-03 will be re-entered and deepened.

Esso has been conducting its operations in the Beaufort Sea from artificial islands. A new wildcat well, West Atkinson L-17, was spudded on the West Atkinson structure near the Tuktoyaktuk Peninsula and 10 km northeast of the Atkinson H-25 oil discovery made

TABLE 4. CANADA, LIQUIDS AND SULPHUR RECOVERED FROM NATURAL GAS, 1970-82

	Propane (cubic metres)	Butane (cubic metres)	Condensate Pentanes Plus (cubic metres)	Sulphur (tonnes)[1]
1970	3 382 352	2 099 228	7 019 513	4 309 041
1971	3 851 547	2 455 929	7 456 208	4 628 393
1972	4 696 619	3 093 703	9 671 111	6 723 409
1973	5 315 544	3 567 161	9 867 029	7 115 881
1974	5 268 092	3 519 638	9 413 046	6 950 327
1975	5 531 963	3 642 717	8 816 323	6 487 466
1976	5 410 000	3 583 000	7 872 000	6 422 000
1977	5 512 000	3 650 000	7 712 000	6 500 040
1978	5 205 100	3 355 900	6 926 300	6 310 511
1979	5 702 400	3 621 000	6 869 200	6 281 500
1980	5 402 400	3 365 900	6 212 800	6 182 500
1981[r]	5 253 200	3 150 500	5 947 700	5 613 761
1982[P]	5 337 800	3 241 900	5 776 500	5 231 136

Source: Statistics Canada.
[1] The term "tonne" refers to the metric ton of 2,204.62 pounds avoirdupois.
P Preliminary; r Revised.

in 1970, the first find made in the Mackenzie-Beaufort region. Later in the year, this well was plugged and abandoned after testing oil. Esso will further develop the Norman Wells oil field located in the Northwest Territories straddling the Mackenzie River. The company plans to increase the field production from 500 m^3/d to 4 000 m^3/d, which requires drilling additional wells, some of which are "horizontal" wells, from islands constructed in the river.

By mid-year, drilling operations were active on the Labrador Shelf and off Baffin Island. Petro-Canada, operating in the Labrador region for the Labrador Group, moved three dynamically positioned drillships on location to drill the Corte Real P-85, the Pothurst P-19 and the Rut H-11 wildcat wells. This region has been primarily gas-prone but recent drilling has shown some indications of oil. Farther north, Canterra Energy Ltd. drilled a new wildcat at its Raleigh N-18 location off Baffin Island. This well was later plugged and abandoned at a depth of 3 858 m, and there are no plans to re-enter.

The eastcoast offshore region continues to command attention as additional drilling is undertaken in the Hibernia area on new structures. Throughout the year, Mobil has been operating two semi-submersible units. The Mobil et al Nautilus C-92, north of the Hibernia field, tested oil and gas flow rates of 418 m^3/d and 66 300 m^3/d respectively. Earlier in the year, drilling from floating platforms was halted following the sinking of the Ocean Ranger. The two remaining semi-submersible units were towed to Newfoundland for inspection. Mobil moved the rigs after inspection to two new locations north of Hibernia, the Bonanza M-71 and the Linnet E-63. An investigation and inquiry into the Ocean Ranger disaster is under way.

In the Scotian Shelf, Mobil and Petro-Canada drilled on the gas productive trend. Mobil drilled near the Venture gas field the Olympia A-12 and the South Venture O-59 wells. Petro-Canada leased the semi-submersible Vinland on a long-term contract for drilling in the Banquereau block at its two sites, the North Banquereau I-13 and the West Esperanto B-78.

Throughout the year, there has been considerable excitement in western Canada because of significant oil discoveries in mainly previously known oil regions.

The search for oil has been encouraged by the higher prices given to new oil, and provincial incentives. As a result, the Provinces of Manitoba, Saskatchewan and Alberta have recorded a higher level of oil directed activity than in the previous two years. In Manitoba, Omega Hydrocarbons has drilled more than 100 successful wells in the Waskada area. As a result of Omega's success, several other companies are also now active in the Virden-Waskada region.

In Saskatchewan, the new provincial government announced changes to its taxation and royalty regime considered positive by industry. Activity in the province has increased with companies lately concentrating their efforts in the Kindersley and Lloydminster areas on deep drilling enhanced oil recovery (EOR) projects, and development.

There has been a recent increase in activity in Alberta. The government announced the inclusion of a development drilling program to its existing $250 million well servicing incentive scheme. The program produced an increase in development drilling especially during the last quarter of the year. The number of geophysical crews increased markedly in the last half of the year and several land sale auctions indicated high selective interest. The most significant oil discoveries made to date in Alberta have been Shekilie, Rumsey, Evi and Cynthia-Pembina. Little information has yet been released. A well in the Rumsey play tested flow rates as high as 590 m^3/d.

TABLE 5. OIL AND GAS WELLS IN WESTERN CANADA AT END OF 1982

	Wells Capable of Production		Wells Actually Producing	
	Oil	Gas	Oil	Gas
Alberta	21,345	25,400	15,259	20,611
Saskatchewan	11,692	1,287	9,020	795
Manitoba	1,002	-	896	-
British Columbia	942	1,923	633	591
Northwest Territories and Arctic Islands	74	9	37	7
Total	35,055	28,619	25,845	22,004

Sources: Provincial and federal government reports.
- Nil.

TRANSPORTATION

Construction of the 636 km eastern leg of the Alaska gas pipeline has been completed and Alberta gas started flowing on September 1, 1982 to the United States.

TABLE 6. WELLS DRILLED BY PROVINCE, 1981 AND 1982

	Oil		Gas		Dry[1]		Total	
	1981	1982	1981	1982	1981	1982	1981	1982
Western Canada								
Alberta	1,483	1,619	3,085	2,499	1,264	1,048	5,832	5,166
Saskatchewan	512	686	25	10	251	103	788	799
British Columbia	27	25	95	42	87	39	209	106
Manitoba	47	163	0	0	15	31	67	194
Yukon, Northwest Territories and Arctic Islands	5	10	1	4	7	6	13	20
Westcoast offshore	0	0	0	0	0	0	0	0
Sub-total	2,074	2,503	3,206	2,555	1,624	1,227	6,909	6,285
Eastern Canada								
Ontario	6	27	76	61	95	68	178	156
Quebec	0	0	1	0	4	0	5	0
Atlantic provinces	0	0	0	0	1	1	1	1
Eastcoast offshore	4	1	2	2	3	4	9	7
Hudson Bay offshore	0	0	0	0	0	0	0	0
Sub-total	10	28	79	63	103	73	193	164
Total Canada	2,084	2,531	3,285	2,618	1,727	1,300	7,102	6,449

Source: Canadian Petroleum Association.
[1] Includes suspended and abandoned wells, but excludes miscellaneous and service wells.

TABLE 7. CANADA, WELLS COMPLETED AND METRES DRILLED, 1981 AND 1982

	1981		1982	
	(No.)	(metres)	(No.)	(metres)
Western Canada				
British Columbia				
New field wildcats	36	103 259	12	30 810
Other exploratory	108	189 990	50	97 396
	144	293 249	62	128 206
Development	65	114 336	47	79 506
Total	209	407 585	109	207 712
Alberta				
New field wildcats	189	297 929	94	160 144
Other exploratory	2,163	3 145 228	1,674	2 441 470
	2,352	3 443 157	1,768	2 601 614
Development	3,534	3 422 798	3,457	3 371 310
Total	5,886	6 865 955	5,225	5 972 924
Saskatchewan				
New field wildcats	173	141 638	141	114 056
Other exploratory	361	314 541	227	202 039
	534	456 179	368	316 095
Development	267	238 660	443	377 443
Total	801	694 839	811	693 538
Manitoba				
New field wildcats	23	25 794	41	40 525
Other exploratory	10	8 958	37	35 019
	33	34 752	78	75 544
Development	34	31 294	117	108 748
Total	67	66 046	195	184 292
Yukon, Northwest Territories and Arctic Island				
New field wildcats	11	30 348	10	32 221
Other exploratory	0	0	2	7 348
	11	30 348	12	39 569
Development	2	8 470	29	26 671
Total	13	38 818	41	66 240
Total western Canada				
New field wildcats	432	598 968	298	377 756
Other exploratory	2,642	3 658 717	1,990	2 783 272
	3,074	4 257 685	2,288	3 161 028
Development	3,902	3 815 558	4,093	3 963 678
Total	6,976	8 073 243	6,381	7 124 706
Eastern Canada				
Eastcoast offshore				
New field wildcats	9	39 511	7	34 099
Other exploratory	0	0	0	0
	9	39 511	7	34 099
Development	0	0	0	0
Total	9	39 511	7	34 099
Ontario				
New field wildcats	31	19 266	23	14 767
Other exploratory	17	8 936	23	12 566
	48	28 202	46	27 333
Development	147	63 870	127	49 759
Total	195	92 072	173	77 092

TABLE 7. (cont'd.)

	1981		1982	
	(No.)	(metres)	(No.)	(metres)
Quebec				
New field wildcats	4	6 879	0	0
Other exploratory	1	1 265	0	0
	5	8 144	0	0
Development	0	0	0	0
Total	5	8 144	0	0
Atlantic provinces				
New field wildcats	1	2 638	0	0
Other exploratory	0	0	0	0
	1	2 638	0	0
Development	0	0	0	0
Total	1	2 638	0	0
Total eastern Canada				
New field wildcats	45	68 294	31	50 701
Other exploratory	18	10 201	23	12 566
	63	78 495	54	63 267
Development	147	63 870	127	49 759
Total	210	142 365	181	113 026
Total Canada				
New field wildcats	477	667 262	329	428 457
Other exploratory	2,660	3 668 918	2,013	2 795 838
	3,137	4 336 180	3,342	3 224 295
Development	4,049	3 879 428	4,220	4 013 437
Total	7,186	8 215 608	6,562	7 237 732

Source: Canadian Petroleum Association.

In April 1982, producers and transporters responsible for the Alaska segment of the 7 700 km Alaska Natural Gas Transmission System (ANGTS) reconfirmed their commitment to the project. However, due to current economic and market difficulties, they announced that the project would be delayed to late-1989.

The Foothills Pipe Lines (Yukon) Ltd. proposal to carry gas from the Mackenzie Delta through the Alaska line to southern Canadian markets, is dependent upon completion of the Alaska segment. This line called the Dempster pipeline is expected to carry up to 34 million m^3/d and cost $3.5 billion.

The Arctic Pilot Project (APP) - a joint undertaking of Petro-Canada, Nova, an Alberta Corporation, Dome Petroleum and Melville Shipping Ltd. - proposed to liquify eastern Arctic gas and ship liquid natural gas (LNG) by ice-breaking tankers to a regasification terminal in Quebec or the Maritimes. Originally, the ultimate destination of the gas would be the U.S. market. Currently, APP sponsors have been looking at the possibility of delivering gas to European markets. In late-July 1982, TransCanada PipeLines Limited (TCPL) withdrew its application to the National Energy Board (NEB) to construct and operate the regasification terminal. APP sponsors asked that NEB hearings be rescheduled to address the northern component of the project separately, before the southern component is considered. The NEB has decided to suspend indefinitely all hearings on the APP, until the APP sponsors have gathered more information on the ultimate destination of the natural gas. Estimated cost of the northern component is $2.1 billion.

TABLE 8. CONSUMPTION OF PETROLEUM PRODUCTS BY PROVINCE, 1982

	Motor Gasoline	Kerosene, Stove Oil, Tractor Fuel	Diesel Fuel Oil	Light Fuel Oil No. 2 and 3	Heavy Fuel Oil No. 4, 5 and 6
	(000 cubic metres)				
Atlantic provinces	2 878	222	1 365	1 940	3 115
Quebec	7 087	286	2 150	4 025	4 312
Ontario	11 983	201	3 237	3 392	1 476
Manitoba	1 500	97	726	118	176
Saskatchewan	1 905	142	1 039	165	17
Alberta	4 813	63	2 627	99	28
British Columbia	4 035	110	2 175	585	1 337
Northwest Territories and Yukon	91	86	232	118	11
Total	34 292	1 207	13 551	10 442	10 472

Source: Statistics Canada.

Polar Gas is proposing to construct a Y line connecting both Arctic Islands (eastern) and Mackenzie Delta (western) gas reserves for delivery to southern Canadian markets. Presently, the application by project sponsors to the NEB is in abeyance. At the earliest, the project could start-up in 1990. The project facilities would extend over 5 000 km and throughput estimated at 61 million m^3/d.

The Trans Québec & Maritimes Pipeline Inc. (TQM) pipeline is currently under construction to Quebec City. Gas service was brought as far as Trois-Rivières in 1982 and is expected in Quebec City by the summer or fall of 1983.

The need for the Maritimes portion has been thrown into uncertainty with the promising exploration results at Sable Island. The National Energy Program Update of May 1982, however, maintained momentum on the Maritimes portion through the provision of funds for the pipeline engineering and design work.

With respect to the Quebec portion, a $500 million fund was made available to the gas distributor, Gaz Inter-Cité Québec Inc. (GICQ), for the construction of the major laterals off the main transmission line. GICQ is expecting to bring gas into the Eastern Townships in the summer of 1983 and up to the Lac St-Jean region the following year.

TransCanada PipeLines undertook a major construction program in 1982, expanding the capacity of its line across the Prairies and building the North Bay Short Cut in northeastern Ontario. The North Bay Short Cut was a $450 million, 400 km project which greatly shortened the distance gas must travel to reach the new Quebec market. It was brought into service in December 1982.

During 1982, Interprovincial Pipe Line (NW) Ltd. has been preparing the various studies and documentation required by the National Energy Board for the Norman Wells Pipeline project, as stipulated under the Certificate of Public Convenience and Necessity issued to Interprovincial. However, the company should be proceeding with right-of-way clearance for the 4 500 m^3/d line in the spring of 1983. It is anticipated that the work will be completed on schedule by 1985. However, the original cost estimation of $360 million was revised upwards in December, 1981 to $580 million.

The Portland Pipeline (Portland, Maine to Montreal) has been running at approximately 30 per cent of total capacity during 1982. This low utilization level is due to decreasing demands for petroleum products in the Montreal area, combined with a higher than anticipated availability of domestic crude oil. With the closure of the Texaco Canada Inc. refinery in October 1982 and the announced closure of the BP Canada Inc. refinery for May 1983 it is unlikely that this trend of low crude runs will improve.

TABLE 9. CANADA, EXPORTS AND IMPORTS OF REFINED PETROLEUM PRODUCTS, 1981r AND 1982

	Exports		Imports	
	1982	1981r	1982	1981r
	(000 cubic metres)			
Propane and butane	393	561	0	0
Aviation gasoline	0	0	0	0
Motor gasoline	527	702	22	119
Aviation turbo fuel (kero-type)	39	90	6	21
Kerosene, stove oil	4	0	0	19
Diesel fuel oil	176	134	0	186
Light fuel oil No. 2 & No. 3	660	1 550	39	34
Heavy fuel oil No. 4, 5 & 6	1 761	2 399	1 572	1 198
Asphalt	254	163	0	21
Petroleum coke	0	0	543	780
Lubricating oils & greases	51	15	39	68
Other products[1]	1 371	1 453	358	66
Total, all products	5 236	7 067	2 579	2 512

Source: Statistics Canada.
[1] Also includes Petro-chem feedstocks, Naphtha specialties, aviation turbo fuel (naphtha type) and still gas.
r Revised.

MARKETS AND TRADE

The production of crude oil, natural gas liquids and synthetic crude oil is estimated to have averaged 252 000 m^3/d during 1982, a decrease over 1981 of 2 per cent or 4 000 m^3/d. The output of conventional crude oil was almost 202 000 m^3/d, natural gas liquids close to 28 000 m^3/d and synthetic crude oil approximately 22 000 m^3/d.

Exports of crude oil and products increased by 8 per cent over 1981 to a new level of 74 000 m^3/d, or an annual total of 27 million m^3. Crude oil volumes accounted for 46 per cent or 33 700 m^3/d, a 32 per cent increase over the 1981 amount.

Sales of Canadian natural gas climbed by 3 per cent to average some 204 million m^3/d with domestic sales being 143 million m^3/d and export volumes 61 million m^3/d.

The wellhead prices of various crude oil types changed during the year. In January, the price of "old" oil was \$147.88/m^3 and remained at that level until July, when it was increased to \$162.04/m^3 to year-end. The "new" oil price in January was \$278.00/m^3, decreased in July to \$260.95/m^3, and then increased in October to \$272.90/m^3, thus reflecting changes in the international price.

In January, the Toronto city gate price of natural gas was \$2.905/gigajoule (1 GJ = 0.95 million cu ft) and then from February to July, increased to \$3.450/GJ. The price was adjusted in August to \$3.698 and again

TABLE 10. CANADA, OIL PRODUCTION, TRADE AND REFINERY RECEIPTS, 1970-82

	Production	Imports	Exports	Refinery Receipts[1]		
				Domestic	Imports	Total
	(000 cubic metres)					
1970	73 322	33 011	38 299	41 172	33 123	74 295
1971	78 339	38 947	43 049	41 852	38 829	80 681
1972	89 347	44 781	54 255	43 441	45 908	89 349
1973	104 272	52 057	66 784	47 716	49 491	97 207
1974	97 742	46 290	53 015	55 250	47 582	102 832
1975	82 802	47 416	41 727	50 963	47 777	98 740
1976	76 075	43 930	29 030	56 455	41 871	98 326
1977	76 447	39 593	19 783	65 420	38 819	104 239
1978	76 001	36 821	15 578	68 055	35 691	103 746
1979	86 722	35 430	16 761	77 240	35 419	112 659
1980	83 309	32 230	11 939	77 572	32 230	109 802
1981	74 382	29 546	9 462	71 230	29 547	100 777
1982	79 255	19 662	12 397	66 536	19 662	86 199

Source: Statistics Canada.
[1] Includes condensate and pentanes plus.

increased to $3.818 in September and remained constant for the balance of the year. The average price throughout the year was $3.548/GJ.

Many changes occurred during the year to further enhance exploration activity in western Canada. Revisions to taxes and royalties were introduced by various provinces along with new incentive schemes, designed to stimulate the petroleum industry. The federal government also introduced various programs and incentives to stimulate activities in conventional and frontier regions.

TABLE 11. CANADA, SUPPLY AND DEMAND OF OILS, 1981 AND 1982

	1981	1982
	(000 cubic metres)	
Supply		
Production		
Light-medium	57 269	58 765
Heavy	9 928	6 789
Synthetic	6 935	7 993
Pentanes plus	6 241	5 767
Natural gas liquids	13 322	12 921
Total production	93 695	92 235
Imports		
Crude oil	29 529	19 674
Products	2 518	2 664
Total imports	32 047	22 338
Total supply	125 742	114 573
Demand		
Domestic	102 601	91 688
Exports		
Light-medium and pentanes plus	4 052	4 271
Heavy	5 329	8 103
Products	7 081	5 256
Natural gas liquids	8 431	9 380
Total exports	24 893	27 010
Stock changes	-547	-3 431
Uses and losses	-1 205	-693
Total demand	125 742	114 573

TABLE 12. CANADA, SUPPLY AND DEMAND OF NATURAL GAS, 1981 AND 1982

	1981	1982
	(million cubic metres)	
Supply		
Gross new production	99 528	100 284
Field waste and flared	-1 579	-1 520
Reinjected	-12 419	-11 661
Net withdrawals	85 530	87 102
Processing shrinkage	11 706	11 234
Net new supply	68 475	69 799
Removed from storage	3 786	4 625
Placed in storage	4 319	5 684
Net storage	-533	-1 058
Total net domestic supply	68 475	69 799
Imports	3	5
Total supply	72 261	74 424
Demand		
Domestic sales		
Residential	9 795	12 289
Industrial	22 963	21 618
Commercial	10 128	9 981
Total	42 886	43 888
Field and pipeline use in production	6 390	5 993
Pipeline	2 139	1 959
Other	625	594
Adjustment metering differences	-128	586
Line pack changes	57	125
Total field and pipeline use	9 083	9 258
Gas unaccounted for	-1 292	-922
Total domestic demand	50 677	52 223
Exports	21 584	22 201
Total demand	72 261	74 424

Source: Statistics Canada.

TABLE 13. CANADA, CRUDE OIL RECEIVED AT REFINERIES, 1981 AND 1982

Location of Refineries		Country of Origin					
		Canada	Middle East	Venezuela	Africa	Other	Total Received
		(000 cubic metres)					
Atlantic provinces	1981	0	6 941	3 109	281	1 587	11 918
	1982	1 370	2 138	2 220	182	1 793	7 703
Quebec	1981	12 274	3 398	4 883	1 500	5 397	27 452
	1982	13 118	1 671	4 432	1 348	3 553	24 121
Ontario	1981	29 762	0	0	84	2 367	32 213
	1982	25 222	0	0	0	2 326	27 548
Prairies	1981	19 354	0	0	0	0	19 354
	1982	17 627	0	0	0	0	17 627
British Columbia	1981	9 666	0	0	0	0	9 666
	1982	9 027	0	0	0	0	9 026
Northwest Territories	1981	174	0	0	0	0	174
	1982	173	0	0	0	0	173
Total	1981	71 230	10 339	7 992	473	9 351	100 777
	1982	66 536	3 809	6 652	1 530	7 671	86 199

Source: Statistics Canada.

Gold

S.A. HAMILTON

SUMMARY

During 1982 the price of gold briefly fell below $US 300 per ounce, an event that seemed impossible in the heady days of 1980 when the price soared to over $800. This caused considerable concern in the Canadian gold mining industry as marginal producers became unprofitable and highly leveraged producers became trapped in a cash flow squeeze. However, unlike the situation in base-metal mining, no major gold producers (larger than 200 tpd) have been forced to close, and layoffs have been limited.

The price of gold on the London Gold Market fell below $400 per ounce in January and continued to fall, reaching a low of $296 on June 21. The rebound from this level was fairly prompt and the price exceeded $400 by the end of August. The high price for the year was $488.50, reached on September 7 amid rumours that a number of debt-ridden nations, including Mexico and Argentina, might default on loan repayments. Gestures by the International Monetary Fund reassured the investor community, the flight to gold tapered off and by the end of September the gold price had returned to the $400 level where it stabilized, trading within a moderate range until December when a mild price rally showed signs of developing.

The mix of factors affecting gold price in 1982 was complex. High interest rates prevailing throughout much of the year made interest bearing investments such as bonds and term deposits more attractive than gold. Despite the deepening recession, the U.S. dollar remained strong, making gold expensive in terms of most other currencies. Sales from the U.S.S.R. were maintained at a steady pace throughout the year so that the market was not forced to accept a sudden influx of metal as it was during the latter part of 1981. The economic slump combined with energy conservation led to an international oil glut and price discounting among OPEC members. Reduced cash flows limited the ability of OPEC countries to add to their gold reserves; indeed there is evidence of sales from the Middle East. The Republic of South Africa continued to sell all its production and to use its reserves as collateral for hard currency loans.

CANADIAN SCENE

The short-term variability of the gold price creates special problems for marginal producers that may operate at a profit one week and at a loss the next. Mining plans cannot be adjusted rapidly enough to accommodate price changes that may easily amount to $50 per ounce over a short period of time. The longer term price cycle, apparently extending over about 5 years from peak to peak, is not well enough understood or well enough established to enable companies wishing to develop new mines to bring the properties into production at the most favourable point in the cycle. As a means of insuring future earnings, some gold producers are venturing into the world of hedges and forward sales. However, the majority continue to sell spot and remain fully exposed to the whims of the market place.

As mining companies' earnings were eroded by falling metal prices, the level of exploration was reduced. This cutback applied not only to gold producers conducting on and off property exploration, but to producers of other minerals seeking to diversify into gold. The decline in the gold price also made it more difficult for junior mining companies specializing in gold exploration to raise funds through equity financing or through bank loans. As a result, exploration activity may have been less intense in 1982 than in 1981, although there are no statistics available to verify this. In the second half of 1982, with the price of gold stronger and interest rates lower, the tempo of gold exploration activity appeared to have picked up.

Volume of gold production in Canada in 1982, at 63 221 kg, was above the 52 034 kg produced in 1981, following three years when

TABLE 1. CANADA, PRODUCTION OF GOLD, 1981 AND 1982

	1981	1982P
	(grams)	
Newfoundland		
Base-metal mines	209 179	78 000
New Brunswick		
Base-metal mines	196 488	201 000
Quebec		
Auriferous quartz mines		
Bourlamaque-Louvicourt	3 414 938	3 230 000
Malartic, Matagami and Chibougamau	10 292 068	15 352 000
Total	13 707 006	18 582 000
Base-metal mines	3 603 606	4 632 000
Total Quebec	17 310 612	23 214 000
Ontario		
Auriferous quartz mines		
Larder Lake	3 223 601	3 362 000
Porcupine	5 991 458	7 140 000
Red Lake and Patricia	7 014 665	7 866 000
Total	16 229 724	18 368 000
Base-metal mines	2 010 964	1 434 000
Total Ontario	18 240 688	19 802 000
Manitoba-Saskatchewan		
Auriferous quartz mines	-	345 000
Base-metal mines	1 609 386	1 540 000
Total Manitoba-Saskatchewan	1 609 386	1 885 000
Alberta		
Placer operations	47 806	11 000
British Columbia		
Auriferous quartz mines	1 115 679	2 620 000
Base-metal mines	6 272 845	4 540 000
Placer operations	291 705	298 000
Total British Columbia	7 680 229	7 458 000
Yukon		
Base-metal mines	622 101	358 000
Placer operations	1 293 209	2 500 000
Total Yukon	1 915 310	2 858 000
Northwest Territories		
Auriferous quartz mines	4 824 583	6 949 000
Canada		
Auriferous quartz mines	35 876 992	46 864 000
Base-metal mines	14 524 569	12 783 000
Placer operations	1 632 720	2 809 000
Total	52 034 281	62 456 000
Total value	$922 089 087	$929 378 000
Average value per oz[1]	$551.18	$465.10

[1] Average of London Gold Market afternoon fixings in Canadian funds.
P Preliminary; - Nil.

TABLE 2. CANADA, GOLD PRODUCTION BY SOURCE, 1970, 1975 AND 1978-82

	Auriferous Quartz Mines		Placer Operations		Base-Metal Ores		Total	
	(grams)	(%)	(grams)	(%)	(grams)	(%)	(grams)	(%)
1970	58 591 610	78.2	228 890	0.3	16 094 525	21.5	74 915 025	100.0
1975	37 529 456	73.0	335 077	0.6	13 568 581	26.4	51 433 114	100.0
1978	36 339 934	67.3	555 663	1.0	17 071 330	31.7	53 966 927	100.0
1979	33 794 332	66.1	899 202	1.7	16 448 825	32.2	51 142 359	100.0
1980	31 928 594	63.1	2 059 727	4.0	16 631 942	32.9	50 620 263	100.0
1981	35 876 992	69.0	1 632 720	3.1	14 524 569	27.9	52 034 281	100.0
1982P	46 864 000	75.0	2 809 000	4.5	12 783 000	20.5	62 456 000	100.0

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

TABLE 3. CANADA, GOLD PRODUCTION, AVERAGE VALUE PER GRAM AND RELATIONSHIP TO TOTAL VALUE OF ALL MINERAL PRODUCTION[1], 1970, 1975 AND 1978-82

	Total Production	Total Value	Average Value per Gram[1]	Gold as per cent of Total Value of Mineral Production
	(grams)	($ Cdn)	($ Cdn)	(%)
1970	74 915 025	88,057,464	1.18	1.5
1975	51 433 114	270,830,389	5.27	2.0
1978	53 966 927	382,423,117	7.09	1.9
1979	51 142 359	590,766,328	11.55	2.3
1980	50 620 263	1,165,416,873	23.02	3.7
1981	52 034 281	922,089,087	17.72	2.9
1982P	62 456 000	929,378,000	14.88	2.8

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Value not necessarily based on average annual gold price.
P Preliminary.

gold output declined. The increase in production is attributable to two factors. The lower price required mines to mine higher grade ore and a number of new gold mines began production near the end of 1981, making a significant impact on 1982 total output. Gold production in 1982 would have been even higher had not so many base-metal mines been forced to shut down in response to low prices. The base-metal mines that have continued to produce are generally those with significant byproduct values. The amount of gold produced from base-metal mines did not decline as much as the number of base-metal mine closures would lead one to expect, suggesting that the remaining base-metal producers may be exploiting parts of their orebodies that have higher than average precious metals values.

Canadian gold producers were somewhat cushioned against the low second quarter gold price by the weakness of the Canadian dollar. However, corporate earnings for the first half of 1982 were not robust and a number of companies reported substantial first half losses. A combination of cost cutting and improved gold prices brightened the picture for the second half but gold mine profits for 1982 were a pale shadow of those reported for 1980.

At the end of 1982 there were 39 lode gold mines in Canada operated by 30 companies. Mine closures during the year were cost cutting measures in response to the low gold price and there is a reasonable probability that some of these operations will be reopened. Only one major gold mine commenced production in 1982 and only one major mine is likely to come on-stream in 1983. Quebec is now the leading gold producing province in Canada, followed by Ontario and British Columbia.

ATLANTIC PROVINCES

Gold production in the Atlantic Provinces remains a byproduct of base-metal mining. Production from this area declined markedly with the closure of Consolidated Rambler Mines Limited's copper mine at Baie Verte. A number of gold properties in central and northern Nova Scotia have been examined but attempts to establish sufficient ore reserves to support a production decision have not been successful. Northumberland Mines Limited closed its pilot mill project due to lack of funds.

QUEBEC

The mines that commenced operation in 1981 completed their tune up period and became fully operational during 1982. Kiena Gold Mines Limited and Bachelor Lake Gold Mines Inc., both of which were financed largely through equity, were able to withstand the low gold prices of the spring. Belmoral Mines Ltd., which had a $30 million loan to finance the construction of its two mines and mill near Val d'Or and the El Coco exploration program, was unable to meet its repayment schedule and the properties were taken over by receivers on behalf of the Continental Illinois Bank (Canada). Belmoral obtained a court injunction to prevent disposal of the assets and commenced negotiations with potential joint venture partners in an attempt to convert the debt into equity. Meanwhile, with the improvement in the price of gold, the company's cash flow increased and with it the ability to service its debt. Exploration Aiguebelle Inc. has entered into a two-year contract with the Louvem Mining Company Inc. for custom milling of ore from the Destor property 30 km north of Noranda. Shipment of development ore began near year-end. The company expects to be in commercial production at 600 tpd by spring 1983. Muscocho Explorations Limited, hampered by a lack of funds, continues inching toward production from its Montauban Twp. property 80 km west of Quebec City. It has acquired a 250 tpd mill and plans to begin test milling of development ore. Sigma Mines (Quebec) Limited carried out mining and metallurgical feasibility tests on the property held by Quebec Gold Belt Mines Limited east of Val d'Or. Sigma is looking at it as a possible source of mill feed. Long Lac Minerals Ltd.'s Silverstack Mine has nearly completed construction of a 1 000 tpd cyanide mill at the Doyon mine and Agnico-Eagle Mines Limited reports that construction of the Telbel shaft is proceeding well. Toward the end of 1982, some promising drill results were reported by Société québécoise d'exploration minière (SOQUEM) from the New Pascalis Mines Limited property near Val d'Or. This has encouraged a flurry of activity on adjacent claims, but more work is necessary before the significance of the area can be assessed.

Corporation Falconbridge Copper has spent $6.6 million on exploration of the Opawica property about 75 km southwest of Chapais. Underground exploration was begun to confirm drill indicated reserves of 635 000 t grading 6.377 g/t gold (diluted).

ONTARIO

The project that will become the largest gold mine in Canada, the Detour Lake Joint Venture, is proceeding as planned toward start-up at 2 000 tpd from the open-pit in mid 1983. Construction of the road connection from Cochrane commenced in 1982 and work on structures such as the mill building was completed. Stripping of the overburden from the open-pit will proceed during the winter of 1982-83.

At Dome Mines, Limited near Timmins, construction of the new 2 400 m shaft is proceeding as planned, as is work on the mill. When refurbishing of the mill is completed none of the old mill equipment, and very little of the original structure, will remain. In effect, the Dome will have a brand new 3 000 tpd mill.

At Kirkland Lake, Willroy Mines Limited, a member of the Lac Group of companies, has announced plans to sink a new shaft on the west section of the property that will open up a new block of ore reserves. Willroy is also considering a new mill. A proposal by the Lac Group to build a plant to reprocess tailings from Lake Shore Mines, Limited has been scaled down to include only test work, pending an improvement in the gold price. During 1982 the Lac Group took a number of steps in a corporate restructuring that will eventually combine mining, mineral exploration and oil and gas exploration and production in one company, Long Lac Minerals Ltd. The Lac Group had a much better financial year than most mining companies and is in the position to finance a substantial part of its development plans from retained earnings and cash flow.

Two grants were made under the Ontario government's BILD program to construct custom milling facilities. Tri-Con Custom Mining & Milling Co. Ltd. is building a mill near Beardmore, and Goldlund Mines Limited, which brought its property near Sioux Lookout into production in 1982, received a grant to enable it to complete its 200 tpd mill. Goldlund has agreed to custom mill test batches of ore or ore from small producers.

Dickenson Mines Limited which embarked on an ambitious, debt-financed mine and mill expansion program in 1980, experienced extreme cash flow problems due to lower gold production, lower gold price and high interest rates. This necessitated a corporate reorganization in which Sullivan Mining Group Ltd. became a major shareholder of Dickenson, with 35 per cent of the shares.

Pamour Porcupine Mines, Limited was forced by the low gold price in the first half of 1982 to scale down its activities in the Timmins area. Planned salvage operations at nearby properties were not undertaken, the No. 2 mine was closed and the workforce reduced from about 1 200 at the beginning of the year to 960 in August. Plans to suspend development at the Timmins property and to close the No. 3 mine were avoided through increased productivity and an improved gold price. Pamour was able to report a small profit for the third quarter of 1982.

Potentially the most interesting development during 1982 was the series of reports from the Hemlo area on Highway 17 east of Marathon. The initial discovery, by International Corona Resources Ltd., was optioned by Teck Corporation. The joint venture agreement requires Teck to provide financing to bring the property into production if the feasibility study that Teck is preparing is positive. Reported ore reserves for the east zone only are 1.18 million t grading 10.28 g/t. The west zone contains substantial additional tonnage of lower grade. In the same area, a joint venture between two junior mining companies, Golden Sceptre Resources Ltd. and Goliath Gold Mines Ltd., reported drill indicated reserves of 2.26 million t grading about 8.57 g/t. This property was optioned by Noranda Exploration Company, Limited which can earn a 50 per cent interest by completing a feasibility study within 6 months and placing the property into production at 900 tpd within a further 18 months. Mill capacity could be made available at Noranda's Geco operation. Exploration activity in the area has been strong and the Lac group is reported to have obtained interesting drilling results from its claims, the ownership of which is being contested. It is not possible to state at this time that a significant new gold camp is in the making but the indications are encouraging.

MANITOBA

During 1982 Brinco Limited assumed full ownership of the San Antonio property which began operating on January 4, 1982. Production was hampered during the first six months by mill tune-up problems and by the low gold price. Targeted production is 685 kg of gold per year. Sherritt Gordon Mines Limited optioned the Agassiz gold property. Reserves are estimated at 2 million t averaging 4.9 g/t gold and 10.3 g/t silver. Exploration is continuing.

BRITISH COLUMBIA

Carolin Mines Ltd., which began production at the end of 1981, was plagued by mill tune-up problems during early 1982 and gold output was below target. A spill of cyanide-laden effluent from the tailings pond into Ladner Creek forced the closure of operations from April until mid-June. As a result, the company encountered severe cash flow problems and had to seek refinancing. A $6 million loan was obtained from State Farm Mutual, with State Farm having the option of converting the loan into equity at $7.01 per share.

Scottie Gold Mines Ltd. also had to suspend operations at its Summit Lake property near Stewart due to leakage of cyanide-laden effluent from the tailings pond. Northair Mines Ltd., the operator and 21 per cent owner of Scottie, also suspended operations at the Brandywine multi-minerals property in response to low metal prices. This property has very limited reserves and may not reopen.

Exploration of gold properties near Hedley, Bridge River, Wells, and Quesnel and in the Toodogone River area continued through 1982 but in no case was a production decision announced. In most cases the

TABLE 4. PRINCIPAL GOLD (MINE) PRODUCERS IN CANADA IN 1982 AND (1981)

Company and Location	Mill or Mine Capacity	Grade of Ore Treated: Gold	Silver	Copper	Combined Lead and Zinc	Ore Treated	Gold contained in Concentrate	Remarks
	(tonnes of ore/day)	(grams/ tonne)	(grams/ tonne)	%	%	(tonnes)	(kilograms)	
NEWFOUNDLAND								
ASARCO Incorporated, (Buchans Unit), Buchans	1 100 (1 100)	.. (0.72)	.. (92.91)	.. (0.80)	.. (14.26)	.. (68 946)	.. (43.2)	New 350 000 t orebody may be brought into production if metal prices improve.
Consolidated Rambler Mines Limited, Baie Verte	1 100 (1 100)	n.a. (2.06)	n.a. (17.83)	n.a. (3.82)	n.a. (-)	n.a. (143 244)	n.a. (207.3)	Mine closed April 30 - ore depleted.
NEW BRUNSWICK								
Heath Steele Mines Limited, Newcastle	3 850 (3 850)	0.82 (0.69)	57.60 (51.43)	0.99 (0.91)	5.42 (5.39)	1 399 078 (1 249 928)	272.5 (229.8)	Mine shut down in May 1983 pending improvement of base metal prices. Mill is being used to treat gold-bearing ore from a surface gossan zone.
QUEBEC								
Agnico-Eagle Mines Limited, Joutel	1 000 (1 000)	6.14 (5.18)	1.03 (1.54)	- (-)	- (-)	317 220 (263 474)	1 788.2 (1 254.1)	Began development of adjacent Telbel property.
Bachelor Lake Gold Mines Inc. Desmaraisville	455 (455)	3.98 (6.68)	- (n.a.)	- (-)	- (-)	82 097 (n.a.)	290.2 (n.a.)	Began production early 1982.
Belmoral Mines Ltd. Ferderber Mill, Val d'Or	800 (800)	6.51 (5.55)	0.82 (0.69e)	- (-)	- (-)	213 134 (91 574)	1 351.8 (406.0)	Mill processes ore from Ferderber mine and Bras d'Or mine. Operations have been supervised by receiver for Continental Bank Illinois.
Camflo Mines Limited, Malartic	1 150 (1 150)	7.20 (4.03)	0.34 (0.15)	- (-)	- (-)	420 467 (420 027)	2 882.4 (1 591.4)	Workings being extended into adjacent Malartic Hygrade ground.
Campbell Resources Inc. Cedar Bay, Henderson and Merrill Pit copper-gold mines	3 175 (2 950)	2.61 (2.50)	6.82 (6.24)	0.99 (0.96)	- (-)	341 768 (330 791)	785.9 (705.6)	Mines closed Aug. 26-Nov. 15 due to low metal prices.
Gwillim gold mine, Chibougamau	180 (180)	4.83 (4.66)	4.87 (4.39)	0.10 (0.10)	- (-)	60 678 (63 177)	279.0 (280.1)	

Corporation Falconbridge Copper, Lake Dufault Division, Millenbach and Norbec mines, Rouyn-Noranda	1 450 (1 450)	0.62 (0.69)	13.37 (19.51)	2.90 (2.79)	0.70 (1.19)	324 129 (452 953)	144.5 (250.2)	Mines closed June 30 due to low metal prices; being maintained on a standby basis.
Corporation Falconbridge Copper, Opemiska Division Perry, Springer and Cooke mines, Chapais	2 600 (2 600)	1.30 (1.13)	10.63 (10.29)	1.59 (1.61)	- (-)	954 463 (849 630)	1 088.7 (751.8)	
Gaspé Copper Mines, Limited Copper Mtn. Mill	21 125 (27 125)	0.07 (0.07)	3.94 (3.94)	0.37 (0.34)	- (-)	4 779 533 (8 996 001)	47.2 (88.4)	Operations suspended June 30, resumed Aug. 15 at reduced rate. Mining suspended for at least six months on Dec. 15, but smelter continues to operate.
Needle Mtn. Mill Murdochville	3 720 (3 720)	0.07 (0.07)	5.90 (5.90)	1.65 (1.26)	- (-)	549 380 (1 064 641)	7.8 (17.7)	
Kiena Gold Mines Limited Val d'Or	n.a. (n.a.)	7.6 (n.a.)	1.41 (n.a.)	- (-)	- (-)	287 916 (101 233)	1 960.7	Ore treated at Lamaque mill. Statistics are mine production.
Lamaque Mining Company Limited Mine Ore	1 900 (1 900)	4.53 (3.19)	0.63 (0.58)	- (-)	- (-)	285 641 (370 826)	1 186.1 (1 071.9)	Mill feed increasingly from custom ore as mine reserves dwindling.
Custom Ore Val d'Or	- (-)	7.37 (4.46)	1.41 (0.69)	- (-)	- (-)	258 910 152 173	1 748.3 (613.9)	Ore mainly from Kiena mine.
Lac Minerals Group Est Malartic Mill Malartic	1 600 (1 000)	6.17 (6.79)	0.41 (0.51)	- (-)	- (-)	528 119 (527 015)	2 735.7 (3 392.6)	1981 figure revised. Custom milled ore from La Mine Doyon and Buckshot open pit.
Les Terrains Aurifères Malartic (Quebec) Limitée Mill Malartic	1 800 (1 800)	5.49 (6.07)	1.13 (0.65)	- (-)	- (-)	466 448 (582 333)	2 207.7 (3 353.2)	1981 figures revised. Custom mills ore from Mine de Bousquet, La Mine Doyon and Barnat mine.
La Mine Doyon Val d'Or	1 360 (-)	4.39 (-)	0.48 (-)	- (-)	- (-)	38 244 (-)	141.0 (-)	Doyon Mill began operating in November, 1982.
Mine de Bousquet Malartic	n.a. (n.a.)	5.59 (6.24)	.. (..)	- (-)	- (-)	393 175 (383 605)	219.2 (239.3)	Ore milled at Les Terrains Aurifères Malartic mill.
Les Mines Selbaie Selbaie Mill Joutel	1 500 (1 500)	1.71 (1.30)	34.29 (26.81)	3.36 (3.22)	0.86 (0.77)	470 351 (94 917)	722.3 (109.2)	Mine commenced production mid-1981.

Company and Location	Mill or Mine Capacity	Grade of Ore Treated Gold	Silver	Copper	Combined Lead and Zinc	Ore Treated	Gold contained in Concentrate	Remarks
	(tonnes of ore/day)	(grams/ tonne)	(grams/ tonne)	%	%	(tonnes)	(kilograms)	
QUEBEC (cont'd.)								
Mattagami Lake Mines Limited, Matagami	4 000 (4 000)	0.51 (0.62)	20.91 (19.58)	0.99 (0.75)	6.15 (4.85)	1 178 041 (1 203 444)	220.2 (230.4)	
Noranda Mines Limited Horne Mill (Chadbourne Circuit)	3 450 (3 450)	3.19 (3.15)	2.40 (3.33)	- (-)	- (-)	252 849 (217 604)	707.6 (600.1)	
(Gallen Circuit) Noranda	.. (..)	1.03 (1.06)	31.89 (33.94)	0.10 (0.12)	4.43 (3.14)	161 916 (34 548)	92.4 (16.9)	Mine commenced production November 1981.
Northgate Patino Mines Inc. Lemoine Mill, Chibougamau	325 (300)	2.23 (4.08)	42.51 (69.60)	2.34 (3.70)	5.93 (8.47)	111 117 (85 002)	215.1 (303.6)	
Copper Rand Mill	3 000 (3 100)	2.81 (2.54)	8.85 (9.12)	1.60 (1.64)	- (-)	663 262 (670 753)	1 562.9 (1 413.1)	
Sigma Mines (Quebec) Limited, Val d'Or	1 270 (1 270)	4.73 (4.05)	0.86 (0.77)	- (-)	- (-)	440 858 (441 980)	2 012.7 (1 745.1)	
ONTARIO								
Campbell Red Lake Mines Limited, Red Lake	975 (1 000)	20.33 (20.23)	2.06 (2.06)	- (-)	- (-)	355 521 (335 223)	6 110.6 (6 236.4)	
Dickenson Mines Limited, Red Lake	455 (635)	8.57 (5.44)	1.03 (1.68)	- (-)	- (-)	178 956 (171 906)	1 288.4 (776.4)	Sullivan Mining Group Ltd. acquired a 35 per cent share interest.
Dome Mines, Limited, South Porcupine	2 000 (1 800)	4.32 (4.66)	0.75 (0.75)	- (-)	- (-)	641 924 (505 483)	2 650.1 (2 274.2)	Mine expansion and rebuilding of mill to handle 3 000 tpd proceeding.
Falconbridge Limited Sudbury District	10 350 (10 342)	0.14 (0.07)	6.86 (3.43)	1.02 (1.01)	- (-)	1 559 178 (2 754 690)	109.0 (93.0)	Operations shut down due to low nickel prices from June 27, 1982 until January 3, 1983.
Goldlund Mines Limited Goldlund Mill	320 (..)	6.17 (..)	- (-)	- (-)	- (-)	15 483 (-)	75.5 (-)	

Inco Limited, Sudbury and Shebandowan districts	49 750 (49 450)	0.17 (0.17)	5.14 (4.46)	1.33 (1.28)	- (-)	3 991 571 (9 220 048)	416.7 (802.5)	Closed end May 1982. Scheduled to reopen April 1983.
Kerr Addison Mines Limited, Virginiatown	800 (1 225)	6.9 (6.75)	- (0.34)	- (-)	- (-)	292 144 (246 451)	1 698.0 (1 602.2)	Ore milled includes 37 143 t custom ore.
Kidd Creek Mines Ltd. Gold Ore Circuit Timmins	- (-)	2.85 (-)	7.95 (-)	- (-)	- (-)	98 150 (-)	213.4 (-)	Ore from Owl Creek open pit gold mine.
Noranda Mines Limited Geco Division Manitouwadge	4 000 (4 080)	0.10 (0.10)	45.60 (46.63)	1.59 (1.83)	3.51 (3.26)	1 350 734 (1 329 489)	86.3 (99.1)	
Pamour Porcupine Mines, Limited, Pamour Division Timmins	2 585 (2 720)	2.78 (2.54)	0.69 (0.69)	- (-)	- (-)	873 629 (921 289)	2 146.8 (2 053.3)	No. 2 mine closed, planned salvage operations at nearby mines not undertaken because of low gold price.
Schumacher Division Schumacher	2 720 (2 720)	3.43 (2.29)	4.56 (4.46)	- (0.23)	- (-)	765 746 (808 923)	2 215.4 (1 529.9)	Mining of copper zone suspended early in year.
Renabie Mines (1981) Limited Renabie Mill	455 (455)	6.51 (6.86)	2.40 (-)	- (-)	- (-)	142 609 (11 340)	705.9 (56.2)	
Willroy Mines Limited, Macassa Division, Kirkland Lake	300 (295)	16.05 (18.07)	2.13 (2.13)	- (-)	- (-)	106 601 (104 472)	1 659.6 (1 592.0)	New shaft planned to open up western portion of orebody.
MANITOBA - SASKATCHEWAN								
Hudson Bay Mining and Smelting Co., Limited,								
Flin Flon Mill	7 050 (7 050)	1.78 (1.30)	20.67 (19.95)	1.90 (1.58)	2.71 (2.24)	1 034 449 (983 990)	1 038.8 (678.0)	Closed for eight weeks ending August 23.
Snow Lake Mill	3 450 (3 450)	0.99 (1.03)	14.16 (12.41)	2.48 (2.56)	3.03 (2.79)	687 574 (771 427)	393.5 (430.2)	Closed for eight weeks ending August 23.
Inco Limited Thompson	12 700 (12 700)	0.10 (0.10)	5.14 (2.74)	0.14 (0.13)	- (-)	1 764 267 (1 801 391)	110.8 (117.2)	
Brinco Limited San Antonio Mine Bissett	400 (-)	5.01 (-)	0.86 (-)	- (-)	- (-)	78 191 (-)	286.1 (-)	Reopening of former producing San Antonio Mine.
Sherritt Gordon Mines Limited, Fox mine, Lynn Lake	2 700 (2 700)	0.48 (0.28)	14.06 (7.57)	1.76 (1.42)	1.77 (1.73)	427 695 (733 538)	109.2 (182.6)	Closed for 15 weeks beginning June 19.

Company and Location	Mill or Mine Capacity (tonnes of ore/day)	Grade of Ore Treated: Gold (grams/ tonne)	Silver (grams/ tonne)	Copper %	Combined Lead and Zinc %	Ore Treated (tonnes)	Gold contained in Concentrate (kilograms)	Remarks
MANITOBA-SASKATCHEWAN (cont'd.)								
Ruttan Mine Leaf Rapids	6 800 (6 800)	0.31 (0.25)	8.17 (7.31)	2.16 (1.30)	0.14 (1.25)	784 363 (1 702 809)	213.9 (379.4)	Closed for 15 weeks beginning June 19.
BRITISH COLUMBIA								
Afton Mines Ltd., Kamloops	7 700 (7 700)	0.34 (0.62)	3.60 (4.90)	0.58 (0.89)	- (-)	1 025 025 (2 324 121)	266.3 (1 103.4)	Mine closed by strike November 1981 - March 15, 1982. Mining suspended June 22 pending improved metal prices.
Brenda Mines Ltd. Peachland	27 220 (27 220)	0.02 (0.02)	1.20 (1.10)	0.14 (0.14)	- (-)	9 484 562 (10 119 317)	104.7 (112.0)	Operations suspended for a six week period from July 26.
Carolin Mines Ltd. Hope	1 360 (1 360)	3.19 (4.11)	0.21 (1.03)	- (-)	- (-)	237 734 (-)	251.3 (-)	Production commenced Jan. 1982. Operations closed April to mid-June due to spill from tailings pond.
Cominco Ltd. Bethlehem Copper Highland Valley	17 690 (17 690)	0.03 (0.03)	2.40 (2.40)	0.38 (0.39)	- (-)	3 112 829 (6 496 183)	48.8 (82.5)	Mining ceased July 1 because uneconomic at current prices.
Dankoe Mines Ltd. Keremeos	400 (400)	11.59 (0.48)	108.99 (190.29)	0.18 (-)	0.27 (0.21)	10 000 (37 743)	103.9 (15.6)	
Du Pont Canada Inc. Baker Mine	90 (90)	18.96 (19.20)	418.29 (381.26)	- (-)	- (-)	31 029 (16 726)	529.0 (278.3)	Limited reserves.
Erickson Gold Mining Corp., Cassiar	180 (110)	19.44 (12.86)	16.15 (7.10)	- (-)	- (-)	35 127 (34 695)	652.1 (423.7)	Milling rate increased 60 per cent to 180 tpd.
Esso Minerals Canada, Granduc Operating Division, Stewart	3 625 (3 625)	0.17 (0.17)	10.29 (10.29)	1.24 (1.44)	- (-)	510 229 (544 576)	67.2 (79.1)	Doubling of mining rate to 3 600 tpd postponed.
The Mosquito Creek Gold Mining Company Limited	91 (91)	13.17 (14.61)	4.22 (4.22)	- (-)	- (-)	21 874 (19 081)	259.1 (250.5)	
Newmont Mines Limited, Similkameen Division, Princeton	20 000 (20 000)	0.34 (0.34)	1.37 (1.37)	0.38 (0.40)	- (-)	6 742 833 (6 942 923)	622.5 (821.5)	Production from Copper Mountain open pit.

Noranda Mines Limited, Babine Division, Bell Copper Mine	15 875 (15 875)	0.19 (0.28)	0.62 (-)	0.37 (0.48)	- (-)	3 374 727 (5 429 531)	361.2 (968.6)	Closed for six weeks starting July 30 then closed indefinitely beginning Oct. 29.
Granisle Mine Babine Lake	11 975 (11 975)	0.21 (0.29)	1.71 (2.98)	0.42 (0.37)	- (-)	1 880 953 (3 832 518)	135.8 (284.5)	Operation "closed for one year" on July 1.
Northair Mines Ltd., Brandywine Mine Squamish	270 (270)	7.99 (7.92)	35.86 (28.63)	0.19 (0.15)	3.64 (3.24)	33 104 (62 548)	253.0 (474.6)	Operations suspended because of low metal prices. Reserves limited.
Placer Development Limited Equity Silver Mine Houston	5 700 (5 170)	1.44 (1.10)	121.71 (143.59)	0.39 (0.36)	- (-)	19 375 672 (1 909 905)	810.7 (641.9)	
Utah Mines Ltd., Island Copper Mine, Coal Harbour	38 100 (37 200)	0.21 (0.21)	1.37 (1.37)	0.43 (0.43)	- (-)	15 291 656 (14 157 525)	1 564.4 (1 622.8)	
Wesfrob Mines Limited Tasu	5 440 (5 440)	0.07 (0.08)	2.98 (3.09)	0.38 (0.32)	- (-)	1 108 115 (1 031 909)	74.2 (72.0)	Mine expected to close in 1983 due to depletion of ore reserves.
Westmin Resources Limited Buttle Lake,	900 (900)	2.74 (2.67)	127.89 (124.11)	1.06 (1.13)	8.39 (8.59)	287 579 (246 150)	670.6 (580.1)	Development of new H-W orebody in progress.
YUKON TERRITORY								
Cyprus Anvil Mining Corporation Faro	10 300 (9 300)	0.15 (0.15)	33.81 (42.00)	- (-)	7.50 (7.70)	1 643 983 (2 751 789)	213.0 (356.9)	Closed June 4. Reopening dependent on higher metal prices.
Hudson Bay Mining and Smelting Co., Limited Whitehorse Copper Division Whitehorse	.. (2 350)	.. (0.82)	.. (10.08)	.. (1.42)	.. (-)	.. (726 091)	.. (504.5)	Operations ceased at end of 1982 when viable tonnages were exhausted.
NORTHWEST TERRITORIES								
Cominco Ltd., Con and Rycon mines, Yellowknife	590 (590)	12.34 (14.06)	3.02 (3.43)	- (-)	- (-)	212 443 (175 994)	2 470.9 (2 326.5)	Company completed arsenic trioxide recovery plant to process accumulated residues.
Cullaton Lake Gold Mines Ltd.	270 (270)	14.23 (10.97)	0.62 (0.34)	- (-)	- (-)	66 123 (8 666)	700.2 (10.8)	Camchib Resources obtained an interest in the property and took over as on-site operator.

Company and Location	Mill or Mine Capacity	Grade of Ore Treated Gold	Silver	Copper	Combined Lead and Zinc	Ore Treated	Gold contained in Concentrate	Remarks
	(tonnes of ore/day)	(grams/ tonne)	(grams/ tonne)	%	%	(tonnes)	(kilograms)	
NORTHWEST TERRITORIES (cont'd)								
Discovery Mines Limited Camlaren Mill	n.a. (150)	n.a. (55.77)	n.a. (5.14)	- (-)	- (-)	n.a. (35 997)	n.a. (498.4)	Mine closed at end of 1981 season.
Echo Bay Mines Ltd. Lupin Bay	900 (n.a.)	9.26 (n.a.)	0.69 (n.a.)	- (-)	- (-)	183 842 (n.a.)	1 548.3 (n.a.)	Production commenced October 1981.
Giant Yellowknife Mines Limited, Yellowknife	1 100 (1 100)	8.57 (6.14)	1.37 (1.23)	- (-)	- (-)	317 515 (358 235)	2 332.6 (1 825.0)	Includes ore from Lolor Mines Limited property milled at Giant Mill.

Source: Federal/Provincial questionnaire survey of companies with producing mines in Canada. This data is supplied on a calendar year basis. In previous annual reviews most of the data were obtained from company annual reports based on the corporate fiscal year. Thus there are some discrepancies between the above statistics and those reported in the 1978 annual review.

- Nil; .. Not applicable; n.a. Not available.

requirement seems to be a stronger gold price. Placer mining in the Caribou, Cassiar, Omenica and Atlin areas was at lower levels in 1982 than in 1981.

YUKON

Placer mining, which reached boom proportions in the Dawson City and Mayo area during the summer of 1981, was much less active during the 1982 season. The spring months, when most of the preparatory work for placer mining such as the removal of the still partly frozen overburden must be done, coincided with the lowest levels for the year in the price of gold. The viability of many of the placer operations is arguable at best but it was generally agreed, following the 1981 season, that a base price of $US 400 per ounce was essential. With the price well below that level at the beginning of the season, some operators such as Copperfields Mining Corporation, a subsidiary of Teck Corporation, felt that it was more economic not to operate at all. Others operated at reduced rates. Operators with heavy debt loads incurred during previous seasons, mainly as a result of purchasing heavy duty earth moving equipment, were badly squeezed by high interest rates and there were a number of bankruptcies. Some of the heavy equipment was sent out of the Yukon to be leased for construction projects in the south. The water use issue continued to create friction, with the placer operators insisting that interference by the Department of Fisheries and Oceans over water use licenses was making an already difficult situation impossible and Fisheries insisting that, under the terms of the Fisheries Act, protection of the fisheries resource was paramount.

Companies have continued to examine lode gold properties but none have yet established sufficient reserves to warrant a production decision.

The Whitehorse Copper mine of Hudson Bay Mining and Smelting Co., Limited, which produced a significant amount of gold as a byproduct of copper production, closed permanently due to depletion of ore reserves at the end of December.

NORTHWEST TERRITORIES

The Northwest Territories gained a major new gold producer in October 1982 when the Lupin mine at Contwoyto Lake north of Yellowknife was brought into production by Echo Bay Mines Ltd., a wholly owned subsidiary of IU International Corporation. The mine has a designed capacity of 950 tpd with an average recovery rate of 92.5 per cent. The company expects to produce 3 575 kg of gold in 1983. Development work is continuing to establish reserves to the 370 m level from the present 200 m level.

Cullaton Lake Gold Mines Ltd. completed its first full year of production from its Cullaton Lake mine in the District of Keewatin west of Rankin Inlet. The Cullaton mill uses the carbon-in-pulp gold recovery process and, possibly because this process is relatively new to the Canadian gold mining industry, experienced more than the usual number of problems in obtaining satisfactory gold recoveries. Cullaton also experienced difficulty in meeting its debt servicing requirements. A corporate reorganization was undertaken in which Camchib Resources Inc. obtained an interest in the property and took over as the on-site operator.

In the Yellowknife area, gold production was from Cominco Ltd.'s Con mine and Giant Yellowknife Mines Limited's Giant mine. Giant did not produce from the Supercrest property in 1982. Reserves at the Salmita property were increased to 140 000 metric tons grading 28.02 g/t gold but a production decision has been delayed pending further review of technical and economic data and the securing of various licences and permits. Cominco Ltd. spent $13 million to complete an arsenic trioxide recovery plant that will process the 25 years accumulation of arsenic waste residues from the stack scrubber and roaster units. This will eventually eliminate the potential environmental hazard associated with surface storage of the waste, while producing a saleable product, arsenic trioxide (As_2O_3). Some gold and silver values will also be recovered.

The burst of gold mine development that followed the gold price explosion of 1979-80 has largely spent itself. There remains a strong interest in gold that will sustain the exploration activity that must take place if new gold mines are to be found and developed. Barring a major collapse of the gold price, Canada can probably expect the development of one or two new gold mines per year of between 500 and 1 000 tpd capacity for the remainder of the decade.

GOLD COINS

During 1982 the Royal Canadian Mint continued the Gold Maple Leaf bullion coin program. Sales for 1982 are estimated at

TABLE 5. GOLD MINE PRODUCTION IN THE NON-COMMUNIST WORLD

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
					(tonnes)						
South Africa	909.6	855.2	758.6	713.4	713.4	699.9	706.4	705.4	675.1	657.6	664.3
Canada	64.7	60.0	52.2	51.4	52.4	54.0	54.0	51.1	50.6	52.0	62.5
United States	45.1	36.2	35.1	32.4	32.2	32.0	31.1	29.8	30.2	42.5	43.5
Other Africa:											
Ghana	22.5	25.0	19.1	16.3	16.6	16.9	14.2	11.5	10.8	11.6	12.0
Zimbabwe	10.9	10.5	10.4	11.0	12.0	12.5	12.4	12.0	11.4	11.6	13.4
Other	1.7	1.7	1.5	1.5	1.5	1.5	2.0	2.5	8.0	12.0	15.0
Zaire	2.5	2.5	4.4	3.6	4.0	3.0	1.0	2.3	3.0	3.2	4.2
Total Other Africa	37.6	39.7	35.4	32.4	34.1	33.9	29.6	28.3	33.2	38.4	44.6
Latin America:											
Brazil	9.5	11.0	13.8	12.5	13.6	15.9	22.0	25.0	35.0	35.0	34.8
Colombia	6.3	6.7	8.2	10.8	10.3	9.2	9.0	10.0	17.0	17.7	15.5
Dominican Republic	-	-	-	3.0	12.7	10.7	10.8	11.0	11.5	12.8	11.8
Chile		3.2	3.7	4.1	3.0	3.0	3.3	4.3	6.5	12.2	18.9
Other	9.0	4.7	2.2	1.9	5.0	5.0	5.2	3.7	5.9	8.1	9.0
Peru	2.6	2.6	2.7	2.9	3.0	3.4	3.9	4.7	5.0	7.2	7.2
Mexico	4.6	4.2	3.9	4.7	5.4	6.7	6.2	5.5	5.9	5.0	5.2
Nicaragua	2.8	2.8	2.4	1.9	2.0	2.0	2.3	1.9	1.5	1.6	2.9
Total Latin America	34.8	35.2	36.9	41.8	55.0	55.9	62.7	66.1	88.3	99.6	105.3
Asia:											
Philippines	18.9	18.1	17.3	16.1	16.3	19.4	20.2	19.1	22.0	24.9	26.0
Japan	7.8	6.2	4.5	4.7	4.6	4.8	4.9	4.4	4.2	3.5	3.8
India	3.3	3.3	3.2	3.0	3.3	2.9	2.8	2.7	2.6	2.6	2.2
Other	2.7	2.7	2.7	2.7	3.0	3.0	3.0	3.0	3.0	3.8	3.6
Total Asia	32.7	30.3	27.7	26.5	27.2	30.1	30.9	29.2	31.8	34.8	35.6
Europe	13.2	14.3	11.6	11.0	11.4	13.2	12.5	10.0	8.6	8.5	10.6
Oceania:											
Papau/New Guinea	12.7	20.3	20.5	17.9	20.5	22.3	23.4	19.7	14.3	17.2	17.8
Australia	23.5	17.2	16.2	16.3	15.4	19.2	20.1	18.6	17.0	18.4	27.4
Other	3.2	2.8	2.2	2.2	2.3	1.8	1.1	1.0	1.0	1.1	1.2
Total Oceania	39.4	40.3	38.9	36.4	38.2	43.3	44.6	39.3	32.3	36.7	46.4
TOTAL	1 177.1	1 111.2	996.4	945.3	963.9	962.3	971.8	959.2	950.1	970.1	1 012.8

Source: Consolidated Gold Fields PLC, Gold 1983, p. 12.
\- Nil.

953,000 ounces, an increase over 1981. Part of this increase is attributed to the sale of one-quarter ounce and one-tenth ounce Gold Maple Leaf bullion coins which the Mint began marketing in November, 1982. These coins are aimed at the segment of the population that would like to own gold coins but cannot afford the fairly substantial outlay for a one ounce coin. The small Maple Leaves will compete directly with the highly successful mini Krugerrands and with the Mexican fractional weight gold coins.

In the numismatic field the Mint produced a 22 karat gold proof coin commemorating the patriation of the Constitution. The issue, with a face value of $100, was limited to 200,000 coins and the selling price was fixed at $C 290.

INTERNATIONAL DEVELOPMENTS

While the price of gold has remained at moderate levels compared to the highs of 1980, it has behaved much better than the prices of other metals which, with the exception of zinc, have achieved record lows. As a result, exploration and development activity that, with stronger demand, would have been allocated broadly across the metal mining spectrum has been focused on precious metals, and on gold more intensively than on silver. This investment activity suggests that the possibilities are good for increased gold production during the 1980s from areas of the world other than the Republic of South Africa.

Western world mine production of gold in 1982 was 1 013.5 t, an increase of 42.5 t or 4.35 per cent from the 971.1 t in 1981. Production from South Africa increased as did production from Canada, Australia and Chile, while most other gold-producing countries maintained levels similar to those recorded in 1981.

REPUBLIC OF SOUTH AFRICA

South African gold production in 1982 was 664.3 t, up 1 per cent from 1981 (Table 5). The increase was due mainly to higher mill throughput. This was sufficient to offset a decline in average grade. In the first half of 1982 the South African industry was faced with falling prices and steadily rising costs. This situation was partially offset by the fall in value of the rand against the dollar. The improvement in the gold price during the second half of 1982 was sufficient that even the marginal producers no longer required state assistance. Some development projects were suspended during 1982 but most capital projects were merely slowed rather than mothballed. No major new gold discoveries were reported in South Africa during 1982. It seems likely that new gold mining ventures will be expansions of existing mines rather than independent new developments. South African gold production has declined by about 27 per cent between 1972 and 1982 and seems likely to continue a gradual decline to the end of the century. Expansion programs and committed new mine development make a precipitous decline in the later 1980s, as forecast by the South African Chamber of Mines in 1979, seem less likely.

Australia

Australian gold production increased to 27.4 t in 1982 from 18.4 t in 1981. This 49 per cent increase was due to a combination of factors: increased throughput of ore and milling of higher grade ore at established mines and the commencement or resumption of production at a number of mines, mainly in the Golden Mile district of Kalgoorlie, Western Australia. As yet, no major new deposits have been identified that appear to warrant development for production. Additional reserves have been outlined on a number of producing and former producing properties. Australia produces a significant amount of gold as a byproduct of base-metal mining. Development of the Roxby Downs copper-gold-uranium orebody will contribute substantially to Australian gold production.

United States

Gold production in the United States during 1982 remained virtually unchanged from 1981. The increased output from new producers was offset by the loss of four months of production from the Homestake mine at Lead, South Dakota due to a strike and the loss of byproduct production from copper mines that were shut down due to low copper prices. Gold production in the United States has been enhanced by the discovery and development of a number of orebodies similar to the Carlin orebody, the first of the type to be developed. These orebodies are generally of low grade compared to North American averages but they are mineable by open-pit methods and in many cases have substantial tonnages of proven ore. The ore does not have to be crushed and ground as in conventional gold milling but can be loaded directly onto a pad which is then leached using a cyanide solution. Gold is recovered from the leach solution by carbon-in-pulp technology. The capital costs for such an operation are lower than for an underground mine and conventional gold mill, and the operating costs per ounce of gold produced are generally below $250, making such operations quite attractive at 1982 gold prices. New mines under development will add significantly to United States gold production in 1983-85.

The Philippines

Gold production in the Philippines increased in 1982 to 26 t, mainly due to an increase in alluvial gold production to 4 t that more than offset the loss of byproduct gold production from copper producers which suspended operation. Primary gold production increased slightly from 8.2 t to 9.4 t. The government has adopted a policy of buying all primary gold production to add to central bank reserves. A support price of $370 was maintained by the central bank during the period when market prices were below this level. Despite this, some small gold producers were unable to operate and the start-up of the Batong-Buhay mine, managed by Philex Mining Corporation was delayed. The Suriago mine opened in July.

Papua-New Guinea

Gold production in 1982 was 18 t of which 17.5 t was byproduct production from the Bougainville copper mine. The balance was alluvial output. Construction of the Ok Tedi gold-copper mine was delayed due to a drought that hampered movement of supplies by river. Initially Ok Tedi will produce about 15 t of gold per year.

U.S.S.R.

Gold production in the Soviet Union in 1982 was estimated by the United States Bureau of Mines (USBM) at 266 t. Sales from communist bloc countries were estimated at 207 t of which about 200 t probably came from the Soviet Union. While the Soviet Union releases very little information on its gold mining industry, it is believed that about two-thirds of production comes from placers in the Soviet Far East and East Siberia. Notes on the productivity of drag lines indicate that production from these placers has been steadily decreasing. A new mining province was created in Uzbekstan centred on the town of Navoi. Gold is one of the minerals produced in this area. Opening of a new underground gold mine was reported in Kazakhstan. Industrial demand for gold in the Soviet Union is reported to be increasing.

People's Republic of China

The People's Republic of China does not release statistics on gold production. However, the USBM estimates that production may be as high as 60 t, which is comparable to that of Canada. Like the Soviets, the Chinese treat gold production as a state secret, and while there is some reason to think that gold production is being stressed as a state priority and is increasing, it is difficult to estimate annual production. A number of foreign visitors have visited Chinese gold mines in recent years and it is from their reports that the picture of Chinese gold mining as somewhat similar both in scale and nature to that of Canada has emerged.

SALES FROM AND ADDITIONS TO OFFICIAL RESERVES

Official reserves transactions are becoming increasingly difficult to identify as countries are utilizing market mechanisms such as swap agreements to raise foreign exchange without irrevocably giving up part of their gold reserves. Canada sold outright 6 t of gold from official reserves and announced that further sales were planned.

A number of countries in Africa and South America purchased domestically produced gold to add to reserves. Purchases by Arab states were reduced from 1981 levels as these countries no longer had significant revenue surpluses. Given the weakened condition of most national economies in 1982, major gold purchases for official reserves in 1983 seem unlikely.

PRICES

The opening fixing of the London Gold Market on January 4, 1982 was $US 399. The price moved generally down from this point, reaching a low of $296.75 at the afternoon fixing on June 21. The gold market recovered fairly strongly from this low point, moving back into the $400 per ounce range by the end of August. In early September, with fear of default of international debt by several developing countries hanging over the international banking system, the gold price reached $488.50 at the morning fixing on September 7, which proved to be the high for the year. Efforts by the International Monetary Fund and the world banking community to assist the indebted countries to restructure their economy and reschedule debt and interest payments were sufficient to reassure nervous financial markets, and interest in gold as a secure investment diminished. The price of gold moved unsteadily downward until mid-November when a mild price rally developed that raised prices from the $400 to $450 level. The final fixing on December 31 was $448. The average for the year was $376.88 ($Cdn 465.10). These averages were substantially below those for 1981 and dramatically below those of 1980 (see Table 6).

TABLE 6. AVERAGE ANNUAL PRICE OF GOLD, 1970, 1975 AND 1978-82

	London Gold Market[1]	
	$US	equiv. $Cdn
		(per troy ounce)
1970	35.97	37.55
1975	161.018	163.781
1978	193.228	220.407
1979	306.686	359.289
1980	612.562	716.087
1981	459.715	551.178
1982	376.877	465.102

[1] Annual average of London Gold Market afternoon fixing price, as reported by Sharpes Pixley Ltd.

USES AND CONSUMPTION*

Use of new gold for jewellery, coin and industrial purposes increased in 1982 to 1 069 t from 1 032 t in 1981 due mainly to demand for gold for fabrication into jewellery. Consumer purchases in this area were brisk during the first half of the year when the price of gold was falling. However, during the second part of the year, with prices moving up toward $500 per ounce, consumer purchases diminished and were replaced by sales back to jewellers as that segment of jewellery purchasers that see it as an investment medium realized a return on their investment. In some European countries and Japan, the strength of the U.S. dollar made the price of gold high in terms of the local currency, and this encouraged dishoarding of old jewellery. This trend was particularly noticeable in Spain and Italy. In the Middle East, small gold bars are making inroads into the area of jewellery as an investment and jewellery purchasers are showing a preference for imported jewellery which is of superior craftsmanship to local products.

For the second year in a row, demand during the Christmas season in both Europe and North America was poor. Wholesalers kept strict control of inventories and there was no buildup to boost demand at the fabricator level. Throughout North America a process of attrition among marginal jewellery fabricators should eventually result in a stronger if less diverse manufacturing and retail sector.

In Japan, where platinum has been the favoured metal, gold jewellery is becoming more popular as consumers become accustomed to the combination of yellow gold with gemstones. The Japanese have also become fond of the mini-Krugerrands and 1/10 oz Gold Maple Leaf and have successfully incorporated them in jewellery designs. Gold jewellery items for both men and women and in a range from 9 to 18 carat alloys are widely available through mass-merchandising outlets, suggesting that gold is becoming accepted across a broad spectrum of the Japanese population.

Electronics

The effort to reduce the amount of gold used in high-technology applications for such purposes as electroplating contacts has progressed to the point where there are now substitutes such as silver/nickel and platinum/nickel alloys that are claimed to have life and reliability characteristics equivalent to gold. In Europe and North America, the development of thin-coating techniques has reduced the amount of gold per unit required. The trend toward microminiaturization and the development of microchips with greater capacity also reduces the consumption of gold. Therefore, despite overall growth in the electronics industry, consumpton of gold decreased from 88 t in 1981 to approximately 81 t in 1982. Given the intense level of competition in high technology industries, the probability is that this trend will continue.

Dentistry

Worldwide demand for gold for use in dental alloys diminished from 62 t in 1981 to 58 t in 1982. The gold content of dental alloys has been reduced over the years despite the fact that the new alloys are harder to work with and have a shorter useful life. In

* Much of the information in this section was obtained from Consolidated Gold Fields PLC, **Gold 1983.** It does not include Comecon countries or the People's Republic of China due to lack of data.

developed countries, increasing emphasis on dental care at first lead to greater use of dental alloys containing gold for repairs. Now dental hygiene programs may be reducing the need for gold by decreasing the incidence of dental carries. In developing countries where comprehensive dental services are not available to the majority of the population, use of gold dental alloys is small.

Miscellaneous

Use of gold in various miscellaneous applications such as gold leaf, gold use for industrial and decorative plating, and liquid gold used to decorate glass and ceramics dropped from 64 t in 1981 to 59.4 t in 1982. Consumption was down in most areas of decorative use due to poor economic conditions. Substitution affected use in high-temperature brazing alloys.

Fabrication of medals, medallions and fake coins increased from 28 t in 1981 to 39 t in 1982. In the United States, sales of medallions under the American Arts Commemorative Series medallion program improved. The program is to be continued in 1983 with the distribution being handled by commercial agencies rather than by the government. Fake coins and medallions are still popular in the Middle East, although bullion coins and small gold bars appear to be capturing an increasing share of the investment/trading market.

Major producers of official coins were South Africa, Canada and the United Kingdom. Sales of the South African Krugerrand were strong in the early part of the year but dwindled as the price of gold rose and ended the year at 80 t, 28 per cent below the level of 1981. Large quantities of coins were sold back as the price increased, indicating that the public has learned to use coins as a trading vehicle. Sales of the Gold Maple Leaf increased in 1982 due to an international marketing campaign and the introduction of the 1/4 and 1/10 ounce coins in time for Christmas. The United Kingdom began minting half sovereigns to compete with the smaller South African and Canadian coins. Mexico minted no bullion coins but sold about 7 t from inventory. A number of other countries minted commemorative numismatic coins.

Investment Demand

Investment demand includes jewellery purchases (in developing countries), hoarding of bars and bullion coins, and investor demand which includes futures trading as well as metals purchases on account. In eastern countries the practice of buying relatively crude but high carat, low markup jewellery as a means of investing in portable gold is a longstanding practice rooted in culture. There are indications, however, that a taste for more sophisticated jewellery is developing and that coins and small bars that are in some cases incorporated into jewellery items, are becoming accepted forms of gold investment. Bar hoarding in 1982 amounted to 294 t with 65 t in the Middle East and 220 t in the Far East including Japan. The Japanese market absorbed 73 t and Indonesia 71 t. In the Middle East the largest accumulations were in Saudi Arabia and the Yemen which between them accounted for 35 t. There is now a substantial kilobar stock in Saudi Arabia which is hoarded and traded by local businessmen.

Institutional and large scale investor demand remained dormant during the first half of 1982. Consolidated Gold Fields estimates that about 300 t of disinvestment selling took place as the price fell. Some buying took place during the price low in June-July but this was probably liquidated during the price run-up in September. The development of metal accounts, which eliminate the need to hold physical metal and also escape transaction taxes on gold, has made it possible to trade profitably on small price movements.

Volumes traded on gold futures markets, mainly in the United States, continued to increase. Persistent short selling by speculators in this market helped to depress the price below $300 in June despite strong physical purchases of small bars, jewellery and bullion coins at that time. The volume of trading in these markets can have a disproportionate effect on price, thereby increasing the volatility of the market and thus the difficulties faced by producers and consumers. Some producers and consumers are now beginning to hedge purchases and sales by covering them with contracts in the futures market.

OUTLOOK

The complexity of the factors affecting the price of gold defy easy analysis. Based on recent past performance, it seems that high interest rates have a stronger effect on keeping the price down than high inflation has on forcing the price up. In North America and Europe, deflationary policies and resulting easing in interest rates in the latter part of 1982 did not trigger any particular resurgence of interest in the gold market. In so far as supply is concerned, as long as the speculative market remains quiescent, there does not appear to be a major supply-demand imbalance. New production plus some sales from reserves plus sales from the East Bloc will likely meet demand from industrial users, jewellery fabricators, hoaders, central banks and investors. This at least is the position taken by one group of forecasters that includes South African producers, Swiss bankers and precious metals dealers. Another group of forecasts based on analysis of economic indicators, anticipates a new bout of inflation that will trigger another spike in the gold price which it estimates might peak in the $3,000 per ounce range.

It is now fairly clear that, despite the ups and downs of the price, there is money to be made in gold mining. This ensures that people will look for gold deposits which they will then attempt to turn into mines. Also, base-metal deposits with precious metals values will often be more attractive to developers than those without. In short, the decline in world gold production has likely been halted, and a small increase may actually occur.

Gypsum and Anhydrite

D.H. STONEHOUSE

SUMMARY 1982

During 1982 crude gypsum production was as much as 30 per cent below the 1981 level, as demand in the United States was unusually low. Canadian wallboard manufacture was approximately 25 per cent less than in 1981. Increased demand from U.S. consumers resulted in an active fourth quarter and total production of crude gypsum was down only 12 per cent at year-end. The Canadian industry operates eleven open-pit mines and three underground mines with a total crushing capacity of about 35 000 tpd. Gypsum products are produced at 18 plants across Canada. Total wallboard production capacity is not published but most plants are capable of producing between 10 and 15 million square metres a year. Competition is keen in eastern Canada where the capacity/demand ratio for gypsum products is high. Gypsum products have limited market range because of the weight, transportation costs, friability and low unit cost. Imports penetrate the Canadian market from some large U.S. producers and exports to the U.S. are made principally from Ontario and Quebec plants. Records indicate 349 850 m^2 were imported in 1982 while 14 384 530 m^2 were exported.

Reduced activity in the building construction sector contributed to the CGC Inc. decision to close its St. Jerome, Quebec plant at mid-year and to Domtar Inc.'s decision to suspend production at its Montreal East plant at the end of March, 1983.

Byproduct gypsum is formed during the acidulation of phosphate rock in phosphate fertilizer manufacture, during the acidulation of fluorspar to form hydrofluoric acid and during the use of lime or limestone to desulphurize smelter and thermal power plant gas. Such byproduct material is not used in the production of gypsum products in Canada.

THE CANADIAN SCENE

Gypsum production in Canada is in direct response to demand from the wallboard industries in Canada and the United States, which in turn satisfy demand from the building construction sector for residential, institutional and commercial construction projects. The fire retardant qualities of gypsum wallboard have encouraged its greater application in the non-residential area in recent years. This, together with increasing amounts used in renovation of older buildings, has made housing starts a less-than-accurate indicator of wallboard demand.

Canadian production of crude gypsum is mainly from Atlantic Canada where major deposits, principally in Nova Scotia and Newfoundland, have been worked for many years by Canadian subsidiaries of U.S. gypsum products producers. The region accounts for over 75 per cent of Canadian gypsum production and for the major portion of exported gypsum which usually is about 70 per cent of total production. Shipments are made from quarries in the Atlantic Region to wallboard plants and portland cement plants in Quebec and Ontario. New Brunswick production is used locally by a cement producer, Ontario production is used on site except for that from the new Westroc Industries Limited mine at Drumbo which is shipped to its Mississauga wallboard plant. Manitoba production, and output from Windermere and Falkland in British Columbia, supply the prairie and British Columbia markets. Imports from Mexico and from the United States are used by both wallboard and cement producers in British Columbia.

Because gypsum is a relatively low cost, high-bulk mineral commodity it is generally produced from deposits situated as conveniently as possible to areas in which markets for gypsum products exist. Exceptions occur if deposits of unusually high

TABLE 1. CANADA, GYPSUM PRODUCTION AND TRADE, 1981 AND 1982

	1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)
Production (shipments)				
Crude gypsum				
Nova Scotia	4 993 000	29,458	4 290 000	27,738
British Columbia	685 000	5,805	416 000	5,468
Ontario	613 000	5,231	506 000	4,506
Newfoundland	512 000	3,824	416 000	3,321
Manitoba	202 000	2,450	88 000	1,492
New Brunswick	20 000	87	10 000	52
Total	7 025 000	46,855	5 726 000	42,577
Imports				
Crude gypsum				
Mexico	126 166	3,467	83 102	2,806
United States	17 217	394	10 742	264
Hong Kong	117	2	-	-
Total	143 500	3,863	93 844	3,069
Plaster of paris and wall plaster				
United States	18 592	3,295	18 627	3,654
France	126	36	175	34
United Kingdom	32	35	15	3
Italy	46	19	16	3
Other countries	54	12	93	30
Total	18 850	3,397	18 926	3,724
	(square metres)		(square metres)	
Gypsum lath, wallboard and basic products				
United States	461 498	806	349 862	643
West Germany	1 114	2	-	-
Total	462 612	808	349 862	643
Total imports gypsum and gypsum products		8,068		7,436
	(tonnes)		(tonnes)	
Exports				
Crude gypsum				
United States	5 080 635	27,551	4 775 755	28,716
Bahamas	14 238	107	-	-
Total	5 094 873	27,658	4 775 755	28,716
	(square metres)		(square metres)	
Gypsum lath, wallboard and basic products				
United States	10 630 619	8,287	13 808 168	12,898
Netherlands	331 432	358	-	-
Saudi Arabia	201 236	325	224 500	576
Other countries	281 065	312	351 862	446
Total	11 444 352	9,282	14 384 530	13,920
Total exports of gypsum and gypsum products		36,940		42,636

Sources: Energy, Mines and Resources Canada; Statistics Canada.
P Preliminary; - Nil.
N.B. Totals may not add due to rounding.

quality are available, even at a somewhat greater distance from markets, if comparatively easy and inexpensive mining methods are applicable, or if low-cost, high-bulk shipping facilities are accessible. Nova Scotia and Newfoundland deposits meet all three of these criteria and have been operated for many years by, and for, United States companies in preference to United States deposits.

In Canada occurrences besides those currently 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, and Loos 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.

THE WORLD SCENE

Gypsum occurs in abundance throughout the world but, because its use is dependent on the building construction industry, developments are generally limited to the industrialized countries. Reserves are extremely large and are conservatively estimated at over 2 billion t.

TABLE 2. CANADA, SUMMARY OF GYPSUM MINING OPERATIONS, 1982

Company	Location	Remarks
Newfoundland		
Flintkote Holdings Limited	Flat Bay	Open-pit mining of gypsum
Nova Scotia		
Little Narrows Gypsum Company Limited	Little Narrows	Open-pit mining of gypsum and anhydrite
Georgia-Pacific Corporation		
Bestwall Gypsum Division	River Denys	Open-pit mining of gypsum
Fundy Gypsum Company Ltd.	Wentworth and Miller Creek	Open-pit mining of gypsum and anhydrite
National Gypsum (Canada) Ltd.	Milford	Open-pit mining of gypsum
Domtar Inc.	MacKay Settlement	Open-pit mining of gypsum
New Brunswick		
Canada Cement Lafarge Ltd.	Havelock	Open-pit mining of gypsum used in cement manufacture
Ontario		
CGC Inc.	Hagersville	Underground mining of gypsum
Domtar Inc.	Caledonia	Underground mining of gypsum
Westroc Industries Ltd.	Drumbo	Underground mining of gypsum
Manitoba		
Domtar Inc.	Gypsumville	Open-pit mining of gypsum
Westroc Industries Ltd.	Amaranth	Open-pit mining of gypsum
British Columbia		
Western Gypsum Ltd.	Windermere	Open-pit mining of gypsum
Canada Cement Lafarge Ltd.	Falkland	Open-pit mining of gypsum

The United States is the world's largest single producer of natural-gypsum and, together with Canada, brings North American production to about 30 per cent of world output.

TRADE

In general, gypsum products are not shipped great distances because freight and handling costs for these relatively inexpensive building materials can become excessive. Markets are usually supplied by the closest producer. There are exceptions to this situation, however, and on occasion imports of wallboard from the United States, particularly into Ontario, Alberta and British Columbia, have been significant. During the last few years these imports have been reduced greatly while exports have shown an increase. Companies well situated for export trade are shipping some products offshore.

USES

Gypsum is a hydrous calcium sulphate ($CaSO_4.2H_2O$) which, when calcined at temperatures ranging from 120° to 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 product. Gypsum is the main mineral constituent in gypsum wallboard, lath and tile. Anhydrite, an anhydrous calcium sulphate ($CaSO_4$), is commonly associated geologically with gypsum.

TABLE 3. CANADA, SUMMARY OF GYPSUM PRODUCTS OPERATIONS, 1982

Company	Location	Remarks
Newfoundland		
Atlantic Gypsum Limited	Corner Brook	Gypsum products manufacture
Nova Scotia		
Domtar Inc.	Windsor	Gypsum plaster manufacture
Quebec		
CGC Inc.	Montreal	Gypsum products manufacture
CGC Inc.	St.-Jerome	Gypsum products manufacture Closed mid-1982
Domtar Inc.	Montreal	Gypsum products manufacture
Westroc Industries Ltd.	Ste. Catherine d'Alexandrie	Gypsum products manufacture
Ontario		
CGC Inc.	Hagersville	Gypsum products manufacture
Domtar Inc.	Caledonia	Gypsum products manufacture
Westroc Industries Ltd.	Clarkson	Gypsum products manufacture
Manitoba		
Domtar Inc.	Winnipeg	Gypsum products manufacture
Westroc Industries Ltd.	Winnipeg	Gypsum products manufacture
Saskatchewan		
Genstar Corporation	Saskatoon	Gypsum products manufacture
Alberta		
Domtar Inc.	Calgary	Gypsum products manufacture
Westroc Industries Ltd.	Calgary	Gypsum products manufacture
Genstar Corporation	Edmonton	Gypsum products manufacture
British Columbia		
Westroc Industries Ltd.	Vancouver	Gypsum products manufacture
Domtar Inc.	Vancouver	Gypsum products manufacture
Genstar Corporation	Vancouver	Gypsum products manufacture

Crude gypsum is crushed, pulverized and calcined to form stucco, which is mixed with water and aggregate (sand, vermiculite or expanded perlite) and applied over wood, metal or gypsum lath to form interior wall finishes. Gypsum board, lath and sheathing are formed by introducing a slurry of stucco, water, foam, pulp and starch between two unwinding rolls of absorbent paper, the result is a continuous "sandwich" of wet board. As the stucco hardens, the board is cut to predetermined lengths, dried, bundled and stacked for shipment.

Keene's cement is made by converting crushed gypsum to insoluble anhydrite by calcining at temperatures as high as 700°C, usually in rotary kilns. The ground calcine, mixed with a set accelerator, produces a harder and stronger plaster product than ordinary gypsum plaster.

Crude gypsum is also used in the manufacture of portland cement where it acts as a retarder to control set. It is used as a filler in paint and paper manufacture, as a substitute for salt cake in glass manufacture and as a soil conditioner.

Byproduct gypsum, produced from the acidulation of phosphate rock in phosphate fertilizer manufacture, has not been utilized in Canada despite available technology from European countries and from Japan. In these countries, byproduct gypsum is used in the manufacture of gypsum products, by cement manufacturing plants, and also for soil stabilization. Recent studies have indicated that a potential radiation hazard exists in the use of phosphogypsum produced from sedimentary phosphate rock which can contain significant quantities of uranium and radium. Methods of extracting U_3O_8 from the phosphoric acid product have been devised, but removal of radium from the byproduct phosphogypsum is yet to be accomplished.

The use of lime or limestone to desulphurize stack gases from utility or industrial plants burning high-sulphur fuel will also result in production of large amounts of waste gypsum sludge, which in itself will present disposal problems if profitable uses are not developed.

Canadian Standards Association (CSA) standards A 82.20 and A 82.35 relate to gypsum and gypsum products.

TABLE 4. WORLD PRODUCTION OF GYPSUM, 1981 AND 1982

	1981	1982[e]
	(000 tonnes)	
United States	10 430	10 160
Canada	7 800	7 530
France	6 305	5 806
U.S.S.R.	5 443	5 443
Spain	5 198	5 171
Iran	5 987	5 443
United Kingdom	3 103	2 994
West Germany	2 250	1 996
People's Republic of China	3 447	3 447
Mexico	1 883	1 724
Italy	3 992	3 810
Other market economy countries	18 356	18 325
Other central economy countries	2 900	2 540
World total	77 094	74 389

Sources: Energy, Mines and Resources Canada; United States Bureau of Mines Mineral Commodity Summaries, January 1983.
[e] Estimated.

TABLE 5. CANADA, GYPSUM PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975, 1978-82

	Production[1]	Imports[2]	Exports[2]	Apparent Consumption[3]
	(tonnes)			
1970	5 732 068	35 271	4 402 843	1 364 496
1975	5 719 451	55 338	3 691 676	2 083 113
1978	8 074 441	70 995	5 178 631	2 966 805
1979	8 098 166	152 953	5 474 765	2 776 354
1980	7 336 000	154 717	4 960 240	2 530 477
1981	7 025 000	143 500	5 094 873	2 073 627
1982P	5 726 000	93 844	4 775 755	1 044 089

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.
P Preliminary.

TABLE 6. CANADA, HOUSE CONSTRUCTION, BY PROVINCE, 1981 AND 1982

	Starts			Completions			Under Construction		
	1981	1982	% Diff.	1981	1982	% Diff.	1981	1982	% Diff.
Newfoundland	3 210	2 793	-13.0	3 936	2 331	-40.8	2 966	3 373	13.7
Prince Edward Island	203	248	22.2	320	98	-69.4	48	196	308.3
Nova Scotia	3 715	3 691	- 0.6	4 374	3 174	-27.4	2 052	2 506	22.1
New Brunswick	2 188	1 680	-23.2	2 477	1 427	-43.4	978	1 122	14.7
Total (Atlantic Provinces)	9 316	8 412	- 9.7	11 107	7 030	-36.7	6 044	7 197	19.1
Quebec	29 645	23 492	-20.8	30 691	21 526	-29.9	12 815	14 164	10.5
Ontario	50 161	38 508	-23.2	45 557	40 437	-11.2	34 071	31 009	-8.9
Manitoba	2 824	2 030	-28.1	4 515	1 633	-63.8	764	1 149	50.4
Saskatchewan	5 972	6 822	14.2	8 085	5 666	-29.9	3 864	4 583	18.6
Alberta	38 470	26 789	-30.4	34 755	31 364	- 9.8	22 960	17 663	-23.1
Total (Prairie Provinces)	47 266	35 641	-24.6	47 355	38 663	-18.4	27 588	23 395	-15.2
British Columbia	41 585	19 807	-52.4	40 286	26 286	-34.8	22 311	13 290	-40.4
Total Canada	177 973	125 860	-29.3	174 996	133 942	-23.5	102 829	89 055	-13.4

Source: Canada Mortgage and Housing Corporation.

TABLE 7. CANADA, VALUE OF CONSTRUCTION[1] BY TYPE, 1981-83

	1981	1982	1983
		($ millions)	
Building Construction			
Residential	16,365	13,342	14,414
Industrial	3,498	2,966	2,569
Commercial	6,986	6,868	5,979
Institutional	2,571	2,896	3,114
Other building	2,117	2,135	2,026
Total	31,537	28,207	28,102
Engineering Construction			
Marine	377	459	465
Highways, airport runways	4,092	4,304	4,306
Waterworks, sewage systems	2,145	2,295	2,421
Dams, irrigation	300	260	264
Electric power	4,801	5,428	5,722
Railway, telephones	1,870	2,067	1,977
Gas and oil facilities	7,110	7,440	8,186
Other engineering	4,652	5,283	4,101
Total	25,347	27,536	27,442
Total construction	56,884	55,743	55,544

Source: Statistics Canada.
[1] Actual expenditures 1981, preliminary actual 1982, intentions 1983.

OUTLOOK

Building construction expenditures were \$32.6 billion in 1982 up from \$31.3 billion in 1981. Total construction was valued at about \$60 billion in 1982. Construction of homes, apartments, schools and offices will continue in the building construction sector and the need for gypsum-based building products will rise steadily. Although new construction materials are being introduced, gypsum wallboard will remain popular because of its low price, ease of installation and well-recognized insulating and fire-retarding properties. The present structure of the gypsum industry in Canada is unlikely to change greatly in the near future. Building materials plants either have sufficient capacities to meet the short-term, regional demand for products, or are implementing expansion programs to provide greater capacity.

Housing starts could increase to about 150,000 in 1983 with the encouragement offered by federal and provincial incentives to first-time homebuyers, especially if mortgage interest rates become attractive.

The Canadian Construction Association predicts slow recovery in the non residential building sector through the next two years and about 4 per cent real growth in the heavy construction sector to 1984. The capital investment intentions of major Canadian companies for 1983 and beyond were adjusted downward by some 8 per cent in real terms during 1982 as caution and uncertainty prevailed.

ANHYDRITE

Production and trade statistics for anhydrite are included with gypsum statistics. Anhydrite is produced by Fundy Gypsum Company Limited at Wentworth, Nova Scotia, and by Little Narrows Gypsum Company Limited at Little Narrows, Nova Scotia. According to the **Nova Scotia Annual Report on Mines 1982,** production of anhydrite in that year was 122 477 t. Most of this 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 Scotia anhydrite.

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
29200-1	Gypsum, crude	free	free	free	free
29300-1	Plaster of paris, or gypsum, calcined, and prepared wall plaster, weight of package to be included in weight for duty; per hundred pounds	free	5.3¢	12.5¢	free
29400-1	Gypsum, ground, not calcined	free	free	15%	free
28410-1	Gypsum tile	12.8%	12.8%	25%	8.5%

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
29300-1	5.3¢	5.0¢	4.8¢	4.5¢	4.3¢	4.0¢
28410-1	12.8%	12.1%	11.4%	10.7%	9.9%	9.2%

UNITED STATES (MFN)

512.21	Gypsum crude	free

		1982	1983	1984	1985	1986	1987
512.24	Gypsum, ground calcined, per ton	53¢	50¢	48¢	46¢	44¢	42¢
245.70	Gypsum or plastic building boards and lath, ad valorem	4.7%	4.2%	3.8%	3.3%	2.9%	2.4%

Sources: The Customs Tariff and Commodities Index, January 1982, Revenue Canada; Tariff Schedules of the United States Annotated 1982, USITC Publication 1200; U.S. Federal Register, Vol. 44, No. 241.

Indium

J. BIGAUSKAS

Indium occurs as a minor constituent of certain ores of zinc, lead, tin, tungsten and iron. It is commonly associated with sphalerite, the major zinc mineral. Commercial indium is recovered mainly from flue dust and residues of zinc smelting operations, but some indium is also recovered from lead smelting. It is recovered at only a few of the world's zinc and lead smelters.

Cominco Ltd. is the only Canadian company which recovers indium. Other major producers of indium are located in the United States, Japan, West Germany, Australia, Peru and Belgium. Statistical data on output and consumption of indium in these countries is lacking, but world refinery production is variously estimated at 50 to 100 tpy.

PRODUCTION

In Canada, indium was first recovered from the smelting operations of Cominco at Trail, British Columbia. The presence of indium in the lead-zinc-silver silver ores of Cominco's Sullivan mine at Kimberley, British Columbia, had been known for many years. In 1942, 13.6 kg were produced by laboratory methods. After a decade of intensive research and development, commercial production began in 1952.

Cominco produces both a standard grade (99.97 per cent) and a high-purity grade (approximately 99.999 to 99.9999 per cent indium). The metal is cast into ingots varying in size from 0.3 kg to 10 kg, and some is processed further into fabricated forms such as discs, wire, ribbon, foil, sheet, powder and spherical pellets. Alloys and chemical compounds of indium, such as indium antimonide, are also produced. These products are sold in the United States through Cominco American Incorporated.

PROPERTIES AND USES

Indium is a silver-white metal that resembles tin in its physical and chemical properties. Its chief characteristics are extreme softness, low melting point and high boiling point. The metal has a melting point of 156°C, boiling point of 2 000°C and atomic weight of 114.8. Its specific gravity at 20°C is 7.31 which is about the same as that of iron.

Indium forms alloys with precious metals and many base metals. A major application is low-melting alloys which can be designed to fit a particular melting point requirement by varying the indium content in the alloy. Indium alloys are also used as solders.

The electronic industry is an important consumer of indium, especially in germanium transistors, diodes and rectifiers. Growth in this field is limited by the increased use of substitutes. Indium is used as coatings or plating for aluminum wire junctions, bearings, dental alloys and for protective finishes on jewellery and silverware. A silver-cadmium-indium alloy is used in nuclear reactor control rods. Alloys of indium are used as holding parts in the machining, grinding and polishing of glass lenses and ceramics. A relatively large quantity of indium is consumed in research and development for new applications.

DEVELOPMENTS

In early 1980 the leading sellers, Indium Corp. of America and Cominco American Incorporated, raised the price of indium from \$18.50 US to \$20 per troy ounce. After July, weakening demand and increased competition from abroad forced the price leader, Indium Corp., into a series of five price cuts. On December 19, 1980, Indium Corp.'s list price was set at \$10.75 after a final price cut of \$1.50. Indium Corp. continued to reduce the price of indium in

1981 a further 33 per cent by May 1981. The company's list price then stabilized until early November when the price was cut from $6.75 to $5.90. Weak demand and competition from low-priced Japanese and Chinese imports were cited as reasons for the decline. During 1982 the indium market continued to be depressed. Other producers sold below Indium Corp.'s listed price and forced further large price cuts until September 21 when the price hit $US 2.85 per troy ounce. A final 25¢ discount was made with the arrival of a new entrant in the indium metal market, Arconium Corp. of America of Providence, RI. Prior to beginning worldwide marketing of indium metal, Arconium produced indium from zinc slag and indium-bearing scrap for the in-plant manufacture of fusible alloy products. Although production capacity is not known, Arconium has stated that its refinery capacity exceeds North American indium consumption, which is about 25 tpy. The company will be producing 99.99 per cent pure indium in 5,000 troy ounce lots. The move surprised market observers since existing capacity already exceeds world demand.

PRICES

Indium prices as quoted by Metals Week.

Effective Date	U.S. ingots[1] $US per troy ounce
November 2, 1981	5.90
February 15, 1982	5.13
April 27	4.00
September 21	2.85
November 4	2.60

[1] 99.97 per cent purity, 100-oz bars in lots of 10 000 oz, delivered.

TARIFFS

Canada - Not specifically enumerated in Canadian tariffs.

United States - Customs Tariffs

Item No.		1982	1983	1984	1985	1986	1987
		(per cent)					
628.45	Metal, unwrought, waste and scrap[1]	1.4	1.1	0.8	0.6	0.2	Free
628.50	Metal, wrought	7.0	6.3	5.6	5.0	4.3	3.6
423.96	Indium compounds	3.1	2.5	1.9	1.2	0.6	Free

Source: Tariff Schedules of the United States Annotated 1982, USITC Publication 1200; U.S. Federal Register Vol. 44, No. 241.

[1] Duty on waste and scrap temporarily suspended.

Iron Ore

M.A. BOUCHER

Shipments of Canadian iron ore in 1982, at 34.5 million t dry weight and valued at $1,211,657,000 showed a severe decline from the already depressed level of the previous year. Shipments in 1981 were 49.5 million t valued at $1,748,112,000. The reduced output was a reflection of the worldwide economic recession that weakened demand for iron and steel products. A modest decrease in demand was forecast early in the year but a major downturn developed by late-summer. In light of shrinking demand and rapidly increasing inventories, Canadian mines adjusted production by temporary closures and reduced operating rates. As a result, the industry operated at about 50 per cent of annual capacity, approximating output levels of a decade earlier.

CANADIAN DEVELOPMENTS

The Quebec-Labrador producers operated at normal levels until late-June when a series of closures began for the summer vacation interval. A further decline in the market for iron ore led to extended shutdowns of 3 to 5 months during the latter half of the year.

The Iron Ore Company of Canada (IOC) closed its Carol Lake operation from June 21 to September 1. Production resumed at a reduced annual rate of 6.5 million t of concentrate and 6 million t of pellets, down from 6.9 and 7.5 million t respectively. The work force was reduced to about 2,000, down from 2,700 prior to the closure.

Direct shipping ore was mined at Schefferville for a shortened summer season of 19 weeks. In November, IOC announced plans to permanently close the Schefferville operation, which was to be completed by July 1983, as a result of declining markets for direct shipping ore.

Wabush Mines closed its mine at Wabush and the pellet plant at Pointe Noire from June 28 to November 1, affecting about 1,000 employees.

Quebec Cartier Mining Company closed the Mount Wright mine from July 20 to September 28, and again from November 8 until January 10, 1983. Production during October was at about one-half the rated capacity.

The Fire Lake mine of Sidbec-Normines Inc. was closed from June 30 to August 24. A second closure was in effect from November 8 until February 2, 1983. Sidbec-Normines is 50.1 per cent owned by Sidbec, the Quebec government-owned steel producer. In view of the serious financial difficulties faced by Sidbec, a Quebec National Assembly legislative committee met on November 10-11 to hear submissions on the future of the company. The matter was still under review at year-end.

Most Ontario producers closed their iron ore mining operations for two to three months during the latter half of the year, reflecting the downturn in demand for steel and efforts to reduce iron ore inventories. The Adams mine, owned by Dofasco Inc., was closed from June 26 to August 3, and again from October 30 to November 30. The nearby Sherman mine, also owned by Dofasco, was closed from July 18 to October 4. In the Kenora area, the Griffith mine, which is situated on a property leased by Stelco Inc., was closed from late-June until September 20 when operations resumed at about two-thirds rated capacity. The Algoma Steel Corporation, Limited's underground mine at Wawa was closed for one week in June, and again from July 31 to September 12. The mine reopened at about 50 per cent capacity as a six-shift-per-week operation but changed on November 14 to 12 shifts per week operating alternate weeks only, a more efficient schedule for winter conditions. Some 400 jobs were affected at the Wawa operation.

In British Columbia, Falconbridge Limited continued to operate its underground copper-iron Wesfrob mine at Tasu throughout the year. This mine is expected to exhaust all

TABLE 1. CANADA, IRON ORE PRODUCTION AND TRADE, 1981 AND 1982

	1981		1982P	
	(tonnes)[1]	($000)	(tonnes)[1]	($000)
Production (mine shipments)				
Newfoundland	25 686 000	886,843	17 853 000	558,498
Quebec	17 842 000	599,546	12 122 000	446,252
Ontario	5 421 000	247,416	3 749 000	187,309
British Columbia	602 000	14,307	772 000	19,598
Total[2]	49 551 000	1,748,112	34 496 000	1,211,657
Imports				
Iron ore				
United States	5 536 678	287,254	3 359 303	192,294
Brazil	257 878	7,675	-	-
Italy	73	6	-	-
Netherlands	5	5	-	-
Total	5 794 634	294,940	3 359 303	192,294
Exports				
Iron ore, direct shipping				
United States	2 269 602	44,429	1 231 712	28,380
Italy	501 050	9,399	373 612	7,411
Belgium and Luxembourg	114 551	2,202	87 461	2,186
Total	2 885 203	56,030	1 692 785	37,977
Iron ore, concentrates				
Netherlands	4 356 760	95,981	3 440 336	83,292
Japan	4 105 213	82,235	2 871 422	69,286
United States	3 760 615	125,438	1 772 358	64,579
United Kingdom	3 752 617	81,950	2 022 889	50,488
West Germany	1 498 716	33,106	1 818 098	44,463
France	974 365	23,097	1 058 680	28,771
Italy	1 165 567	26,230	812 850	19,825
Belgium and Luxembourg	732 814	19,514	424 340	11,567
Philippines	452 575	8,881	288 924	7,223
Spain	97 402	2,080	252 820	7,046
Yugoslavia	259 090	5,957	127 242	3,489
Pakistan	87 048	1,788	125 706	3,007
Austria	106 314	2,314	105 464	2,795
Portugal	49 858	1,241	49 365	1,721
Other countries	52 351	1,487	50 133	1,749
Total	21 451 305	511,299	15 220 627	399,301
Iron ore, agglomerated				
United States	13 198 629	695,065	5 950 725	335,958
United Kingdom	2 080 354	109,797	1 771 644	109,957
Netherlands	736 356	37,585	1 010 758	61,600
West Germany	478 024	25,724	819 767	47,749
Italy	403 321	18,460	348 244	16,489
Belgium and Luxembourg	72 700	3,884	257 172	15,118
Other countries	130 019	6,715	129 362	6,583
Total	17 099 403	897,230	10 287 672	593,454
Iron ore, nes				
United States	8 639	495	80 147	2,801
Other Countries	7 277	284	23	1
Total	15 916	779	80 170	2,802

TABLE 1. (cont'd.)

	1981		1982P	
	(tonnes)[1]	($000)	(tonnes)[1]	($000)
Total exports, all classes				
United States	19 237 485	865,427	9 034 942	431,718
United Kingdom	5 832 971	191,747	3 794 533	160,445
Netherlands	5 093 116	133,566	4 451 094	144,892
West Germany	1 976 740	58,830	2 637 865	92,212
Japan	4 105 213	82,235	2 871 422	69,286
Italy	2 069 938	54,089	1 534 706	43,725
Belgium and Luxembourg	920 065	25,600	768 973	28,871
France	974 365	23,097	1 058 680	28,771
Philippines	452 575	8,881	288 924	7,223
Other countries	789 359	21,866	840 115	26,391
Total	41 451 827	1,465,338	27 281 254	1,033,534
Consumption of iron ore at Canadian iron and steel plants	15 207 691	..	11 999 449	..

Sources: Energy, Mines and Resources Canada; Statistics Canada; American Iron Ore Association.
[1] Dry tonnes for production (shipments) by province; wet tonnes for imports and exports.
[2] Total iron ore shipments include shipments of byproduct iron ore.
P Preliminary; - Nil; .. Not available; nes Not elsewhere specified.

economic ore reserves in 1983. Craigmont Mines Limited ceased production of byproduct iron ore at Merritt. On depletion of the copper-iron orebody in February 1982, the concentrator was used to process the remaining coarse iron ore stockpile, which was depleted in December.

Borealis Exploration Limited carried out a diamond drilling and bulk sampling program on its iron property on Melville Peninsula in the Northwest Territories. This work had been recommended in an April 1982 preliminary feasibility study by Scott-Ortech Mining Ltd.

In July 1982, Norcen Energy Resources Limited, a diversified company controlled by Ravelston Corporation Limited of Toronto, increased its interest in Hanna Mining Company of Cleveland, Ohio from 8.8 per cent to 20 per cent. Hanna is a major shareholder and managing agent of the Iron Ore Company of Canada.

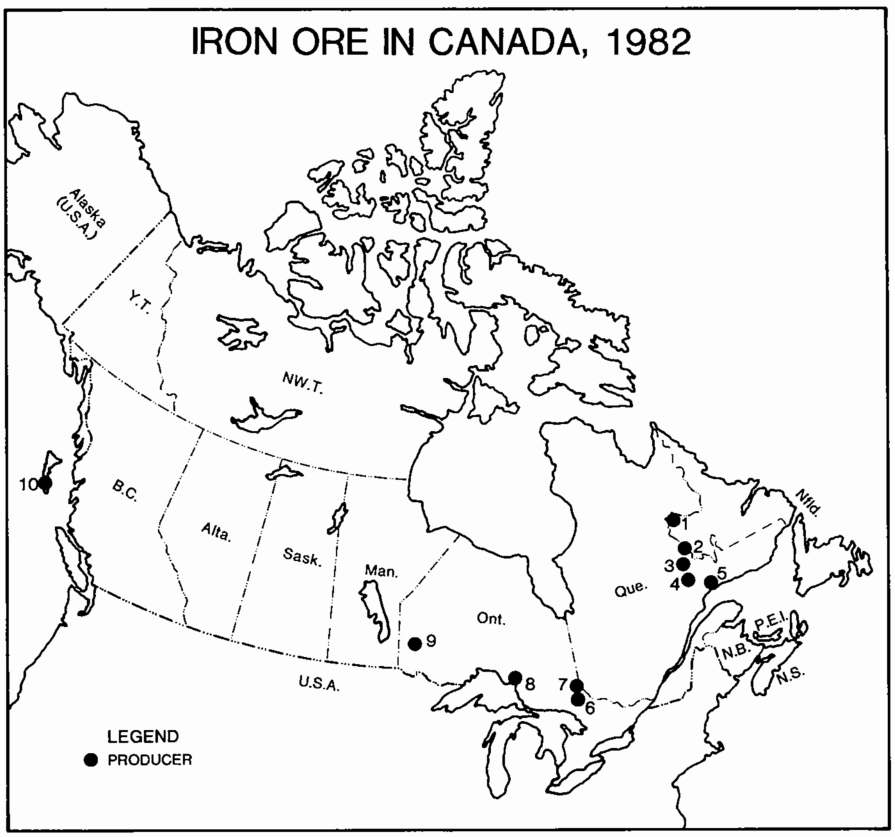
DIRECT-REDUCTION

Steel production in the United States was severely reduced in 1982. As a result, the demand for scrap, which can be substituted for direct reduced iron (DRI) in steelmaking, was weak and scrap prices became very depressed. No. 1 heavy melting scrap was selling at $US 85 per t in early January and decreased steadily to about $US 50 at the end of the year, the lowest price for any extended period since 1973.

A combination of low scrap prices and rising energy costs (electricity, oil, and natural gas) placed producers of direct reduced iron under severe competitive pressure. At the end of the year, at least 12 of the 42 DRI plants in the western world were either closed or operated at much reduced capacity. Sidbec's plant at Contrecoeur, Quebec was the only plant in operation in North America at the end of the year.

Ivaco Inc. of Longueuil, Quebec was reported to be studying the possibility of building a 400 000 tpy pig iron plant, that could cost approximately $Cdn 75 million. The proposed plant would use the direct smelting process developed by the Swedish company Boliden AB. Boliden claims its process can use a wide variety of iron ore fines and low-quality coals.

Table 9 indicates that while DRI production capacity was 18.0 million t in 1982, production was only 7.47 million t, or 41 per cent of capacity.



Producers
(numbers refer to numbers on map above)

1. Iron Ore Company of Canada, Knob Lake Division (Schefferville)
2. Iron Ore Company of Canada, Carol Division (Labrador City)
2. Scully Mine of Wabush Mines (Wabush)
3. Quebec Cartier Mining Company (Mount Wright)
4. Sidbec-Normines Inc. (Gagnon, Fire Lake)
5. Iron Ore Company of Canada, Sept-Iles Division (Sept-Iles)
5. Wabush Mines, Pointe Noire Division (Pointe Noire)
5. Quebec Cartier Mining Company and Sidbec-Normines Inc. (Port Cartier)
6. Sherman Mine of Dofasco Inc. (Temagami)
7. Adams Mine of Dofasco Inc. (Kirkland Lake)
8. Algoma Ore division of The Algoma Steel Corporation, Limited (Wawa)
9. The Griffith Mine (Bruce Lake)
10. Wesfrob Mines Limited (Moresby Is.)

TABLE 2. CANADA, IRON ORE PRODUCTION (SHIPMENTS), 1980-82

Company and Location	Ore Mined	Product Shipped	1980	1981	1982P
			(000 tonnes, natural wt)		
Adams Mine, Kirkland Lake, Ont.	Magnetite	Pellets	1 213	1 230	964
Algoma Ore division of The Algoma Steel Corp. Ltd., Wawa, Ont.	Siderite	Sinter	1 500	1 485	870
Caland Ore Company, Limited Atikokan, Ont.	Hematite and goethite	Pellets	534	-	-
		Concentrate	639	142	-
Griffith Mine, Bruce Lake, Ont.	Magnetite	Pellets	1 520	1 537	910
Iron Ore Company of Canada Schefferville, Que.	Hematite, goethite and limonite	Direct shipping	3 251	2 832	1 675
Carol Lake, Lab.	Specular hematite and magnetite	Concentrate	6 963	7 090	5 609
		Pellets	8 430	10 056	5 830
Sept Iles, Que.	Schefferville "treat ore"	Pellets	2 808	1 347	129[1]
Quebec Cartier Mining Company, Mount Wright, Que.	Specular hematite	Concentrate	11 970	13 139	9 047
Sidbec-Normines Inc. Fire Lake and Lac Jeannine, and Port Cartier, Que.	Specular hematite	Concentrate	95	50	47
		Pellets (standard)	2 850	3 500	3 122
		Pellets (low silica)	1 354	1 343	681
Sherman Mine, Temagami, Ont.	Magnetite	Pellets	1 078	1 142	850
Wabush Mines, Wabush, Labrador and Pointe Noire, Que.	Specular hematite and magnetite	Pellets	4 855	5 291	3 048
Wesfrob Mines Limited, Queen Charlotte Islands, B.C.	Magnetite	Pellet feed	611	537	726
		Fine magnetite	24	39	37
Byproduct producer					
Inco Limited, Sudbury, Ont.	Pyrrhotite	Pellets	66	54	-
		Magnetite concentrate	-	126	-
Total			49 761	50 940	33 545

[1] Stockpile ore.
P Preliminary; - Nil.

The Midrex and HyL plants account for 90.5 per cent of the DRI produced in the world. Most DRI Plants are located in countries where natural gas or oil is inexpensive.

WORLD DEVELOPMENTS

World iron ore production decreased from 860.8 million t in 1981 to 788.5 million t in 1982. Most of the decrease occurred in the United States and Canada.

For the past few years, several steel producers in the western world have suffered heavy financial losses due to poor demand for steel and strong competition. In an attempt to reduce costs, many steel companies in Europe and Japan substituted lumps, fines and concentrates for pellets, the last being the most expensive form of iron feedstock for these companies under recent operating conditions. For this reason, several pellet plants were either closed during the year or operated at much reduced capacity.

Iron ore production in the United States was reduced sharply from 74 million t in 1981 to about 35 million t in 1982. The decline was the direct result of lower steel production in the United States.

In August, Brazil signed an agreement with the World Bank for a \$US 304.5 million loan for the development of Carajas iron ore. The loan was the last of a \$US 1.5 billion foreign financing package assembled by Japanese banks, the European Community and a group of European and U.S. banks. Scheduled for completion in 1986 at a rated capacity of 35 million tpy, the Carajas iron ore project is expected to cost \$US 4.9 billion.

Kawasaki Steel Corp. and Companhia Vale do Rio Doce (CVRD), Brazil's state mining company, are studying a proposal to build a 5 million tpy sintering plant for the Carajas project at the loading port of San Luis. The plant would cost about \$US 200 million and would meet the government's objective of increasing the export value of Carajas iron ore.

The Kudremukh iron ore mine in India went into production during 1982 but was forced to stockpile iron ore concentrate because Iran did not take delivery of its agreed share of the output.

A meeting of the Association of Iron Ore Exporting Countries (APEF) was held in Geneva in November. Member countries called for "closer cooperation in the future between consumers and producers of iron ore, at all levels, in order to avoid longer

TABLE 3. PRODUCTION AND CAPACITY OF PIG IRON AND CRUDE STEEL AT CANADIAN IRON AND STEEL PLANTS, 1981 AND 1982

	1981	1982P
	(tonnes)	
Pig iron		
Production	9 743 499	8 000 149
Capacity at December 31[1]	12 216 000	10 507 000
Steel ingots and castings		
Production	14 811 223	11 871 374
Capacity at December 31	21 726 197	21 766 469

Source: Statistics Canada.
[1] In blast or in use.
P Preliminary.

TABLE 4. RECEIPTS, CONSUMPTION AND INVENTORIES OF IRON ORE AT CANADIAN IRON AND STEEL PLANTS, 1981 AND 1982

	1981	1982
	(tonnes)	
Receipts imported[1]	5 961 357	3 203 949
Receipts from domestic sources[1]	9 313 840	6 543 299
Total receipts at iron and steel plants	15 275 197	9 747 248
Consumption of iron ore[1]	15 207 691	11 999 449
Inventory at docks, plants, mines and furnace yards, December 31	17 226 747	16 833 586
Inventory change	2 731 716	-393 161

Source: American Iron Ore Association.
[1] Statistics shown in Table 4 are slightly different from corresponding statistics in other parts of this review due to the use of different information sources.

TABLE 5. CANADIAN CONSUMPTION OF IRON-BEARING MATERIALS BY INTEGRATED[1] IRON AND STEEL PRODUCERS, 1982

Material Consumed	Consumed In				
	Sinter Plants at Steel Mill	Direct Reduction Plants	Iron and Steel Furnaces: Production of Pig Iron	Iron and Steel Furnaces: Steel Furnaces	Iron and Steel Furnaces: Total in Furnaces
			(tonnes)		
Iron ore					
Crude and concentrate	134 520	13 696	45 394	-	45 394
Pellets	34 652	778 206	10 027 210	62 680	10 089 890
Sinter	57 816	-	812 382	-	812 382
Sinter produced at steel plant	-	-	578 498	-	578 498
Direct reduced iron	-	-	-	500 351	500 351
Other iron-bearing materials					
Flue dust	45 601	-	-	-	28 322
Mill scale, cinder, slag	283 086	-	280 874	2 257	283 131
Total:					12 337 968

Source: Company data.
[1] Dofasco Inc.; Sidbec-Dosco Inc.; Sydney Steel Corporation; The Algoma Steel Corporation, Limited; Stelco Inc.
- Nil.

range imbalances between supply and demand, which would have serious adverse consequences for the future stability of both the iron ore and iron and steel industries."

PRICES

Competitive pressures resulted in the emergence of price ranges for some types of ore. Mesabi non-Bessemer iron ore, priced at $US 32.02 a t at the beginning of the year was being quoted in a range from $US 31.73 to $32.01 per t by April, and it remained in this range for the rest of the year. A price spread also emerged for iron ore pellets, with quotation's falling within the range from US 79.21 cents per iron unit to US 85.51 cents per iron unit. Pellets were priced at US 79.21 cents per iron unit at the end of 1981. The price for direct reduced iron remained unchanged at $US 115.00 per t fob Contrecoeur.

Contracted prices for iron ore products on international markets increased substantially in 1982. Most contracts called for increases of 11 to 17 per cent above 1981 prices. Pellet price advances were weaker, with increases in the order of 8-10 per cent.

OUTLOOK

The world iron ore industry is not expected to improve significantly in 1983 because iron

TABLE 6. WORLD IRON ORE PRODUCTION, 1980-82

	1980	1981	1982[e]
	(000 tonnes)		
U.S.S.R.	244 713	241 999	239 787
Brazil	114 732	99 979	97 541
Australia	95 542	85 999	85 348
People's Republic of China[e]	74 984	70 107	71 123
United States	70 730	74 348	35 562
Canada (mine shipments)	49 068	49 551	34 496
India	40 670	41 119	41 658
France	28 980	21 599	20 321
Sweden	27 184	23 225	20 321
Republic of South Africa	26 313	28 318	26 417
Liberia	18 187	19 704	18 289
Venezuela	16 102	15 531	13 209
Chile	8 269	7 999	..
Mauritania	8 725	8 881	..
Spain	9 227	8 565	..
North Korea	8 027	8 027	..
Mexico	7 631	8 020	..
Peru	5 704	6 069	..
Other countries	41 081	41 739	84 380
Total	895 869	860 779	788 452

Sources: U.S. Bureau of Mines; Energy, Mines and Resources Canada.
[e] Estimated; .. Not available.

TABLE 7. CANADA, IMPORTS OF STEEL SCRAP, BY PROVINCE OF ENTRY, 1980-82

		1980		1981		1982	
		World	U.S.	World	U.S.	World	U.S.
Nova Scotia	tonnes	175	175	-	-	--	--
	$000	17	17	-	-	--	--
New Brunswick	tonnes	640	640	1 131	1 131	62	--
	$000	92	92	89	89	16	--
Quebec	tonnes	56 641	56 628	60 701	60 659	28 605	26 785
	$000	4,361	4,359	5,486	5,405	2,812	2,741
Ontario	tonnes	364 745	364 737	311 917	311 840	194 335	194 291
	$000	31,150	31,146	30,648	30,592	15,376	15,350
Manitoba	tonnes	56 385	56 385	55 781	55 781	8 233	8 233
	$000	3,823	3,823	4,390	4,390	514	514
Saskatchewan	tonnes	146 801	146 801	127 733	127 733	68 005	68 005
	$000	14,579	14,579	13,419	13,419	5 337	5 337
Alberta	tonnes	41 682	41 682	24 600	24 600	3 291	3 291
	$000	4,317	4,317	2,423	2,423	315	315
British Columbia	tonnes	2 999	2 669	2 005	1 956	926	926
	$000	300	276	270	265	109	109
Canada Total	tonnes	670 068	669 717	583 869	583 700	303 458	301 533
	$000	58,639	58,609	56,724	56,583	24,479	24,366

Source: Statistics Canada.
- Nil; -- Amount less than significant threshold.

TABLE 8. CANADA, EXPORTS OF STEEL SCRAP, BY PROVINCE OF LADING, 1980-82

		1980		1981		1982	
		World	U.S.	World	U.S.	World	U.S.
Newfoundland	tonnes	-	-	-	-	-	-
	$000	-	-	-	-	-	-
Nova Scotia	tonnes	209	59	29	29	-	-
	$000	44	12	2	2	-	-
New Brunswick	tonnes	405	357	340	200	485	425
	$000	34	21	71	14	55	27
Quebec	tonnes	264 903	7 904	114 663	12 896	156 651	21 326
	$000	33,979	997	14,672	2,005	15,659	2,288
Ontario	tonnes	241 332	231 740	235 487	233 326	220 134	162 618
	$000	26,398	24,983	28,461	28,134	20,811	15,880
Manitoba	tonnes	6 924	6 887	1 472	1 472	1 410	1 410
	$000	1,243	1,237	281	281	194	194
Saskatchewan	tonnes	2 080	2 080	2 195	2 195	3	3
	$000	290	290	381	381	1	1
Alberta	tonnes	793	793	1 288	1 266	1 377	1 377
	$000	99	99	197	192	125	125
British Columbia	tonnes	116 583	110 443	90 769	87 068	85 687	84 263
	$000	13,936	12,951	9,889	9,272	7,568	7,136
Yukon	tonnes	-	-	72	72	-	-
	$000	-	-	4	4	-	-
Canada Total	tonnes	633 229	360 263	446 315	338 524	465 747	271 422
	$000	76,023	40,590	53,958	40,285	44,413	25,651

Source: Statistics Canada.
- Nil.

TABLE 9. CAPACITY AND PRODUCTION OF DIRECT REDUCED IRON (DRI), 1982

Process	Plant	Country	Capacity (mtpy)	Production (million t)
ACCAR	NML	Canada	0.035	*
ACCAR	SMC	Canada	0.240	*
ACCAR	OSIL	India	0.150	*
ARMCO	Houston	USA	0.330	.066
CODIR	Dunswart	S. Africa	0.150	.100**
DRC	Rockwood	USA	0.060	*
FIOR	Fior	Venezuela	0.350	.233
HyL I	Monterrey I/III	Mexico	0.570	.468
HyL I	Puebla I/II	Mexico	0.045	.818
HyL I	Tamsa	Mexico	0.235	.245
HyL I	USIBA	Brazil	0.250	.187
HyL I	Krakatau	Indonesia	2.300	.436
HyL I	Iraq	Iraq	0.485	*
HyL I	SIDOR I/II	Venezuela	2.472	.559
HyL III	Monterrey II	Mexico	0.250	.177
KM	Burma	Burma	0.020	.020**
MIDREX	GSC	USA	0.400	*
MIDREX	HSW	W. Germany	0.400	.139
MIDREX	Sidbec I/II	Canada	1.000	.497
MIDREX	Dalmine	Argentina	0.330	.318
MIDREX	ACINDAR	Argentina	0.420	.574
MIDREX	QASCO	Qatar	0.400	.452
MIDREX	SIDOR I/II	Venezuela	1.630	1.382
MIDREX	ISCOTT I/II	Trinidad	0.840	.237
MIDREX	NORDFERRO	W. Germany	0.880	.183
MIDREX	OSM	USA	0.300	*
MIDREX	Delta Steel I/II	Nigeria	1.100	.083
MIDREX	HADEED I	Saudi Arabia	0.400	.009
PUROFER	NISCO	Iran	0.330	*
SLRN	Pirantini	Brazil	0.065	.039
SLRN	Stelco	Canada	0.350	*
SLRN	SIIL I	India	0.030	.025**
SLRN	Siderperu	Peru	0.100	.043
SLRN	NZS	New Zealand	0.150	.160**
PLASMARED	SKF	Sweden	0.070	.030**
			18.037	7.474

Source: Midrex Corp., North Carolina, U.S.A.
* Not operating. ** Estimated.
mtpy = million tonnes per year.

and steel markets in the western world have been seriously eroded by reduced capital spending and weak consumer demand. An oversupply of iron ore on world markets will subject Canadian exporters to increased competition from foreign producers. Some strengthening of the iron ore market, due to improved consumer demand, should become evident during the second half of 1983. However, any stimulus to the market will be tempered over the short term by a reduction of inventories to levels consistent with demand, and by a cautious outlook in the capital goods sector. General economic conditions are not expected to improve quickly and as a result, 1983 Canadian iron ore production and exports are unlikely to increase above the 1982 level. Current forecasts for the western world suggest a faultering economic recovery in 1983 and a strengthening of the iron ore market in 1984.

The North American base price for iron ore, generally related to production costs, will probably remain close to 1982 levels due to the prevailing weak market and a trend to lower inflation rates. A reduction of 10-15 per cent is expected in the contract price for iron ore in offshore markets.

TABLE 10. LAKE ERIE BASE PRICE OF SELECTED ORES[1] AT YEAR-END, 1970 AND 1975-82

	1970	1975	1976	1977	1978	1979	1980	1981	1982
					($US)				
Mesabi Non-Bessemer (per t)	10.63	18.21	19.94	20.84	21.95	24.21	28.05	32.02	31.73-32.01
Old Range Non-Bessemer (per t)	10.87	18.45	20.19	21.09	22.19	24.46	28.30	32.26	32.26
Pellets (per natural iron unit)[2]	0.262	0.464	0.523	0.546	0.599	0.667	0.725	0.792	0.792-0.855

Sources: Skillings Mining Review; Iron Age.
[1] 51.5 per cent of iron natural, at rail of vessel, lower lake ports. [2] One iron unit equals 1 per cent of a tonne. A 60 per cent iron ore, therefore, has 60 units.

TABLE 11. SELECTED PRICES OF IRON ORE BOUND FOR JAPAN AND EUROPE 1976-82
(US cents per Fe Unit DMT, FOB)

Ore	Market	Source	%Fe	1976	1977	1978	1979	1980	1981	1982
Fines (including concentrate)	Europe	Rio Doce	(64)	22.7	23.0	21.5	23.5	28.1	28.1	32.5
		Iscor	(65)	23.0	22.3	20.6	22.4	26.9	26.9	31.4
		Kiruna	(66)	28.2	27.3	23.6	26.6	34.5	33.0	34.7
		Carol Lake		-	-	-	23.7	29.3	29.3	33.0
		Mt. Wright	(66)	-	25.0	22.5	24.0	29.75	29.75	33.0
	Japan	Rio Doce		17.4	19.8	19.7	21.6	25.4	26.9	30.5
		Iscor		17.9	17.9	18.5	21.6	25.0	26.9	30.5
		Hamersley		17.4	20.3	20.9	22.7	27.6	29.7	34.8
		Carol Lake	(65)	-	-	21.2	21.4	25.1	27.0	29.8
Lump	Europe	Rio Doce		25.9	24.9	22.6	26.6	31.2	31.2	-
		Iscor	(65)	30.0	28.3	23.7	25.5	31.9	31.9	35.9
	Japan	Rio Doce		20.6	20.8	20.3	21.6	25.4	26.9	30.5
		Iscor	(65)	22.4	22.4	23.0	24.7	28.6	30.9	35.0
		Hamersley		21.5	25.6	24.3	25.7	31.2	33.6	39.4
Pellets	Europe	Rio Doce		43.8	42.8	36.4	40.2	47.1	43.1	47.5
		Kiruna		47.4	45.5	38.0	42.2	49.9	48.5	-
	Japan	Rio Doce (Nibrasco)		-	-	-	46.0	50.3	55.2	53.6
		Savage River		-	-	-	37.9	46.2	48.9	53.4

Sources: The Tex Report, Metal Bulletin and Japan Commerce Daily.
- Not available; DMT dry metric tonne; FOB free on board.

Iron and Steel

T.R. McINNIS

OVERVIEW

Nineteen eighty-two was a year of crisis for the world steel industry. Economic recession spread, and demand for steel dropped markedly. The year was a period of intensified export efforts to help maintain operating rates and employment, especially in Europe.

A global move toward protection of domestic markets accelerated. The European Community (EC) and the United States were involved in negotiations to limit steel imports into the United States, which resulted in agreement on a quota share of the U.S. carbon steel market for the EC steel industry. The related conflict over EC specialty steel exports to the United States was not resolved.

Canadian crude steel production in 1982 decreased 19.6 per cent from 1981 quantities to 11.87 million t.

Rolled steel shipments from domestic mills, including ingots and semis, decreased by 22 per cent in 1982 relative to 1981 to 9.35 million t. Compared to the last quarter of 1981, Canadian demand for steel was weak in the first quarter of 1982 and continued to fall during the year, reaching an extremely depressed level in the fourth quarter.

Canadian exports of rolling mill products decreased by 3 per cent in 1982 to 2.84 million t. Imports of rolled steel products decreased significantly to 928 000 t, a drop of 65 per cent from 1981 quantities of 2.63 million t.

CANADIAN DEVELOPMENTS

With the deepening of the economic recession in North America and its spread throughout the world, the domestic steel industry faced a declining market from the very beginning of the year. High levels of consumer inventories at the beginning of 1982 aggravated the problem of a general drop in domestic demand which, combined with increased competition from low-priced imports, resulted in production curtailments and layoffs. By the end of the year, employment had deteriorated to the point where approximately 27 per cent of the labour force was laid off and the industry was operating at 45 per cent of capacity. Highlights by company are as follows:

Stelco Inc.: When post-strike work resumed at Stelco in December 1981, 1,900 employees were not recalled due to the reduced demand for steel. The number of employees on layoff increased throughout the year to 2,750 in July, 3,500 in September and, by year-end, almost 7,000 persons or about 28 per cent of the company's normal total employment of 25,000.

The company was proceeding with the completion of its rolling mill at the Lake Erie Works and with conversion of a second steelmaking vessel for "lance bubbling equilibrium operation" (LBE). The open-hearth facilities ceased production indefinitely. All other major capital expenditures were deferred.

Dofasco Inc.: Dofasco managed to avoid layoffs until November 5 when approximately 2,100 employees were affected. This was 15 per cent of normal employment of approximately 14,000.

The company was proceeding with completion of its new No. 2 hot strip mill and was converting one of its oxygen furnaces to LBE operation. A $90 million pickling line and a $10 million conversion of an existing galvanizing line to the production of Galvalume was deferred.

The Algoma Steel Corporation, Limited: The impact of the recession and resultant drop in orders caused the company to initiate layoff

TABLE 1. CANADA, GENERAL STATISTICS OF THE DOMESTIC PRIMARY IRON AND STEEL INDUSTRY, 1980-82

		1980r	1981	1982p
Production				
Volume indexes				
Total industrial production	1971=100	135.5	137.7	122.8
Iron and steel mills[1]	1971=100	138.2	134.8	106.2
		($ million)	($ million)	($ million)
Value of shipments, iron and steel mills[1]		6,431.4	6,970.5	6,095.9
Value of unfilled orders, year-end, iron and steel mills		932.9	784.6	494.4
Value of inventory owned, year-end, iron and steel mills		1,564.6	1,918.5	1,741.3
		(number)	(number)	(number)
Employment, iron and steel mills[1]				
Administrative		12,547	13,719	12,871
Hourly rated		45,204	40,999	36,599
Total		57,751	54,718	49,470
Employment index, all employees	1961=100	166.6	158.0	142.9
Average hours per week, hourly rated		39.7	38.9	38.1
		($)	($)	($)
Average earnings per week, hourly rated		392.10	439.33	501.77
Average salaries and wages per week, all employees		413.37	468.76	528.89
		($ million)	($ million)	($ million)
Expenditures, iron and steel mills[1]				
Capital: on construction		99.5	104.8	63.1
on machinery		484.7	605.2	381.6
Total		584.2	710.0	444.7
Repair: on construction		48.0	45.3	39.3
on machinery		661.5	653.9	624.7
Total		709.5	699.2	664.0
Total capital and repair		1,293.7	1,409.2	1,108.7
		($ million)	($ million)	($ million)
Trade, primary iron and steel[2]				
Exports		1,822.4	2,122.2	1,831.4
Imports		1,243.0	2,077.6	1,128.7

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] S.I.C. Class 291 - Iron and Steel Mills: covers the production of pig iron, steel ingots, steel castings, and primary rolled products, sheet, strip, plate, etc. [2] Includes pig iron, steel ingots, steel castings, semis, hot and cold-rolled products, pipe, wire and forgings. Excludes sponge iron, iron castings.
p Preliminary; r Revised.

notices in January, with actual layoffs put into effect at later dates. By year-end, 37 per cent of the 12,000 people normally employed by Algoma were laid off. The company deferred all major investment projects and postponed the completion of a new seamless tube mill for about a year. Equipment for the mill will be purchased and delivered on schedule, and stored until needed.

Sidbec-Dosco Incorporated: Sidbec-Dosco began reducing employment rolls at the end of February 1982. By year-end the decline amounted to 1,100 persons.

The company has had very serious economic problems, caused primarily by its participation in the joint venture iron ore mining company, Sidbec-Normines Inc. A Quebec National Assembly legislative committee met on November 10-11 to hear submissions on the future of Sidbec. The matter was still under review at year-end.

Sydney Steel Corporation (Sysco): Problems with the company's only operating blast furnace in early 1982 resulted in 1,200 of Sysco's 2,000 employees taking annual vacation as an alternative to a massive layoff. Additional plant stoppages were caused by a 12-day strike in April-May, followed by layoffs until August 24 when 700 employees returned to work. The workforce had returned to approximately 1,600 employees by year-end.

Interprovincial Steel and Pipe Corporation Ltd. (IPSCO): The reduced demand for oil country pipe resulted in the layoff of 150 people in March from a workforce of 2,300. A total of 585 people, 25 per cent of the workforce, were on layoff by August. In December, operations were closed for three weeks.

Lake Ontario Steel Company Limited (Lasco): Capital investment in 1982 was relatively small compared to 1981. The company completed a major expansion program at the end of 1981, costing approximately $100 million and doubling steelmaking capacity to 900 000 tpy. Capacity utilization at the expanded plant averaged less than 50 per cent during 1982. Employment, which had increased to over 1,100 as a result of the company's expansion, declined to about 675 at the end of the year.

Slater Steel Industries Limited: Slater Steel owns Burlington Steel of Hamilton, Ontario, Joslyn Mfg. & Supply Co. of Fort Wayne, Indiana and Colt Canada Inc. of Sorel, Quebec. Capital expenditures in 1982 of $7.8 million were directed toward modernization, and additions to plant facilities and equipment at the three sites. Specific charges made at Burlington Steel included a new 30-inch billet breakdown facility, installation of water-cooled roofs in the melting furnaces, expansion of reheat furnace capacity, and improvements to the 21-inch mill drive. Induction heating equipment was installed at the Joslyn stainless steel plant and an Electro Slag Remelting (ESR) facility was nearing completion at the same location. Slater Steel purchased Colt Canada, a specialty steel manufacturer, in November 1982 and absorbed this facility into its corporate structure as the Crucan Division. With this acquisition, Slater Steel is capable of producing a wide range of carbon, alloy and stainless steels, and is well situated to take advantage of any increase in demand.

Slater was also affected by the downturn in economic activity. Orders fell by over 30 per cent and employment was reduced by approximately 30 per cent. The company operated its plants at about 60 per cent of capacity during 1982.

Ivaco Inc.: Capital spending was reduced substantially in 1982 in comparison with 1981.

During 1982, Ivaco signed a letter of intent to construct the world's first commercial INRED plant at its l'Orignal, Ontario site. INRED is a smelting process developed by Boliden AB of Sweden. The process uses iron ore concentrates and pulverized low-grade coal to produce hot metal of blast furnace quality. Important advantages attributed to the INRED process include its small economic scale of plant and a total cost of production that is said to be less than the cost of producing pig iron in blast furnace operations.

The steel mill at l'Orignal was operated at close to capacity during 1982, a significant achievement in view of the depressed market environment.

Manitoba Rolling Mills (Canada) Limited: Manitoba Rolling Mills is a subsidiary of AMCA International Limited. The operation experienced a decline in orders but, because of its specialized market, sales remained strong enough to sustain profitability during the year. The company was able to avoid

TABLE 2. CANADA, PIG IRON PRODUCTION, SHIPMENTS, TRADE AND CONSUMPTION, 1980-82

	1980	1981	1982P
		(tonnes)	
Furnace capacity January 1[1]			
Blast	11 190 000r	11 272 000	12 432 000
Electric	540 000r	525 000	600 000
Total	11 730 000r	11 797 000	13 032 000
Production			
Basic iron	10 015 698	9 007 942	7 463 457
Foundry iron[2]	876 930	735 557	536 692
Total	10 892 628	9 743 499	8 000 149
Shipments	783 261	738 698	559 529
Imports			
Tonnes	2 075	6 964	2 262
Value ($000)	513	1,200	540
Exports			
Tonnes	562 351	466 358	485 621
Value ($000)	110,994	101,785	96,420
Consumption of pig iron			
Steel furnaces	9 966 585	9 589 451	7 926 396
Consumption of iron and steel scrap			
Steel furnaces	8 398 681	7 378 826	5 618 834

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.
P Preliminary; r Revised.

the layoff of employees. A plant modernization project that included the upgrading of one of the company's two electric furnaces has been completed.

WORLD DEVELOPMENTS

The world consumption of steel in 1982 decreased significantly compared to the market of 1981. Western world crude steel production declined 13.3 per cent to 399 million t, while total world crude steel production declined 8.99 per cent to 644.8 million t.

Conflicts concerning steel trade issues dominated European Community and United States relations in 1982. While U.S. steel production was on a declining trend in late-1981, imports continued to increase, prompting American steel producers to file petitions charging unfair trade practices early in 1982. The United States government subsequently found that the U.S. steel industry had been injured by imports, and that subsidies and dumping had occurred on a wide range of carbon and specialty steel products from various countries, including EC producers. A three-year agreement was concluded on October 21, 1982 whereby imports of EC carbon steel products were limited to a fixed share of the U.S. market, ranging from 2.2 to 10.7 per cent, depending on product category. Pending, U.S. countervailing and anti-dumping duties on EC steel imports were waived as a consequence of the agreement. The conflict over specialty steel products had not been resolved by year-end.

UNITED STATES

United States crude steel production declined 38.2 per cent in 1982 relative to 1981 to 67.7 million t. Apparent steel consumption, expressed as crude steel equivalent, during the same period declined 34 per cent to 88.0 million t.

TABLE 3. CANADA, CRUDE STEEL PRODUCTION, SHIPMENTS, TRADE AND CONSUMPTION, 1980-82

	1980	1981	1982P
		(tonnes)	
Furnace capacity, January 1[1]			
Steel ingot			
Basic open-hearth	3 742 250	3 742 250	3 622 250
Basic oxygen converter	10 329 900	11 746 200	12 285 640
Electric	4 449 500	4 526 000	5 387 135
Total	18 521 650	20 014 450	21 295 025
Steel castings	425 390	392 990	471 444
Total furnace capacity	18 947 040	20 407 440	21 766 469
Production			
Steel ingot			
Basic open-hearth	3 250 833	1 999 248	1 645 891
Basic oxygen	8 771 284	8 679 354	7 248 158
Electric	3 661 860	3 958 669	2 868 247
Total	15 683 977	14 637 271	11 762 296
Continuously cast, included in total above	4 072 921	4 770 276	3 894 604
Steel castings[2]	217 266	173 952	109 078
Total steel production	15 901 243	14 811 223	11 871 374
Alloy steel in total	1 974 564	1 659 287	959 557
Shipments from plants			
Steel castings	198 095	159 691	104 721
Rolled steel products	12 294 817	11 999 291	9 349 217
Total	12 492 912	12 158 982	9 453 938
Steel ingots included with rolled steel products above	938 229	583 705	816 938
		(000 tonnes)	
Exports, equivalent steel ingots	3 837.7r	3 568.2	3 624.1
Imports, equivalent steel ingots	1 434.9	3 398.9	1 251.2
Indicated consumption, equivalent steel ingots	13 498.2r	14 641.7	9 498.1

Source: 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.
P Preliminary; r Revised.

Activity in the U.S. steel industry declined to the lowest level since 1946. Capacity utilization averaged 48 per cent and approximately 9 million t of annual steelmaking capacity was closed during 1982. Employment, which had already been severely reduced by 1981 declined a further 24 per cent in 1982.

EUROPEAN COMMUNITY

Crude steel production in the EC declined 11.6 per cent to 111.4 million t in comparison to 1981 quantities. This decline reflected reduced demand both domestically and in export markets. Exports fell 19 per cent from 42.4 million t in 1981 to 34.3 million t in 1982 while apparent consumption fell 3 per cent or 3.1 million t. Annual capacity was reduced from 200.4 million t to 195.9 million t, while capacity utilization averaged 57 per cent. These reductions resulted in a 6 per cent decline in employment during 1982.

The European steel industry continued to be subjected to controls by the EC Commission in efforts to reduce capacity and to improve industry efficiency, operating rates and profitability. Fines were imposed on those in violation of the mandatory provisions. At year-end, the EC was calling for the industry to reduce crude steel capacity by a further 29 per cent in the immediate future. Guideline prices and production quota monitoring were instituted as measures to reduce discounting by producers.

JAPAN

Crude steel production in Japan declined 2.2 per cent in 1982 compared to the previous year to 99.5 million t. The Japanese steel industry operated at 63 per cent of annual capacity which at year-end was 157.6 million t, only 0.7 per cent less than 1981. Employment declined by less than 1 per cent.

Exports increased slightly by 0.4 million t to 37.4 million t as did imports which rose from 2.0 to 2.7 million t. Apparent domestic steel consumption declined by 0.7 per cent to 78.6 million t.

U.S. authorities also initiated investigations, at the request of U.S. steel producers, on imports of Japanese steel. These investigations were not completed at year-end.

PRICES

The 1982 Lake Erie base price of iron ore pellets increased from 80.5 cents (US) a natural iron unit to 86.9 cents (US). Premium medium volatile bituminous coal imported from the United States on a long-term contract basis was $Cdn 84-$90 per t cif at Ontario steel mills compared with $92-$99 at year-end 1981.

The price of No. 1 heavy melting composite steel scrap was $US 85 per t at the beginning of the year and decreased to $US 50 by year-end. Direct reduced iron was $US 115 per t fob Contrecoeur, Quebec, the same price as in 1981.

List prices of steel mill products were not increased during 1982. The market for steel was depressed to the point where some discounting occurred.

OUTLOOK

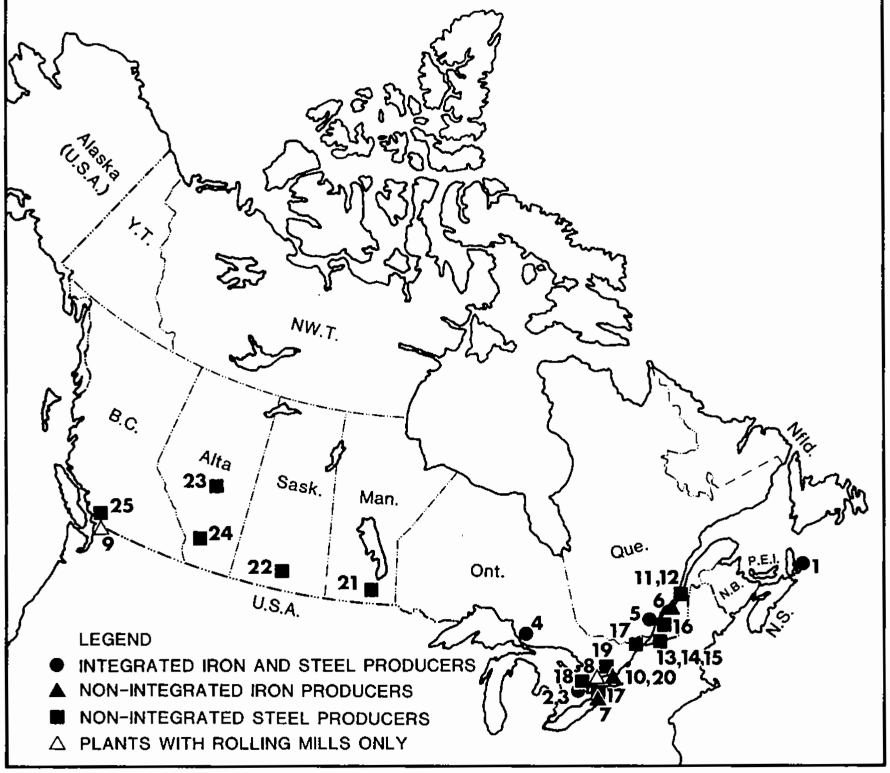
There is no evidence for a significant recovery in the global steel industry in 1983. The steel industries in the developed

TABLE 4. PRODUCER SHIPMENTS[1] OF ROLLED STEEL[2], 1981 AND 1982

	1981	1982	Growth
	(000 tonnes)		(per cent)
Ingots and semis	996.8	525.0	- 47.3
Rails	839.7	412.1	- 50.9
Wire rods	987.2	898.0	- 9.0
Structural shapes	520.7	331.6	- 36.3
Concrete reinforcing bar	681.0	542.7	- 20.3
Other hot-rolled bars	1 022.1	753.1	- 26.3
Track material	68.0	57.2	- 15.9
Plate	1 802.8	1 122.6	- 37.7
Hot-rolled sheet and strip	2 274.3	1 998.9	- 12.1
Cold finished bars	95.0	68.3	- 28.1
Cold reduced sheet, strip other and coated	1 761.0	1 709.5	- 2.9
Galvanized sheet	950.7	930.2	- 2.2
Total	11 999.3	9 349.2	- 22.1
Alloy steel in total shipments	947.0	700.8	- 26.0

Source: Statistics Canada: Primary Iron and Steel (monthly).
[1] Includes producer exports. [2] Includes ingots and semis, but not steel castings; comprises both carbon and alloy steels.

IRON AND STEEL IN CANADA, 1982



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 Incorporated (Contrecoeur)

Non-integrated iron producers

6. QIT-Fer et Titane Inc. (Sorel)
7. Canadian Furnace Division of Algoma (Port Colborne)

Plants with rolling mills only

8. Stanley Strip Steel Division of Stanley Canada Inc. (Hamilton)
9. Pacific Continuous Steel Limited (Delta)

Non-integrated steel producers

10. Courtice Steel Limited
11. Stelco Inc. (Contrecoeur)
12. Atlas Steels a Division of Rio Algom Limited (Tracy)
13. Colt Canada Inc. (Sorel)
14. Canadian Steel Foundries Division of Hawker Siddeley Canada Inc. (Montreal)
15. Canadian Steel Wheel Limited (Montreal)
16. Sidbec-Dosco Incorporated (Montreal and Longueuil)
17. Ivaco Rolling Mills Division of Ivaco Inc. (L'Orignal)
18. Atlas Steels a Division of Rio Algom Limited (Welland)
19. Burlington Steel Division of Slater Steel Industries Limited (Hamilton)
20. Lake Ontario Steel Company Limited (Whitby)
21. Manitoba Rolling Mills (Canada) Limited (Selkirk)
22. Interprovincial Steel and Pipe Corporation Ltd. (Regina)
23. Stelco Inc. (Edmonton)
24. Western Canada Steel Limited (Calgary)
25. Western Canada Steel Limited (Vancouver)

TABLE 5. DISPOSITION OF ROLLED STEEL PRODUCTS[1], 1981 AND 1982

	1981	1982	Growth
	(tonnes)		(per cent)
Wholesalers, warehouses and steel service centres	1 963 575	1 230 570	-37.3
Automotive vehicles and parts	1 256 498	1 082 718	-13.8
Agricultural equipment	153 315	93 065	-39.3
Contractors products	492 810	345 534	-29.9
Metal building systems	63 664	38 351	-39.8
Structural steel fabricators	1 144 341	666 223	-41.8
Containers	415 911	404 365	-2.8
Machinery and tools	485 923	343 977	-29.2
Wire, wire products and fasteners	741 452	596 678	-19.5
Natural resources and extractive industries	242 589	177 869	-26.7
Appliances and utensils	129 474	92 886	-28.3
Stamping, pressing and coating	457 517	336 595	-26.4
Railway operating	346 862	245 800	-29.1
Railroad cars and locomotives	119 201	53 126	-55.4
Shipbuilding	27 897	25 634	-8.1
Pipes and tubes	1 926 456	1 095 312	-43.1
Miscellaneous	55 953	47 671	-14.8
Total domestic shipments	10 023 438	6 876 374	-31.4
Producer exports[2]	1 975 853	2 472 843	+25.2
Total producer shipments	11 999 291	9 349 217	-22.1

Sources: Statistics Canada; Primary Iron and Steel (monthly).
[1] Includes ingots and semis, but excludes steel castings, pipe and wire. [2] Total rolled steel exports amounted to 2 942.5 and 2 843.7 million t in 1981 and 1982, respectively.

TABLE 6. CANADA, VALUE[1] OF TRADE IN STEEL CASTINGS, INGOTS, ROLLED AND FABRICATED PRODUCTS, 1980-82

	Imports			Exports		
	1980r	1981r	1982p	1980r	1981r	1982p
			($000)			
Steel castings	41,301	40,982	26,138	16,148	16,092	13,144
Steel forgings	48,004	30,361	23,494	69,775	80,743	71,223
Steel ingots	24,560	25,380	3,066	14,627	53,499	20,837
Rolled products						
Semis	9,671	33,687	8,795	71,628	209,695	51,296
Other	697,888	1,404,161	641,941	1,152,306	1,035,376	1,184,708
Fabricated						
Pipe and tube	358,052	465,435	365,877	302,625	524,931	298,889
Wire	63,084	76,346	58,786	84,340	100,093	94,925
Total steel	1,242,560	2,076,352	1,128,097	1,711,449	2,020,429	1,735,022

Source: Statistics Canada.
[1] The values in this table correspond with the tonnages shown in Table 7.
p Preliminary; r Revised.

TABLE 7. CANADA, TRADE IN STEEL BY PRODUCT[1], 1980-82

	Imports			Exports		
	1980	1981r	1982p	1980r	1981r	1982p
	(000 tonnes)					
1. Steel castings (including grinding balls)	16.3	23.7	13.6	14.2	14.0	8.1
2. Ingots	94.8	72.0	38.8	65.3	220.5	81.5
3. Semi-finished steel blooms, billets, slabs	9.9	95.0	12.2	261.3	674.1	176.7
4. Total (1+2+3)	121.0	190.7	64.6	340.8	908.6	266.3
5. Finished steel						
A) Hot-rolled						
Rails	23.8	35.0	25.7	240.3	174.4	94.6
Wire rods	106.5	195.7	112.9	541.8	325.6	342.7
Structurals	209.8	364.7	120.4	298.7	268.4	213.3
Bars	67.3	127.2	95.3	290.5	267.3	204.5
Track material	5.9	6.8	6.0	13.4	18.3	12.3
Plate	247.7	662.3	213.1	340.0	290.5	250.4
Sheet and strip	170.9	643.8	100.6	417.1	247.9	630.8
Total hot-rolled	831.9	2 035.5	674.0	2 141.8	1 592.4	1 748.6
B) Cold-rolled						
Bars	16.2	18.6	11.3	15.3	18.7	19.3
Sheet and strip	29.1	153.2	59.6	135.9	100.7	308.5
Galvanized	31.2	110.5	62.2	166.0	157.6	345.3
Other[1]	103.3	152.5	106.6	233.6	178.5	163.8
Total cold-rolled	179.8	434.8	239.7	550.8	455.5	836.9
6. Total finished steel (A+B)	1 011.7	2 470.3	913.7	2 692.6	2 047.9	2 585.5
7. Total rolled steel (2+3+6)	1 116.4	2 637.3	964.7	3 019.2	2 942.5	2 843.7
8. Total steel (4+6)	1 132.7	2 661.0	978.3	3 033.4	2 956.5	2 851.8
9. Total steel (raw steel equivalent)[2]	1 434.9	3 398.9	1 251.2	3 837.7	3 568.2	3 624.1
10. Fabricated steel products						
Steel forgings	9.2	6.3	5.9	40.6	42.4	32.2
Pipe	322.1	364.8	249.7	388.8	502.9	277.1
Wire	52.6	65.5	49.3	94.9	106.9	96.3
11. Total fabricated	383.9	436.6	304.9	524.3	652.2	405.6
12. Total castings, rolled steel and fabricated (8+11)	1 516.6	3 097.6	1 283.2	3 557.7	3 608.7	3 257.4

Source: Statistics Canada.
[1] Includes steel for porcelain enameling, terneplate, tinplate and silicon steel sheet and strip.
[2] Calculation: finished steel (row 6) divided by 0.77, plus steel castings, ingots and semis (row 4).
p Preliminary; r Revised.

TABLE 8. CANADA, TRADE IN STEEL[1] BY COUNTRY, 1980-82

	Imports			Exports		
	1980r	1981r	1982p	1980r	1981r	1982p
	(000 tonnes)					
United States	622.8	1 067.0	497.4	2 229.0	2 906.2	1 711.9
ECSC[2] countries	275.4	1 040.2	320.9	242.4	102.0	364.9
Japan	373.2	419.6	230.6	49.0	1.0	7.9
Other	245.2	570.8	234.3	1 037.3	599.5	1 172.7
Total	1 516.6	3 097.6	1 283.2	3 557.7	3 608.7	3 257.4

Source: Statistics Canada.
[1] Comprised of steel castings, ingots, semis, finished steel, forgings, pipe and wire.
[2] European Coal and Steel Community includes the European Economic Community members (Belgium, Denmark, France, Ireland, Italy, Luxembourg, Netherlands, United Kingdom, West Germany and effective 1981, Greece).
p Preliminary; r Revised.

TABLE 9. WORLD RAW STEEL PRODUCTION, 1981 AND 1982

	1981	1982P
	(million tonnes)	
U.S.S.R.	148.5	148.0
Japan	101.7	99.8
United States	108.8	67.5
West Germany	41.6	35.8
People's Rep. of China	35.6	35.5
Italy	24.8	24.0
France	21.3	18.5
Poland	15.7	15.7
Czechoslovakia	15.3	15.0
United Kingdom	15.6	14.0
Romania	13.0	14.0
Brazil	13.2	13.3
Spain	12.9	13.2
Canada	14.8	12.2
South Korea	10.8	11.8
India	10.8	10.3
Belgium	12.3	9.8
South Africa	9.0	8.5
East Germany	7.5	7.5
Mexico	7.6	7.1
Australia	7.6	6.3
North Korea	5.5	5.7
Netherlands	5.5	4.4
Austria	4.7	4.3
Sweden	3.8	4.0
Yugoslavia	4.0	3.8
Hungary	3.6	3.7
Luxembourg	3.8	3.4
Argentina	2.5	3.0
Bulgaria	2.5	2.5
Taiwan	3.1	(1)
Finland	2.4	(1)
Turkey	2.4	(1)
Others	14.7	22.4
Total	706.9	645.0

Source: International Iron and Steel Institute.
(1) Included in "Others".
P Preliminary.

western world countries are going through restructuring and consolidation in response to a shift in markets and product requirements. A further factor has been a significant reduction in steel intensity due to decreasing size and weight of automobiles, and other technological changes.

The total market for steel in all members countries of the Organization for Economic Co-operation and Development (OECD) is expected to show only modest increases of approximately 1 per cent for 1983. Steel consumption annual growth for the decade is forecast to be slightly less than 1 per cent for the developed western world countries and about 1.5 per cent of the total world.

Canada's steel industry performance in 1983 will continue to be affected by poor demand in Canada, and continuing pressure from imports. A buildup from very low user inventories of steel is expected to increase domestic shipments by 8 to 9 per cent and 1984 is expected to be better with some increase in consumption. Domestic consumption in 1985 is forecast at 13.5 million t, still below its 1979 volume of 15.6 million t. Export sales are expected to increase modestly by mid-decade.

In the United States, the demand for steel is expected to grow at an average annual rate slightly less than 1 per cent during the decade beginning in 1980. Consumption of steel in 1983 is expected to increase significantly by 15 to 17 per cent relative to 1982. U.S. domestic production could increase more than consumption as a result of the quota arrangement with the EC and other efforts to protect domestic producers from low-priced imports. The next peak in the steel demand cycle is expected to occur in 1985 with consumption, expressed as raw steel equivalent forecast to increase 3.5 per cent in 1984 and approximately 25 per cent in 1985, which will still be less than the record 144.6 million t consumed in 1974.

TABLE 10. CANADIAN CRUDE STEEL SUPPLY AND DEMAND, 1970 AND 1975, 1978-82

	Crude steel production	Imports[1]		Exports[1]		Indicated consumption[2]	
		A[3]	B[4]	A[3]	B[4]	A	B
	(000 tonnes)						
1970	11 200	1 524	1 986	1 696	2 086	11 028	11 100
1975	13 025	1 713	2 194	1 168	1 723	13 570	13 496
1978	14 898	1 632	2 278	2 884	3 581	13 646	13 595
1979	16 078	2 314	2 956	2 767	3 553	15 625	15 481
1980	15 901	1 435	2 067	3 838	4 594	13 498	13 374
1981	14 811	3 399	4 137	3 568	4 459	14 642	14 489
1982P	11 871	1 251	1 725	3 624	4 218	9 498	9 378

Source: Statistics Canada.
[1] Trade of Canada, adjusted to equivalent crude steel by Energy, Mines and Resources, Canada. [2] Production plus imports, less exports, with no account taken for stocks. The two columns of figures depend on the two sets of values for trade. [3] Calculations: total finished steel (all hot and cold-rolled steel but excluding wire, steel forgings, pipe and tube) divided by 0.77 plus steel castings, ingots and semis (See Table 7). [4] Calculations: total hot and cold-rolled steel, steel forgings, wire, and steel pipe and tube, divided by 0.75, plus steel castings (piston ring castings), ingots (ingot moulds and stools), and semis.
P Preliminary.

TABLE 11. CANADA, EXPORTS OF STEEL SCRAP, BY PROVINCE OF LADING, 1980-82

		1980		1981		1982P	
		World	U.S.	World	U.S.	World	U.S.
Newfoundland	tonnes	-	-	-	-	-	-
	$000	-	-	-	-	-	-
Nova Scotia	tonnes	209	59	29	29	-	-
	$000	44	12	2	2	-	-
New Brunswick	tonnes	405	357	340	200	535	469
	$000	34	21	71	14	55	27
Quebec	tonnes	264 903	7 904	114 663	12 896	172 678	23 508
	$000	33,979	997	14,672	2,005	15,659	2,288
Ontario	tonnes	241 332	231 740	235 487	233 326	242 656	179 256
	$000	26,398	24,983	28,461	28,134	20,811	15,880
Manitoba	tonnes	6 924	6 887	1 472	1 472	1 554	1 554
	$000	1,243	1,237	281	281	194	194
Saskatchewan	tonnes	2 080	2 080	2 195	2 195	3	3
	$000	290	290	381	381	1	1
Alberta	tonnes	793	793	1 288	1 266	1 518	1 518
	$000	99	99	197	192	125	125
British Columbia	tonnes	116 583	110 443	90 769	87 068	94 454	92 884
	$000	13,936	12,951	9,889	9,272	7,568	7,136
Yukon	tonnes	-	-	72	72	-	-
	$000	-	-	4	4	-	-
Canada Total	tonnes	633 229	360 263	446 315	338 524	513 398	299 192
	$000	76,023	40,590	53,958	40,285	44,413	25,651

Source: Statistics Canada.
P Preliminary; - Nil.

TABLE 12. CANADA, IMPORTS OF STEEL SCRAP, BY PROVINCE OF ENTRY, 1980-82

		1980		1981		1982P	
		World	U.S.	World	U.S.	World	U.S.
Nova Scotia	tonnes	175	175	-	-	1	1
	$000	17	17	-	-	---	---
New Brunswick	tonnes	640	640	1 131	1 131	68	1
	$000	92	92	89	89	16	---
Quebec	tonnes	56 641	56 628	60 701	60 659	31 532	29 526
	$000	4,361	4,359	5,486	5,405	2,812	2,741
Ontario	tonnes	364 745	364 737	311 917	311 840	214 218	214 169
	$000	31,150	31,146	30,648	30,592	15,376	15,350
Manitoba	tonnes	56 385	56 385	55 781	55 781	9 075	9 075
	$000	3,823	3,823	4,390	4,390	514	514
Saskatchewan	tonnes	146 801	146 801	127 733	127 733	74 962	74 962
	$000	14,579	14,579	13,419	13,419	5,337	5,337
Alberta	tonnes	41 682	41 682	24 600	24 600	3 628	3 628
	$000	4,317	4,317	2,423	2,423	315	315
British Columbia	tonnes	2 999	2 669	2 005	1 956	1 021	1 021
	$000	300	276	270	265	109	109
Canada Total	tonnes	670 068	669 717	583 869	583 700	334 505	332 383
	$000	58,639	58,609	56,724	56,583	24,479	24,366

Source: Statistics Canada.
P Preliminary; - Nil; --- Amount too small to be expressed.

TABLE 13. CANADA, ROLLED STEEL SUPPLY AND DEMAND, 1978-82

	Producer or Mill Shipments[1]	Exports[2]	Imports[3]	Apparent Rolled Steel Consumption[4]	Raw Steel Production[5]
			(000 tonnes)		
1978	11 693	2 267	1 257	10 683	14 898
1979	12 230	2 132	1 811	11 909	16 078
1980	12 097	3 019[r]	1 116	10 194[r]	15 901
1981	11 999	2 943	2 637	11 693	14 811
1982P	9 349	2 844	965	7 470	11 871
% Change 1982/1981	-22.1	-3.4	-63.4	-33.5	-19.8

Source: Statistics Canada.
[1] Comprises domestic shipments plus producer exports. A portion of domestic shipments to warehouses and steel service centres is also exported. Excludes steel castings amounting to 157 000 t in 1978, 200 000 t in 1979, 198 000 t in 1980, 160 000 t in 1981 and 105 000 t in 1982. [2] Total exports includes producer exports plus exports from warehouses and steel service centres. Excludes exports of pipe, wire, forgings and steel castings. [3] Excludes imports of pipe, wire forgings and steel castings. [4] Excludes apparent consumption of steel castings. [5] Includes production of steel castings amounting to 170 493 t in 1978, 223 353 t in 1979, 217 266 t in 1980, 173 952 t in 1981, and 109 078 t in 1982.
P Preliminary; [r] Revised.

TABLE 14. CANADA, EXPORTS OF STAINLESS STEEL SCRAP, BY PROVINCE OF LADING, 1980-82

		1980		1981		1982P	
		World	U.S.	World	U.S.	World	U.S.
Newfoundland	tonnes	-	-	14	14	-	-
	$000	-	-	3	3	-	-
Nova Scotia	tonnes	157	52	140	122	133	13
	$000	155	41	116	102	84	11
New Brunswick	tonnes	154	-	350	281	273	10
	$000	120	-	263	221	197	6
Quebec	tonnes	4 638	1 518	2 136	1 519	4 403	1 496
	$000	3,319	1,350	1,942	1,398	3,065	894
Ontario	tonnes	11 781	7 348	12 011	11 377	15 982	9 890
	$000	9,900	5,835	6,953	6,277	9,138	4,366
Manitoba	tonnes	154	154	163	163	283	283
	$000	71	71	75	75	144	144
Saskatchewan	tonnes	69	69	-	-	-	-
	$000	10	10	-	-	-	-
Alberta	tonnes	70	70	39	39	223	223
	$000	60	60	26	26	168	168
British Columbia	tonnes	1 603	627	1 589	868	2 608	1 530
	$000	1,082	341	1,031	522	1,032	339
Canada Total	tonnes	18 626	9 838	16 442	14 383	23 905	13 445
	$000	14,717	7,708	10,409	8,624	13,828	5,928

Source: Statistics Canada.
P Preliminary; - Nil.

In the EC, steel demand is expected to remain depressed in 1983, and increase by 1 to 2 per cent a year for 1984 and 1985. Negotiated quota agreements on steel imports into the EC market should reduce the problems created by imports. Export markets will be depressed by the general weakness of world demand and increasing protection of domestic markets in most countries. The EC Commission has planned for a reduction of about 46 million t in Community annual steel capacity by 1985 in a program to rationalize the industry and to balance supply with demand. However, plant closures are running behind schedule and the continuation of an oversupply situation is likely for the near future.

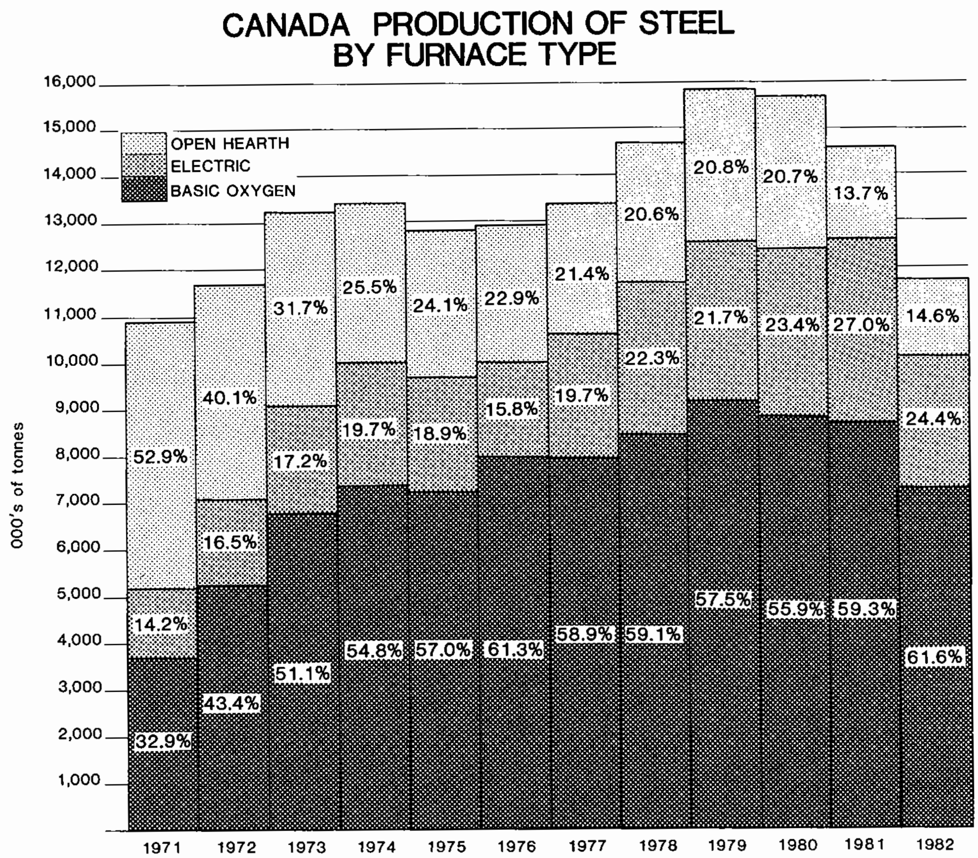
Japanese production of steel will likely fall in 1983 because of soft domestic demand and reduced export markets. A production growth rate of less than 1 per cent is expected for 1984, increasing to about 2 per cent in 1985.

TABLE 15. PRICES FOR RAW MATERIALS AND SELECTED STEEL PRODUCTS, 1981 AND 1982[1]

	Currency	1981	1982
Raw Materials			
Iron Ore Pellets, Lake Erie Base Price, per metric iron unit[2]	$US	0.792	0.792-0.855
Coal, imported premium medium-volatile bituminous, long term contract, cif Ontario steel mills, per tonne	$Cdn	92.00-99.00	84.00-90.00
Scrap, Number 1 heavy melting, per tonne	$US	74.31	54.95
Direct Reduced Iron, per tonne	$US	115.00	115.00
Basic Pig Iron, per tonne	$Cdn	268.00	234.79
Steel Price Index 1971=100	1980	1981	1982
Structural steel shapes, unfabricated, heavy and intermediate	266.9	290.9	302.9
Steel and strip, hot rolled carbon	249.3	281.6	306.5
Sheet and strip, cold reduced, carbon, alloy and silicon	249.1	280.1	308.2
Plate, carbon and alloy	285.3	321.4	351.3

Sources: Statistics Canada; Skillings Mining Review; Iron Age; Energy, Mines and Resources Canada.

[1] Prices in effect at end of December of each year. [2] One iron unit equals one per cent of a tonne. Hence, iron ore pellets with a grade of 65 per cent iron would contain 65 iron units per tonne.



CANADA PRODUCTION OF STEEL
BY FURNACE TYPE
OPEN HEARTH
ELECTRIC
BASIC OXYGEN
000's of tonnes
16,000
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
52.9%
14.2%
32.9%
40.1%
16.5%
43.4%
31.7%
17.2%
51.1%
25.5%
19.7%
54.8%
24.1%
18.9%
57.0%
22.9%
15.8%
61.3%
21.4%
19.7%
58.9%
20.6%
22.3%
59.1%
20.8%
21.7%
57.5%
20.7%
23.4%
55.9%
13.7%
27.0%
59.3%
14.6%
24.4%
61.6%

Lead

J. BIGAUSKAS

SUMMARY

Increased world mine production of lead and its principal coproduct zinc, declining consumption of refined lead and declining net exports of lead to socialist countries are the factors which contributed to the slackening of the world lead market in 1982.

Substantial worldwide capacity closures - which totalled 296 000 tpy in the secondary lead sector alone - eased the situation. This still was not enough, however, to balance supply with declining demand. Thus, the pattern of overall metal surplus of the previous two years continued. The price of lead slid to its lowest nominal level since 1975 and provided poor returns or losses for those that remained in production.

CANADIAN SCENE

MINING

Canadian mine production increased by only 9 000 t over 1981 levels to 341 000 t of lead in concentrate (Tables 1, 2, 3 and Figure 1), but this gain was made despite a flurry of shutdowns beginning in June and July.

Although ASARCO Incorporated decided to delay milling at its Buchans, Newfoundland mine this year, mine exploration continued across newly recognized thrust faults. The intersection of a 10 m ore horizon grading 7.6 per cent combined lead and zinc and 51 g/t of silver spurred hopes that further exploration would add to the 355 000 t of ore already outlined. Grades are reported to be approximately 5.95 per cent lead, 10.25 per cent zinc, 1.39 per cent copper and 98 g/t silver.

In Nova Scotia an announcement was made in July that Canada Wide Mines Ltd., a subsidiary of Esso Resources Canada Limited, would permanently close its Gays River lead-zinc mine. Operations had been suspended in August 1981 due to ore irregularities and flooding problems in the mine. A year of re-evaluation followed the suspension, but the company was unable to resolve the difficulties. Efforts to find a buyer for the former lead producer of Yava Mines Limited were unsuccessful. The mine was put into receivership in September 1981.

Increased production rates owing to the 1981 expansion of Brunswick Mining and Smelting Corporation Limited's No. 12 mine, higher ore recoveries and a rigorous program of cost controls helped this Bathurst, New Brunswick lead-zinc-copper producer to achieve more favourable results in the latter part of 1982. Mine production at the No. 12 mine reached a record 3 534 750 t while at the No. 6 mine production totalled 98 750 t. It is anticipated that mining at No. 6 will be terminated in 1983 since exploration has not indicated any further reserves. After Heath Steele Mines Limited announced plans to halt production at its Little River Joint Venture - a zinc-copper-lead mine near Newcastle, New Brunswick - the provincial government offered an aid package to keep the mine in operation until at least April 30, 1983 at which time Heath Steele's position will be re-evaluated.

The nine week shutdown of Mattabi Mines Limited (60 per cent owned by Noranda Mines Limited) and the Lyon Lake Division of Noranda beginning in mid-July came as a result of soft markets for copper, zinc and lead. At Mattabi, computer control of reagent addition in the concentration improved recoveries in the copper/lead circuit. A shaft which is being sunk to mine the lower ore zone reached 593 m in November. Changes to mining methods and grade control systems gave encouraging results at Lyon Lake. The deepening of Lyon Lake's shaft, deferred from mid-1982, is expected to resume in the second quarter of 1983. Noranda's Geco Division also deferred non-essential mine development as a cost-cutting strategy. Further modifications of the milling circuit were undertaken, and recoveries at this copper-zinc-silver-lead operation improved.

TABLE 1. CANADA, LEAD PRODUCTION, TRADE AND CONSUMPTION, 1981 AND 1982

	1981		1982p	
	(tonnes)	($000)	(tonnes)	($000)
Production				
All forms[1]				
British Columbia	80 357	78,870	83 119	60,188
Northwest Territories	45 522	44,680	81 310	58,877
New Brunswick	68 373	67,108	81 840	59,261
Yukon	55 970	54,935	35 838	25,950
Nova Scotia	11 716	11,499	-	-
Newfoundland	2 749	2,699	1 151	833
Ontario	3 387	3,324	6 251	4,527
Manitoba	480	471	783	567
Quebec	2	2	-	-
Total	268 556	263,588	290 292	210,203
Mine output[2]	332 045	..	341 212	..
Refined production[3]	168 450	..	174 310	..
Exports				
Lead contained in ores and concentrates				
Japan	51 715	25,006	36 928	10,643
United States	41 943	21,609	11 401	4,072
Belgium-Luxembourg	18 831	11,488	22 386	8,310
West Germany	13 621	6,767	16 573	5,238
U.S.S.R.	9 566	5,285	-	-
Other countries	10 414	5,577	19 455	6,635
Total	146 090	75,732	106 743	34,898
Lead pigs, blocks and shot				
United States	57 808	53,496	53 106	34,329
United Kingdom	32 534	25,917	37 043	23,325
Italy	6 560	6,026	7 179	4,907
West Germany	5 952	5,248	4 061	2,539
Belgium and Luxembourg	6 003	4,965	17 528	11,976
Netherlands	3 218	2,698	2 001	1,448
Other countries	7 740	6,345	25 214	15,468
Total	119 815	104,695	146 132	93 992
Lead and alloy scrap (gross weight)				
Brazil	1 782	3,473	-	-
United States	2 967	1,941	6 254	2,254
Sweden	2 269	1,326	2 512	535
Taiwan	1 328	552	550	174
Denmark	445	211	234	101
Other countries	990	358	6 340	1,925
Total	9 781	7,861	15 890	4,989
Lead fabricated materials not elsewhere specified				
United States	3 325	3,180	5 978	4,624
U.S.S.R.	2 699	2,380	-	-
Denmark	273	320	-	-
South Korea	346	254	-	-
Other countries	176	202	664	408
Total	6 819	6,336	6 642	5,032

TABLE 1. (cont'd)

	1981 (tonnes)	1981 ($000)	1982P (tonnes)	1982P ($000)
Imports				
Lead pigs, blocks and shot	9 220	8,720	5 661	3,894
Lead oxide, dioxide and tetroxide	1 363	1,687	840	938
Lead fabricated materials not elsewhere specified	2 786	3,772	1 752	2,304
Lead concentrates	48 945	36 737	34 389	16,384
Lead in crude ores	2 347	761	22	5
Lead in dross, skimmings and sludge	57	27	81	23
Lead and lead alloy scrap	40 796	12,585	54 527	14,697

	1980 Primary	1980 Secondary[5]	1980 Total	1981P Primary	1981P Secondary[5]	1981P Total
	(tonnes)					
Consumption[4]						
Lead used for, or in the production of:						
Antimonial lead	1 300	x	x	7 133	x	x
Battery and battery oxides	49 600	8 172	57 772	41 117	12 032	53 149
Cable covering	x	x	x	x	x	x
Chemical uses; white lead, red lead, litharge, tetraethyl lead, etc.	14 054	7 490	21 544	14 669	4 939	19 608
Copper alloys; brass, bronze, etc.	163	71	234	202	66	268
Lead alloys:						
solders	1 684	4 956	6 640	1 774	4 972	6 746
others (including babbitt, type metals, etc.)	136	238	374	108	303	411
Semi-finished products: pipe, sheet, traps, bends, blocks for caulking, ammunition etc.	3 290	x	x	4 812	x	x
Other lead products	4 379	11 303	15 682	6 378	12 426	18 804
Total, all categories	74 606	32 230	106 836	76 193	34 738	110 931

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Lead content of base bullion produced from domestic primary materials (concentrates, slags, residues, etc.) plus estimated recoverable lead in domestic ores and concentrates exported. [2] Lead content of domestic ores and concentrates produced. [3] Primary refined lead from all sources. [4] Available data, as reported by consumers. [5] Includes all remelt scrap lead used to make antimonial lead.
P Preliminary; - Nil; .. Not available; x Confidential, but included in "other".

TABLE 2. CANADA, LEAD PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975, 1978-82

	Production		Exports			Imports	
	All forms[1]	Refined[2]	In ores and concentrates	Refined	Total	Refined[3]	Consumption[4]
	(tonnes)						
1970	353 063	185 637	186 219	138 637	324 856	1 995	84 765
1975	349 133	171 516	211 909	110 882	322 791	1 962	89 193
1978	319 809	194 054	142 693	131 951	274 644	1 715	100 762
1979	310 745	183 769	151 485	117 992	269 477	2 133	98 018
1980	251 627	162 463	147 008	126 539	273 547	2 602	106 836
1981	268 556	168 450	146 090	119 815	265 905	9 220	110 931
1982P	290 292	174 310	106 743	146 132	252 875	5 661	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Lead content of base bullion produced from domestic primary materials (concentrates, slags, residues, etc.) plus the estimated recoverable lead in domestic ores and concentrates exported. [2] Primary refined lead from all sources. [3] Lead in pigs and blocks. [4] Consumption of lead, primary and secondary in origin.
P Preliminary; .. Not available.

In Kimberley, British Columbia one of Canada's largest producers of lead concentrate, the Sullivan Mine, closed at the end of June for five weeks after a decision by the operator, Cominco Ltd., to temporarily close its Trail, British Columbia lead and zinc smelter/refinery, the destination of Sullivan's concentrates. Dickenson Mines Limited's Silvana Division, which produces a small amount of lead concentrate for the Trail facility, also closed at the end of June for five weeks. The minor lead producer operated by Northair Mines Ltd. in the Brandywine Creek area closed in July and remains on a care and maintenance basis.

The closure of the Faro mine, operated by Cyprus Anvil Mining Corporation, on June 4 came after a loss of $10.6 million in 1981 and further losses in the first half of 1982. Negotiations with the union and with the federal and territorial governments were initiated by the company to obtain concessions in power, transportation and infrastructure costs as well as increased productivity which Cyprus reports it needs to make the operation viable (see also the Zinc Review in this series). In 1981 Cyprus produced 30 000 t of lead and 140 000 t of zinc in concentrates for markets in Japan and Europe. Another lead concentrate producer, the Elsa mine of United Keno Hill Mines Limited, was closed indefinitely in June because of declining revenue from its principal product, silver.

Although Pine Point Mines Limited maintained production throughout 1982 at its lead-zinc mine in the Northwest Territories, the company announced in December that it would suspend production on January 2, 1983 for an indefinite period. The company plans to review the situation on a monthly basis and will resume operations when conditions permit.

Uncertainty over the future state of base metal and silver markets, and negotiations over the financing of an $8 million, 90 km road upgrading led to the postponement of production from the Prairie Creek, NWT mine of Cadillac Explorations Limited (40 per cent) and Procan Exploration Company (60 per cent). The mine had been scheduled to begin production at 900 tpd by the end of 1982 and to produce 25 000 tpy of lead and 25 000 tpy of zinc in concentrates.

Canada's most northerly mines, despite both the harsh northern (and economic) climate, produced throughout 1982. Nanisivik Mines Ltd. successfully re-negotiated sales contracts for its lead and zinc concentrates with "substantially improved terms." The contract covers the period 1982-1984. In addition, a higher throughput in 1982 helped to offset the effects of higher operating costs and slightly lower ore grades at the Baffin Island mine. The company continued its program of mine exploration on a zone 50 m below the main orebody and spent a

TABLE 3. PRINCIPAL LEAD MINES IN CANADA, 1982 (1981)

Company and Location	Mill Capacity	Copper	Lead	Zinc	Silver	Gold	Ore Milled	Lead Concentrates Produced	Grade	Content	Lead Content All[1] Concentrates	Destination[2] of Concentrates
	(tonnes/ day)	(%)	(%)	(%)	(grams/ tonne)	(grams/ tonne)	(tonnes)	(tonnes)	(%)	(tonnes)	(tonnes)	
Newfoundland												
ASARCO Incorporated,	1 100	-	-	-	-	-	-	-	-	-	-	-
Buchans Unit, Buchans	(1 100)	(0.80)	(5.31)	(8.95)	(92.91)	(0.72)	(68 946)	(5 395)	(54.73)	(2 953)	(3 403)	(3)
Nova Scotia												
Barymin Explorations	-	-	-	-	-	-	-	-	-	-	-	-
Limited, Yava Unit	(550)	(-)	(5.28)	(-)	(5.93)	(-)	(180 360)	(12 309)	(68.24)	(8 399)	(8 399)	(5)
Esso Resources Canada	-	-	-	-	-	-	-	-	-	-	-	-
Limited, Gays River	(1 500)	(-)	(1.37)	(2.19)	(-)	(-)	(242 735)	(4 270)	(75.10)	(3 207)	(3 236)	(5)
New Brunswick												
Brunswick Mining and	10 000	0.30	3.55	8.90	100.01	-	3 633 499	295 628	30.28	89 524	100 479	1,5,6,8
Smelting Corporation Limited, Bathurst	(10 000)	(0.35)	(3.50)	(8.74)	(97.89)	(-)	(3 422 690)	(290 781)	(27.43)	(79 775)	(89 864)	(1,5,6,8)
Heath Steele Mines	3 800	0.99	1.45	3.97	57.60	0.82	1 399 078	38 972	23.75	9 256	13 398	1,5,6,7
Limited, Newcastle	(3 600)	(0.91)	(1.45)	(3.94)	(51.43)	(0.69)	(1 249 928)	(31 187)	(24.61)	(7 675)	(11 090)	(3,5,6,7,8)
Ontario												
Kidd Creek Mines Ltd.,	13 000	0.76	0.95	7.76	213.26	-	870 414	27 116	13.35	3 620	6 661	3
Kidd Creek Mine, Timmins	(12 250)	(0.60)	(0.70)	(8.26)	(171.43)	(-)	(908 593)	(24 331)	(10.73)	(2 611)	(4 786)	(3)
Mattabi Mines Limited,	2 700	0.64	0.74	7.42	105.94	-	752 931	11 821	19.69	2 327	4 244	6
Sturgeon Lake	(2 700)	(0.56)	(0.57)	(6.50)	(86.40)	(-)	(896 197)	(11 311)	(15.26)	(1 726)	(3 551)	(3,6)
Noranda Mines Limited,	4 550	1.59	0.13	3.51	45.60	0.10	1 350 734	951	54.26	516	1 509	2
Geco Division, Manitouwadge	(4 550)	(1.83)	(0.07)	(3.16)	(46.63)	(0.10)	(1 329 489)	(335)	(49.36)	(165)	(928)	(8)
Manitoba-Saskatchewan												
Hudson Bay Mining and	7 250	1.90	0.00	2.71	20.67	1.78	1 034 449	-	-	-	530	(-)
Smelting Co., Limited, Flin Flon concentrator	(7 250)	(1.58)	(0.14)	(2.10)	(19.95)	(1.30)	(983 990)	(-)	(-)	(-)	(559)	(-)
Snow Lake concentrator	3 450	2.48	0.19	2.84	14.16	0.99	687 574	1 311	60.00	787	1 003	2
	(3 450)	(2.56)	(0.14)	(2.65)	(12.41)	(1.03)	(771 427)	(736)	(61.78)	(455)	(694)	(2)

TABLE 3 (cont'd)

Company and Location	Mill Capacity (tonnes/ day)	Copper (%)	Lead (%)	Zinc (%)	Silver (grams/ tonne)	Gold (grams/ tonne)	Ore Milled (tonnes)	Lead Concentrates Produced (tonnes)	Lead Concentrates Grade (%)	Lead Concentrates Content (tonnes)	Lead Content All[1] Concentrates (tonnes)	Destination[2] of Concentrates
British Columbia												
Cominco Ltd., Sullivan mine, Kimberley	9 050 (9 050)	- (-)	4.98 (4.43)	3.23 (3.23)	65.49 (62.06)	- (-)	2 219 198 (2 209 669)	154 804 (134 281)	61.38 (62.66)	95 019 (84 140)	100 498 (88 986)	2 (2)
Dickenson Mines Limited, Silmonac mine, Sandon	(100) (100)	- (-)	3.54 (4.18)	2.83 (3.49)	403.89 (430.29)	- (-)	26 189 (26 764)	1 560 (1 940)	54.15 (55.40)	845 (1 075)	858 (1 093)	2 (2)
Northair Mines Ltd., Brandywine area	250 (250)	0.19 (0.15)	1.32 (1.15)	2.32 (2.09)	35.86 (28.63)	7.99 (7.92)	33 104 (62 548)	811 (1 271)	46.87 (48.82)	380 (620)	415 (675)	2 (2)
Teck Corporation, Beaverdell	100 (100)	- (-)	0.29 (0.35)	0.62 (0.82)	386.64 (353.14)	- (-)	36 380 (35 774)	279 (395)	23.23 (20.48)	65 (81)	92 (110)	2 (2)
Westmin Resources Limited Lynx and Myra Falls mines, Buttle Lake	900 (900)	1.06 (1.13)	1.11 (1.22)	7.28 (7.37)	127.89 (124.11)	2.74 (2.67)	287 579 (246 150)	5 560 (5 358)	43.36 (42.73)	2 411 (2 289)	3 043 (2 809)	2 (2)
Yukon Territory												
Cyprus Anvil Mining Corporation, Faro	9 050 (9 050)	- (-)	2.80 (2.90)	4.70 (4.80)	33.81 (42.00)	0.15 (0.15)	1 643 983 (2 751 789)	58 911 (111 628)	57.80 (55.10)	34 050 (61 507)	36 958 (65 934)	4 (4,8)
United Keno Hill Mines Limited, Elsa	450 (450)	- (-)	3.70 (3.59)	0.65 (0.64)	843.43 (750.17)	- (-)	50 341 (60 712)	3 175 (3 531)	30.00 (29.11)	953 (1 028)	953 (1 028)	3 (3)
Northwest Territories												
Cominco Ltd., Polaris Mine Little Cornwallis Island	2 050 (-)	- (-)	7.00 4.75	17.00 (15.34)	- (-)	- (-)	469 922 (23 277)	41 640 (1 430)	72.60 (67.15)	30 230 (960)	31 264 (1 005)	8 (8)
Nanisivik Mines Ltd., Baffin Island	2 200 (2 200)	- (-)	1.50 (1.46)	11.30 (11.31)	58.15 (62.40)	- (-)	633 621 (624 275)	12 223 (11 056)	72.19 (74.48)	8 823 (8 234)	9 180 (8 785)	5,8 (6,8)
Pine Point Mines Limited, Pine Point	10 000 (10 000)	- (-)	2.97 (2.02)	7.27 (4.78)	- (-)	- (-)	2 218 299 (3 298 655)	76 685 (78 429)	76.50 (77.16)	58 664 (60 516)	64 296 (64 723)	2,3,4,7,8 (2,3,4,7,8)

Source: Data provided by companies in response to questionnaire from Energy, Mines and Resources Canada.
[1] Includes lead in zinc, copper, silver and bulk concentrates. [2] Destination: (1) Brunswick; (2) Trail; (3) United States; (4) Japan, (5) West Germany; (6) Belgium, (7) United Kingdom, (8) Unspecified and other countries.
- Nil.

TABLE 4. CANADA LEAD-BEARING DEPOSITS CONSIDERED MOST PROMISING FOR FUTURE PRODUCTION

Company and Location	Deposit Name	Indicated Tonnage (000 tonnes)	Per Cent Lead	Lead Content (000 tonnes)
New Brunswick				
Billiton Canada Ltd. and Gowganda Resources Inc.	Restigouche	2 900	4.5	130.6
Caribou-Chaleur Bay Mines Ltd.	Caribou	44 800	1.70	761.8
Cominco Ltd	Stratmat 61	2 040	2.44	49.8
Key Anacon Mines Limited	Middle Landing	1 690	3.03	51.1
Kidd Creek Mines Ltd. and Bay Copper Mines Limited	Halfmile Lake	10 160	2.60	264.2
		61 590	2.04	1 257.5
British Columbia				
Cyprus Anvil Mining Corporation	Cirque	39 920	2.2	878.2
Yukon Territory				
Cyprus Anvil Mining Corporation	DY Zone	14 700	5.6	823.2
	Swim Lake	4 540	4.0	181.4
Hudson Bay Mining and Smelting Co., Limited	Tom	7 840	8.1	635.2
Aberford Resources Ltd. and Ogilvie Joint Venture	Jason	11 790	5.0[e]	589.7
Placer Development Limited and United States Steel Corporation	Howard's Pass	272 160[e]	3.6[e]	9 800.0
Sulpetro Minerals Limited and Sovereign Metals Corporation	MEL	4 780	1.93	92.3
		315 810	4.1	13 000.0
Northwest Territories				
Cominco Ltd. and Bathurst Norsemines Ltd.	Seven deposits	19 050	0.75	142.9
Kidd Creek Mines Ltd.	Izok Lake	11 020	1.4	154.3
Westmin Resources Limited, Du Pont Canada Inc. and Phillip Brothers (Canada) Ltd.	X-25	3 450	3.3	113.8
	R-190	1 270	6.2	78.7
		34 790	1.4	489.7
Canada		**452 110**	**3.4**	**15 625**

Source: Canadian Reserves of Copper, Nickel, Lead, Zinc, Molybdenum, Silver and Gold, as of January 1, 1981, MR 191. Energy Mines and Resources Canada, 1981.
[e] Estimated.

further $1.6 million for reconnaissance exploration in the northern part of the island.

The rich Polaris lead-zinc mine of Cominco Ltd. tuned up to near capacity production levels by March. Initially, the operation is concentrating on extracting ore from the thinner but higher quality Panhandle section of the orebody. A decline driven during the exploration phase passes the ore from the primary crusher, 170 m below the surface, to the concentrator which is on a permanently berthed barge. Capacity is 2 050 tpd.

Other lead and zinc projects under consideration are shown in Table 4.

SMELTING AND REFINING

Canada's production of primary refined lead in 1982 was 174 000 t (Table 2), up 6 000 from 1981 despite the five-week long shutdown of the largest producer, the Trail, British Columbia facility of Cominco Ltd. In response to weak world markets for lead and zinc and worldwide overcapacity, the company halted operations from June 26 to August 3. Refined lead capacity at the Trail plant is 145 000 tpy. In 1982 Cominco started a new $15 million mercury removal plant which captures mercury vapour released from concentrates during the roasting process using the Boliden/Norzink Mercury Removal Process. Among its benefits, the process will allow the smelter to process ores with higher mercury content while reducing the mercury in byproduct sulphuric acid and environmental hazards in the workplace.

Capacity utilization at Brunswick Mining and Smelting Corporation's smelter at Belledune, New Brunswick, reached 91.2 per cent in 1982. The increase in feed and improved lead grades in concentrate resulted in a record level of production. A flash smelting research project was completed on a pilot test scale at the facilities of Outokumpu Oy, Finland. Substantial recovery and cost improvements over conventional smelting are indicated from results of the tests. Present capacity at the lead smelter is 72 000 tpy.

Secondary lead production contributed an additional 67 566 t of refined lead in 1982, a decline of 2 142 t from the previous year. One secondary lead refinery operated by the Surrette Battery Co. Ltd. in Nova Scotia closed in early 1982. Nameplate capacity at the plant, built in 1964, was 3 000 tpy. Remaining secondary lead capacity stood at 123 000 t at the end of 1982.

CONSUMPTION

Canada's consumption of refined lead, as measured by producers' shipments, declined to 106 000 t in 1982, down 9 000 t from the previous year.

WORLD SCENE

MINING

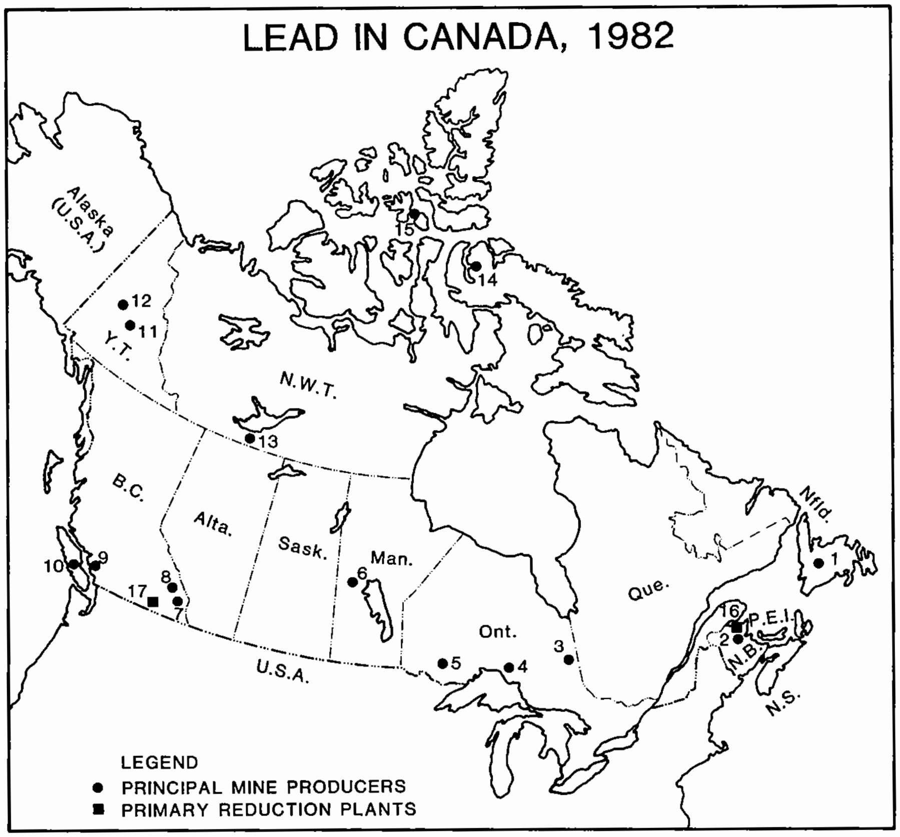
The non-socialist world's mine output of lead was 2.6 million t in 1982, the highest level since 1973 (Table 5). This is largely the result of a return to normal production levels in Ireland and the United States, increased levels of production from the Americas in general and a substantial boost in output from Australia.

In the United States, despite the closures of several major lead producing mines, and major strikes in the Missouri lead belt, total production increased by 11 per cent over 1981.

In Alaska, exploration drilling at the Red Dog deposit held by Cominco American Incorporated and Nana Regional Corp., has revealed about 85 million t of ore grading 17.1 per cent zinc, 5 per cent lead and 82 g/t silver. The target date for production is estimated to be 1986.

The poor performance of small and medium-sized Peruvian mines during the year prompted the Peruvian government to declare a state of emergency and enact a freeze on personnel layoffs. The Peruvian Miners Association, which represents 70 mines and more than half of the country's lead concentrate output, favoured more extreme cost cutting measures such as layoffs of a large number of employees. Instead the government made $120 million in credit available through its state-owned mining bank to small and medium sized mines for up to 20 per cent of the value of 1981 output when metal prices fell below a floor level. In spite of the difficulties faced by the industry, Peruvian mine output rose by 7 per cent.

The Real de Angeles mine of Minera Real de Angeles S.A. de C.V. in Mexico began production in June. This, the world's largest individual silver mine, is expected to produce 31 000 t of lead in lead-silver



Principal mine producers
(numbers refer to locations on map above)

1. ASARCO Incorporated (Buchans Unit)
2. Brunswick Mining and Smelting Corporation Limited
   Heath Steele Mines Limited (Little River Joint Venture)
3. Kidd Creek Mines Ltd.
4. Noranda Mines Limited (Geco Division)
5. Mattabi Mines Limited
   Noranda Mines Limited (Lyon Lake)
6. Hudson Bay Mining and Smelting Co., Limited
7. Cominco Ltd. (Sullivan mine)
   Teck Corporation (Beaverdell mine)
8. Dickenson Mines Limited (Silmonac mine)
9. Northair Mines Ltd. (Northair mine)
10. Westmin Resources Limited (Lynx and Myra)
11. Cyprus Anvil Mining Corporation (Faro)
12. United Keno Hill Mines Limited (Elsa)
13. Pine Point Mines Limited
14. Nanisivik Mines Ltd.
15. Cominco Ltd. (Polaris mine)

Metallurgical Plants

16. Brunswick Mining and Smelting Corporation Limited, Smelting Division, Belledune
17. Cominco Ltd., Trail

concentrates. First stage flotation is expected to produce a concentrate containing 60 per cent lead and more than 4 000 g/t silver. Mexico's mine output of lead rose by 12 per cent during 1982.

Mine production of lead in Yugoslavia declined by 5 per cent to 113 000 t of contained lead. The Zletovo-Sasa lead and zinc mines in Macedonia plan to double annual output of ore by the end of 1985 from the present 1 million t.

Spain's largest lead producer, the Aznalcollar zinc-lead-copper mine which opened in 1979, closed in December 1981 after losing $US 20 million during the year. As a result Spain's overall lead production declined substantially in 1982. In February the operator, Andaluza de Piritas SA, negotiated an agreement with its unions and pledged to re-open the mine within six months.

Société Minière et Metallurgique de Penarroya S.A. decided to close its L'Argentiere lead-zinc-silver mine in October. The mine which originally opened in 1962 has now exhausted its reserves. At last report the operation produced 30 000 tpy of combined lead and zinc concentrates.

Production and milling of ore at Tara Mines Ltd.'s Navan Mine in Ireland resumed in March. A prolonged strike which began in July 1981 halted supplies of both zinc and lead to European customers. The cost of restarting the operation was estimated at 10 million Irish pounds. The operation normally produces about 50 000 tpy of lead and 220 000 tpy of zinc in concentrates. Mogul of Ireland Ltd. closed its lead-zinc mine near Nenagh, Ireland, in July because of increasing production costs and depressed prices. In 1980 the mine produced 15 200 t of lead and 26 000 t of zinc in concentrates.

Australian mine output of lead rose substantially in 1982 to 440 000 t. In August, M.I.M. Holdings Limited started up a $26.5 million heavy medium plant at Mount Isa, Queensland as part of its lead expansion project. Contained lead production has been boosted from 150 000 tpy to 180 000 tpy. Energy saving features were incorporated into the design. EZ Industries Ltd.'s Elura lead-zinc-silver mine continues toward a start-up targeted for early 1983. The orebody contains 27 million t of proven reserves averaging 5.6 per cent lead, 8.3 per cent zinc and 139 g/t silver. The mill will have the capacity to process 1.1 million tpy of ore and is expected to yield 40 000 tpy of lead in concentrates. The Que River Mine 90 per cent owned by Aberfoyle Limited substantially boosted production from last year's start-up level. Ore grades have held up at around 7.7 per cent lead, 14.4 per cent zinc and 184 g/t silver. Indicated recoverable ore reserves are estimated at 2.4 million t.

In late October the Black Mountain Mineral Development Company Limited announced that it would close operations for three weeks in December because of the slack lead concentrate market. While sales from this new operation rose steeply in the second quarter, the cost of sales rose proportionately. This effectively cancelled increased revenues. The Gold Fields of South Africa Ltd. Group owns 51 per cent of the mine and Phelps Dodge Corporation holds 49 per cent.

Early in the year, the Republic of Korea announced the discovery of an estimated 6.3 million t of lead/zinc ore which ranges from 5 to 20 per cent combined metal content. Japan also made a promising discovery in the Hokuroku mining district of northern Honshu, Japan's major base-metal mining area. The ore, at a depth of 300 m, averages 3.02 per cent lead, 8.01 per cent zinc, 760 g/t silver and 4 g/t gold. Dowa Mining Co., Ltd. holds the mining rights in the area.

Hindustan Zinc Ltd. which is actively engaged in exploration in India, has indicated that some 61 million t of 13.4 per cent zinc and 1.57 per cent lead have been outlined in the Bhilwara district of Rajasthan. If given approval by the Indian government, the company will arrange for a mining development feasibility study. Hindustan Zinc's Rajpura-Dariba-lead-zinc mine and concentrator is scheduled to begin production next September at a rate of 3 000 tpd of ore.

The Nikolayevskiy mine in the U.S.S.R., although still under construction, has produced its first consignment of ore. The mine is the largest and the deepest of its kind in the Soviet Union and deposits are reported to be rich. First stage completion is expected in 1984.

WORLD SMELTING AND REFINING

Refined lead production in the non-socialist world fell by 112 000 t in 1982 as a result of temporary closures and permanent shutdowns

TABLE 5. WESTERN WORLD LEAD PRODUCTION AND CONSUMPTION, 1982

	Mine Production	Metal Production	Metal Consumption
	(000 tonnes)		
Europe			
Austria	4	18	53
Belgium	-	94	61
Denmark[1]	28	18	16
Finland	2	7	25
France	6	209	200
Germany F.R.	30	351	332
Greece	21	3	24
Ireland	39	10	12
Italy	16	131	243
Netherlands	-	33	60
Norway	4	0	13
Portugal	-	5	19
Spain	72	133	102
Sweden	79	50	21
Switzerland	-	7	17
United Kingdom	2	306	272
Yugoslavia	113	118	114
Total	416	1 493	1 583
Africa			
Algeria	3	5	19
Congo	6	-	-
Egypt	-	-	16
Morocco	100	59	5
Nigeria	-	2	-
South Africa[2]	125	71	57
Tunisia	5	15	4
Zaire	-	-	-
Zambia	24	15	3
Others	-	-	15
Total	263	167	119
America			
Argentina	30	31	29
Bolivia	13	-	-
Brazil	26	48	55
Canada	341	242	99
Chile	1	-	-
Columbia	-	-	-
Honduras	15	-	-
Mexico	168	152	93
Peru	201	82	19
United States	543	1 023	1 088
Venezuela	-	10	15
Others	-	9	16
Total	1 338	1 597	1 414
Asia			
Burma	4	4	-
Hong Kong	-	-	-
India	15	23	68
Indonesia	-	5	-
Iran	24	-	30
Japan	46	302	354
Korea Rep.	10	15	36
Malaysia	-	-	11
Phillippines	-	6	12
Taiwan	-	35	30
Thailand	18	6	16
Turkey	8	6	8
Other	-	6	39
Total	125	408	604
Oceania			
Australia	444	255	56
New Zealand	-	6	13
	444	261	69
Total Non-Socialist World	2 586	3 926	3 788

TABLE 5. (cont'd)

Source: International Lead and Zinc Study Group.
[1] Includes Greenland. [2] Includes Namibia
- Nil.
Totals may not add due to rounding.

mostly in the secondary sector (Table 5). Reduced scrap lead collection due to low lead prices and higher scrap collection costs have meant lower returns to the scrap recyclers.

It is estimated that in the non-socialist world 296 000 tpy of secondary capacity closed in 1982. Most of the shutdowns occurred in the United States where it is estimated that 213 000 tpy of capacity were progressively closed. Remaining operators were reported to be operating at only 50-55 per cent of capacity. As a result, refined lead production declined by 4.1 per cent in the United States to 1.023 million t in 1982.

The reopening of operations at the Kellogg, Idaho lead-zinc smelter of The Bunker Hill Co. has again become a possibility when metal markets improve. The closure of this plant, which produced a fifth of U.S. primary lead output in late 1981, moderated the effects of slack markets. It is not expected, however, that it will operate near its previously rated capacity of 118 000 tpy of lead and 99 000 tpy of zinc.

The U.S. Labour Department's Occupational Safety and Health Administration twice extended an initial June 29 deadline for primary and secondary refiners to comply with a program to reduce worker exposure to lead.

In Mexico the Monterrey smelter of Industrial Minera Mexico S.A. resumed production on September 24 after a strike that lasted nearly 12 weeks. In 1981 the smelter produced 67 000 t of lead, 449 t of silver and 1 256 kg of gold. Peruvian output of refined lead was 3 000 t higher than in 1981, when labour-management difficulties slowed output at Empresa Minera del Centro del Peru S.A.'s (CENTROMIN) refinery. In West Germany, an increase in refined lead production of 3 000 t to 351 000 t was registered in spite of reported shortages of scrap feed at secondary producers. For this reason Metallgesellschaft AG halted production at its 35 000 tpy smelter at Braubach for eight weeks beginning in mid-July.

In response to inflationary pressures which followed the devaluation of the franc at mid-year, the French government instituted a nation-wide price freeze on June 14. Under pressure from the nonferrous metals industry to rescind the four-month-long measure, the French government agreed to an exemption allowing producers to adjust to the international market. This was announced after special exemptions to the freeze had initially been denied.

Compagnie Française des Mines du Laurium proceeded with plans to close its 30 000 tpy lead smelter in Laurium, Greece in early 1982. The company negotiated with the Greek government after losses were incurred in 1981, asking the government to purchase a stake in the company. The offer was refused and the plant was closed. Later in the year, however, several proposals were submitted to the government by a Finnish firm. One outlined the installation of a new lead smelting plant with a capacity of 40 000 tpy.

Japan's metal production dropped by 4.7 per cent in 1982. Efforts to promote the rationalization of the industry, the development of energy-saving technology and new uses for lead are nonetheless being made. Consideration is being given to a new 50 000 tpy lead refinery in Mindanao, Philippines. Mount Isa Mines Ltd. and Britannia Refined Metals Ltd. are reported to be involved in this proposal.

The completion of a new 50 000 tpy lead refinery in the Republic of Korea, has been rescheduled for 1985. Korea Zinc Co. Ltd. expects that the new refinery at Onsan will mean that South Korea will have to start importing concentrates as its domestic source is limited to approximately 22 000 tpy. By 1985 Korea will have to import 100 000 tpy of lead concentrates. The Korean government is likely to continue its policy of encouraging Korean investment in offshore mineral development including nonferrous metal mines. Interest has already been demonstrated in Canada as a supplier.

Iran announced plans for a smelter with a capacity of 35 000 - 40 000 tpy early in 1982. Production is expected to begin in 1987-88. Iranian reserves are thought to be sufficient to supply the facilities for about 50 years.

Société Minière et Métallurgique de Tunisia has engaged foreign consultants to refurbish or replace its lead smelter at Megrine in south Tunis. The cost of the project is expected to be $30 million. Several companies have shown interest, including Société Minière et Métallurgique de Penarroya S.A. of France (the former owner of the smelter), The SNC Group of Canada, and a consortium of Canadian and European firms.

CONSUMPTION AND STOCKS

The non-socialist world's consumption of lead metal in 1982 fell for the third consecutive year to 3.8 million t or 2.5 per cent lower than in 1981 (Table 5). Among European consumers, Belgium, Denmark, Ireland, the Netherlands, Norway, Switzerland and the United Kingdom were the only countries which recorded a higher level of consumption for 1982. Overall European consumption dropped to 1 583 000 t from 1 595 000 t in 1981.

Increased consumption in South Africa, Egypt, Algeria and Zambia underlie the slight overall rise in Africa's consumption. In the Americas, lead consumption declined in all significant consuming countries. For the United States and the Americas as a whole, declines of 3.5 per cent and 3.6 per cent respectively, were registered. Consumption in the United States was 1 088 000 t with the greatest decline measured for storage batteries (Table 6). While some Asian countries (India, Iran, Thailand) increased their demand for lead metal, a 7.3 per cent decline in Japan's

TABLE 6. UNITED STATES CONSUMPTION OF LEAD BY END-USE, 1981 AND 1982

	1981	1982P
	(tonnes)	
Storage batteries	770 152	522 109
Gasoline antiknock additives	111 367	119 233
Solder, type metal, terne metal and bearing metals	48 436	33 174
Pigments	80 165	50 686
Ammunition - shot and bullets	49 514	43 828
Sheet and pipe	28 184	12 171
Cable covering	12 072	14 545
Caulking	5 522	1 951
Other uses	61 689	30 928
Total reported[1]	1 167 101	828 625
Estimated undistributed consumption	-	237 600
Grand Total	1 167 101	1 066 225

Source: United States Bureau of Mines, Mineral Industry Surveys, Lead Industry in December 1982.
[1]Includes lead content of scrap used directly in fabricated products.
P Preliminary; - Nil.

consumption was the major reason for the overall reduction of 13 000 t in Asian consumption compared to 1981.

The combination of weakening demand for lead metal, lower net imports by socialist countries and a relatively small decline in overall metal production led to large increases in stocks during 1982. The most spectacular rise was in London Metal Exchange (LME) stocks. Holdings at the LME doubled from January's month-end level of 60 500 t to a year-end high unmatched in previous years, 126 000 t.

Lagging demand for lead also forced producers to stockpile more of their output. Producer stocks peaked at 270 000 .at the end of June - up 29 per cent from June 1981 - and then declined to 244 000 t at the end of December. Consumer stocks declined to 191 000 t by the end of 1982, a drop of 23 000 t from the 1981 level.

PRICES

The price of lead responded strongly to the oversupply situation that developed in 1982 (Table 7). The LME settlement price fell from a monthly average of £354/t in December 1981 to a low of £296 in June. A short-lived recovery brought the price to £318/t in July but it then slid, averaging £275/t in December.

The U.S. producer price averaged 31.07 cents per pound in December 1981 and dropped steadily to 24.76 cents in June 1982. Thereafter it wavered around 26 cents before it dropped to an average of 21 cents per pound in December.

The Canadian producer price for lead sold in Canada opened the year at 40 cents per pound and then declined to 32 cents in early June. During this period the Canadian dollar slipped significantly against its U.S. counterpart. The average noon spot rate declined from $US 0.8386 per Canadian dollar in January to 0.7841 in June. The declining value of the Canadian dollar during this period moderated the price drop in Canada. The price of Canadian lead rose briefly to 36.0-36.5¢ in mid-July and then declined by year-end to 27-27.5¢.

TABLE 7. LEAD METAL PRICES, 1982

Month	London Metal Exchange Spot	U.S. Domestic Delivered Price	Canada Delivered Carlots
	£ per tonne	¢ per pound	$ per pound
January	343.7	29.7	36.63
February	334.6	28.7	36.13
March	339.3	27.6	33.80
April	324.3	26.1	33.00
May	317.5	26.1	33.00
June	296.4	24.8	32.13
July	318.3	27.2	36.00
August	303.1	25.8	33.20
September	301.0	25.3	32.50
October	293.3	23.2	32.50
November	283.3	21.6	29.50
December	277.2	20.5	27.50
1982 Average	311.0	25.5	32.9
1981 Average	362.5	36.5	44.5

Source: Metals Week and Northern Miner quotes as compiled by Energy, Mines and Resources Canada.

TRADE

Significant declines in exports of lead ores and concentrates from major producers such as Canada, Peru, Morocco, Sweden and Greenland eased the oversupply situation that persisted throughout 1982 in the raw materials market. France's imports of lead concentrate in 1982 grew by 16 000 t to 109 000 t (metal content) because of exhaustion of the L'Argentiere mine. West Germany's requirements dropped to 109 000 t from 122 000 t in 1981. Japan's requirements were nearly the same as in 1981 at 137 000 t.

Exports of lead bullion from Australia rose 28 000 t in 1982 from a relatively low level of 137 000 t in 1981. Imports of lead bullion increased significantly over depressed 1981 levels for major purchasers such as the United Kingdom, West Germany, Italy and the Netherlands.

Some major producers of refined lead - Australia, Canada, West Germany, Sweden and Morocco - increased their exports of metal in 1982 while exports from others such as Peru, Mexico and the United Kingdom declined. Declining consumption in the non-socialist world in 1982 was also evident from the stagnant or declining level of refined lead purchases by major importing nations such as Italy, the United States, Japan, the United Kingdom, India and the Netherlands.

Net trade with the socialist world also weakened during 1982. The International Lead and Zinc Study Group estimates that a net 72 000 t of lead in concentrates was imported by the socialist world in 1982, 33 000 t less than in 1981. Net socialist imports of refined metal declined by 15 000 t to 116 000 t.

GOVERNMENT INITIATIVES

On November 1, 1982, the U.S. Environmental Protection Agency tightened regulations on the lead content of gasoline for both large and small gasoline refineries. The new standard limits large refineries to 1.10 grams per gallon for leaded gasoline. The previous standard allowed refineries to average or pool the lead content of all gasoline, leaded or unleaded. Small refineries are subject to a new 1.90 gram per gallon standard until July 1, 1983 when they will also have to comply with the standard set for the large refineries. In addition, the new standard applies to imported leaded gasoline which was previously exempted, but quarterly averaging is still allowed for importers.

USES

Future prospects for the electric vehicle (EV) battery market suffered a setback in 1982 with sharp reductions in U.S. government funding for research in this area. This has left only the private sector to fund further research for this potential market. As a result of the cutback, the Lead Industries Association, a non-profit trade association which represents both producers and consumers of lead and lead products, shifted its emphasis from promoting personal passenger EV's to fleet-owned-and-operated cars, vans and trucks. Another major project was launched by the Association in 1982. Testing of a lead-based asphalt stabilizing compound, lead dialkyldithiocarbamate, began on a stretch of highway pavement in Ontario. Some predict a potential market of 36 000 tpy in North America.

OUTLOOK

With continued declines in overall non-socialist world consumption of lead and expected declines in net exports to socialist countries, the outlook continues to be less than encouraging for higher-cost primary lead producers. A slight rise in non-socialist world consumption to 3.9 million t is expected in 1983 but this presupposes that the elusive upturn in the world economy materializes. Should this not develop, 1983 could be a critical year for the primary sector. Clearly, the cutbacks already enacted by the higher-cost secondary lead producers in 1982 could lead to opportunities for the primary lead producers if there is a marginal rise in demand, although profits and prices would probably remain relatively low. In the more extreme case, given further declines in demand, extended or more closures in the primary sector could result.

Programs to reduce production costs in Canada's lead mines and refineries have already been a feature of corporate strategy throughout 1982. This will be essential in 1983 as well. Under these circumstances, a continuous challenge will be to ensure the longer term health of the industry through ongoing exploration and development of Canadian lead-zinc-silver ores.

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
32900-1	Ores of lead	free	free	free	free
33700-1	Lead, old scrap, pig and block	free	free	1¢/lb	free
33800-1	Lead in bars and in sheets	4.6%	4.6%	25%	3%
33900-1	Manufacturers of lead not otherwise provided for	14.8%	14.8%	30%	free*

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
			(%)			
33800-1	4.6	4.5	4.4	4.3	4.1	4.0
33900-1	14.8	13.9	12.9	12.0	11.1	10.2

UNITED STATES (MFN)

602.10	Lead bearing ores per lb. on lead content	0.75¢
624.02	Lead bullion	3.5%
624.03	Other	3.5%

		1982	1983	1984	1985	1986	1987
				(%)			
624.04	Lead waste etc.	3.2	3.0	2.8	2.7	2.5	2.3

EUROPEAN ECONOMIC COMMUNITY: (MFN)

		1982	Base Rate	Concession Rate
			(%) (unless otherwise specified)	
26.01	Lead ores & concentrates	free	free	free
78.01	Lead unwrought	3.5	3.5	3.5
	Lead waste & scrap	free	free	free

JAPAN (MFN)

26.01	Lead ores & concentrates	free	free	free
78.01	Lead unwrought			
	Unalloyed	6.9	7.5	6.0
	Alloyed	7.88 yen/kg	12.0	6.5
	Other	7.5 yen/kg	7.0	4.7
	Lead waste & scrap	1.9	5.0	3.2

Sources: The Customs Tariff and Commodities Index, January 1982, Revenue, Canada; Tariff Schedules of the United States Annotated (1982), USITC Publication 1200; U.S. Federal Register Vol. 44, No. 241; Official Journal of the European Communities, Vol. 24, No. L 335, 1981; Customs Tariff Schedules of Japan, 1981.

* Pending passage by Parliament of the notice of Ways and Means motion tabled on November 12, 1981 (D47-543E), entries entitled to the General Preferential Tariff "Subject to Amendment".

Lime

D.H. STONEHOUSE

SUMMARY 1982

Canadian lime shipments in 1982 were down 14 per cent from 1981 levels because of reduced demand from major consuming sectors. Lime, once used mainly as a construction material, is now used principally in the steel, pulp and paper and mining industries where its chemical qualities are required as a flux, in digesting liquors and as a neutralizing agent. Significant markets in the environmental control field have not developed as predicted but there is great opportunity in such areas as water and sewage treatment and in the removal of SO_2 from smelter stack gases and from thermal power plant emissions.

There were no major developments or changes to the industry structure in Canada during 1982. Total capacity remained in the range of 12 000 tpd and the industry is able to meet foreseeable demand across the country from existing capacity.

Domtar Inc. closed its Bellefonte, Pa. plant in the United States June 30 because of reduced demand from the steel industry.

Periodic interest in markets for magnesia have given rise to investigations into the development of dolomitic limestone or of magnesite deposits. During 1982 a German-owned company, Refractechnik GmbH, having purchased a magnesite property near Radium Hot Springs, British Columbia from Baymag Mines Co. Limited of Calgary, proposed to process the magnesite in one of Canada Cement Lafarge Ltd.'s kilns at Exshaw, Alberta to produce a high-purity magnesium oxide. The company planned to market the magnesia as an agricultural industry feed supplement and as a desulphurizing material.

USES AND OUTLOOK

Carbonate rocks are basic to industry. They form about 15 per cent of the earth's crust 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 dolomites - sedimentary rocks composed mainly of the mineral dolomite ($CaCO_3 \cdot MgCO_3$). 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 as the primary material in the manufacture of portland cement and lime. Limestones are also used as flux material, in glass manufacture, as refractories, fillers, abrasives, soil conditioners and in the manufacture of a host of chemicals.

Quicklime (CaO or $CaO \cdot MgO$) 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. Although the word "lime" is used generally, and wrongly, to refer to pulverized limestone as well as to forms of burned lime, it should refer only to calcined limestone (quicklime) and its secondary products, slaked lime and hydrated lime. Slaked lime is the product of mixing quicklime and water, hydrated lime is slaked lime dried and, possibly, reground.

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 high 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.

Although quicklime and hydrated lime are not of relatively high monetary value, they are transported considerable distances in bulk or in packages if a market exists.

TABLE 1. CANADA, LIME PRODUCTION AND TRADE, 1981 AND 1982

	1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)
Production[1]				
By type				
Quicklime	2 359 000	142,070	2 010 000	..
Hydrated Lime	196 000	11,804	181 000	..
Total	2 555 000	153,874	2 191 000	148,861
By province				
Ontario	1 773 000	106,815	1 463 000	99,484
Quebec	365 000	21,956	329 000	22,444
Alberta	183 000	11,047	159 000	10,812
British Columbia	111 000	6,671	107 000	7,077
Manitoba	..	4,450	..	5,100
New Brunswick	..	2,935	..	3,944
Total	2 555 000	153,874	2 191 000	148,861
Imports				
Quick and hydrated				
United States	23 101	1,911	15 875	1,500
France	43	51	88	43
Total	23 144	1,962	15 963	1,543
Exports				
Quick and hydrated				
United States	430 960	25,621	280 650	17,840
Honduras	1 244	218	-	-
Barbados	415	35	-	-
Other countries	226	25	487	104
Total	432 845	25,899	281 137	17,944

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Producers' shipments and quantities used by producers.
P Preliminary; - Nil; .. Not available.

TABLE 2. CANADA, LIME PRODUCTION, TRADE AND APPARENT CONSUMPTION, 1970, 1975, 1978-82

	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
1978	1 857 580	176 631	2 034 211	31 130	478 552	1 586 789
1979	1 662 405	196 920	1 859 325	41 480	490 863	1 409 942
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
1982P	2 010 000	181 000	2 191 000	15 963	281 137	1 925 826

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Producers' shipments and quantities used by producers. [2] Production, plus imports, less exports.
P Preliminary.

TABLE 3. CANADIAN LIME INDUSTRY, 1982

Company	Plant Location	Type of Quicklime
New Brunswick		
Havelock Processing Ltd.	Havelock	High-calcium[2]
Quebec		
Domlim Inc.	Lime Ridge	High-calcium[2]
	St. Adolphe de Dudswell	High-calcium
Domtar Inc.	Joliette	High-calcium[2]
Gulf Canada Limited, Shawinigan Chemical Division	Shawinigan	High-calcium[2]
Quebec Sugar Refinery[1]	St.-Hilaire	High-calcium
Ontario		
The Algoma Steel Corporation, Limited[1]	Sault Ste. Marie	High-calcium and dolomitic
Allied Chemical Canada, Ltd.[1]	Amherstburg	High-calcium
BeachviLime Limited	Beachville	High-calcium
Guelph DoLime Limited	Guelph	Dolomitic[2]
Chromasco Limited[1]	Haley	Dolomitic
Domtar Inc.	Beachville	High-calcium[2]
Reiss Lime Company of Canada, Limited	Spragge	High-calcium
Stelco Inc.	Ingersoll	High-calcium
Steetley Industries Limited	Dundas	Dolomitic
Manitoba		
Alberta Sugar Company[1]	Fort Garry	High-calcium
Steel Brothers Canada Ltd.	Faulkner	High-calcium
Alberta		
Canadian Sugar Factories Limited[1]	Taber	High-calcium
	Picture Butte	High-calcium
Steel Brothers Canada Ltd.	Kananaskis	High-calcium[2]
Summit Lime Works Limited	Hazell	High-calcium and dolomitic[2]
British Columbia		
Steel Brothers Canada Ltd.	Kamloops	High-calcium
Texada Lime Ltd.	Fort Langley	High-calcium

[1] Production for captive use. [2] Hydrated lime produced also.

Freight costs can represent a large part of the consumer's cost. Production costs have increased significantly as a result of higher energy costs. The industry, on average, uses about 6.4 gigajoules per t of production. New plants have incorporated preheater systems, and the need to replace some of the older less-efficient production capacity with fuel-conserving equipment is well recognized. A new-design, short-rotary kiln (65 metres) and preheater system can reduce energy consumption to about 5.1 gigajoules per t of product.

THE CANADIAN SCENE

Lime is a high-bulk, comparatively low-cost commodity and it is uncommon to ship it long distances when the raw material for its manufacture is available in so many localities. The preferred location for a lime plant is obviously near the 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 produced over 80 per cent of

TABLE 4. CANADA, CONSUMPTION OF LIME, QUICK AND HYDRATED, 1980 AND 1981 (PRODUCERS' SHIPMENTS AND QUANTITIES USED BY PRODUCERS, BY USE)

	1980		1981P	
	(tonnes)	($000)	(tonnes)	($000)
Chemical and metallurgical				
Iron and steel plants	1 169 281[2]	59,166	1 237 519[2]	74,529
Pulp and paper mills	303 484	15,356	271 945	16,378
Water and sewage treatment	113 219	5,729	22 760[3]	1,371
Nonferrous smelters	113 818[2]	5,759	117 632[2]	7,085
Cyanide and flotation mills	68 805[2]	3,481	(4)	(4)
Sugar refineries	19 006	962	25 841	1,556
Other industrial[1]	643 531	32,563	690 040	41,557
Agricultural	17 084[3]	864	17 370	1,046
Road stabilization	8 716[3]	441	9 338[3]	565
Other uses	97 056	4,911	162 555	9,787
Total	2 554 000	129,232	2 555 000	153,874

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Includes glassworks, fertilizer plants, tanneries, uranium plants and other miscellaneous industrial uses. [2] Figures represent quicklime only. Figures for hydrated lime are included in "other industrial" to avoid disclosing confidential company information. [3] Figures represent hydrated lime only. Figures for quicklime are included in "other uses". [4] Confidential figures are included in "other industrial works".
P Preliminary.

Canada's total lime output in 1982, with Ontario contributing about two-thirds of Canada's total. Production figures do not include some captive production such as that from pulp and paper plants that burn sludge to recover lime for reuse in the causticization process.

Exports of lime were down 35 per cent from 1981. Canadian companies operating lime plants in the United States include Steel Brothers Canada Ltd. with a new plant at Delta, Utah and Steetley Industries Limited with a plant at Gibsonburg, Ohio.

The metallurgical industry provides the largest single market for lime. With increased application of the basic oxygen furnace (BOF) in the steel industry, lime consumption increased greatly in certain areas of the United States and Canada. An increase in the demand for steel will result in the need for more fluxing lime and will encourage the development of captive sources by steel producers. The pulp and paper industry is currently the second-largest consumer of lime, most of which is used in the preparation of digesting liquor and in pulp bleaching. Any reduction of activity in either of these two industry sectors, brought on by strikes or lack of product demand, can have an immediate and serious effect on the lime industry, at least regionally. Developments in mechanical fiberizing in the pulp industry could reduce the current lime requirements of this industry significantly.

The uranium industry uses lime to control hydrogen-ion concentrations during uranium extraction, to recover sodium carbonate and to neutralize waste sludge. In the production of beet sugar, lime is used to precipitate impurities from the sucrate. It is used also in the manufacture of many materials such as calcium carbide, calcium cyanamide, calcium chloride, fertilizers, insecticides, fungicides, pigments, glue, acetylene, precipitated calcium carbonate, calcium hydroxide, calcium sulphate, magnesia and magnesium metal.

The rapidly-growing concern for the safeguarding and treatment of water supplies and the appeal for enforced anti-pollution measures should result in greater use of lime for water and sewage treatment. The removal of sulphur dioxide (SO_2) from hydrocarbon fuels, either during the burning procedure, or from stack gases by either wet or dry scrubbing, could necessitate the use of lime. This may become a major market for

TABLE 5. WORLD PRODUCTION OF QUICKLIME AND HYDRATED LIME INCLUDING DEAD-BURNED DOLOMITE SOLD AND USED, 1981 AND 1982

	1981p	1982e
	(000 tonnes)	
U.S.S.R.	25 002	24 494
United States	17 137	13 245
West Germany	8 546	7 983
Japan	8 509	7 983
Poland	6 749	6 350
Brazil	4 990	4 536
Mexico	4 627	..
Romania	3 810	..
France	3 679	3 175
East Germany	3 402	..
Belgium	3 221	2 722
United Kingdom	3 003	..
Czechoslovakia	2 994	..
Yugoslavia	2 703	..
Canada	2 059	1 814
Italy	1 956	1 724
Other countries	14 556	33 203
Total	116 943	107 229

Sources: Energy, Mines and Resources Canada; Statistics Canada; U.S. Bureau of Mines Minerals Yearbook Preprint 1981; U.S. Bureau of Mines, Mineral Commodity Summaries, 1983.
p Preliminary; e Estimated; .. Included in other countries.

this commodity as SO_2 emission regulations are developed. Lime is effective for this purpose, inexpensive, and can be regenerated in systems where the economics would so dictate. The creation of large amounts of gypsum waste sludge during SO_2 removal will present a disposal problem. Paradoxically, the lime industry is itself caught up in the clean-up campaigns sponsored by various levels of government, particularly efforts directed at dust removal.

Soil stabilization, especially for highways, offers a potential market for lime. However, not all soils have the physical and chemical characteristics to react properly with lime to provide a dry, impervious, cemented and stable roadbed. Hydrated lime added to asphalt hot-mix prevents the asphalt from stripping from the aggregate. This could become more important as new technologies relating to asphalt maintenance and repair are adopted and as the sources of good clean aggregate become scarce.

The use of lime-silica bricks, blocks and slabs has not been as popular in Canada as in European countries, although lightweight, cellular, insulating masonry forms have many features attractive to the building construction industry.

Markets for lime are not likely to show marked improvement until the total economy begins to improve.

PRICES

Canada lime prices quoted in Corpus Chemical Prices

	December 1982
Lime carloads and truckload lots fob plant	
High calcium quicklime - bulk	$65.04 per tonne
High calcium hydrated - bulk	$67.96 per tonne

fob - Free on board.

TARIFFS

CANADA

Item No.		British Preferential	General Preferential	Most Favoured Nation	General
29010-1	Lime	free	free	free	25%

UNITED STATES (MFN)

512.11	Lime hydrated	free
512.14	Lime other	free

Sources: The Customs Tariff and Commodities Index, January 1982, Revenue Canada; Tariff Schedules of the United States Annotated 1982, USITC Publication 1200; U.S. Federal Register, Vol. 44, No. 241.

Manganese

D.G. LAW-WEST

Manganese is essential in the production of nearly all types of steel and approximately 95 per cent of all manganese produced is consumed by the iron and steel industry. Accordingly, the demand for manganese ores is essentially determined by the world production of iron and steel. Manganese is considered to be a strategic commodity because of its critical role in iron and steel making, for which there are no acceptable substitutes.

CANADA

Canada has no domestic producers of manganese ore although several low-grade deposits have been identified in Nova Scotia, New Brunswick and British Columbia. The largest of these deposits, located near Woodstock, New Brunswick is reported to contain about 45 million t of mineralization grading 11 per cent manganese and 14 per cent iron. Although processes have been developed to utilize such low-grade deposits, commercial production is unlikely to be economic at current manganese prices.

The two ferromanganese producers in Canada, Union Carbide Canada Limited and Chromasco Limited, use imported metallurgical-grade manganese ore as feed material. These companies have plants at Beauharnois, Quebec and both sell their production mainly to domestic steel producers.

Union Carbide operates a 30 MW furnace with annual capacity of 87 000 t of standard ferromanganese. The same furnace is also used periodically to produce silicomanganese. However, output is reduced since silicomanganese production requires more power than for ferromanganese production. During 1982, Union Carbide operated near capacity although, with demand from the steel companies greatly reduced, substantial inventories were accumulated. The company expects to operate at reduced output during most of 1983.

The 1981 agreement between Union Carbide Canada and the Elkem A/S-led consortium remained in force throughout 1982. The agreement gives Elkem the option to buy the company's ferroalloy operations at Beauharnois and Chicoutimi, Quebec, as well as the Metals Division in Toronto, by the end of 1987. The option period will allow Elkem to find Canadian investment participants in order to obtain approval of the sale by the Foreign Investment Review Agency. Concurrent with its press release on the Canadian option, Union Carbide Corporation announced the sale of its ferromanganese and silicomanganese operations in the United States and Norway to the same Elkem-led group.

Chromasco Limited shut down three of its four furnaces at Beauharnois early in the year. This action effectively reduced Chromasco's output by 85 per cent. In addition to ferromanganese, the company also produces ferrosilicon at the Beauharnois plant.

Canada also imports manganese metal, an important additive in specialty steels as well as in aluminum alloys. The main consumers of manganese metal are Atlas Steels, a Division of Rio Algom Limited, Aluminum Company of Canada, Limited (Alcan) and Reynolds Aluminum Company of Canada Ltd.

High-purity manganese dioxide and battery-grade manganese ores are imported into Canada by various companies including Duracell Inc., Gould Manufacturing of Canada, Ltd. (Industrial Battery Division), Cominco Ltd. and Canadian Electrolytic Zinc Limited (CEZ).

WORLD DEVELOPMENTS

Estimated world manganese ore production dropped nearly 8 per cent to 24 million t in 1982 from 26 million t in 1981, mainly due to reduced demand from the steel industry.

TABLE 1. CANADA, MANGANESE, TRADE AND CONSUMPTION, 1981 AND 1982

	1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)
Imports				
Manganese in ores and concentrates[1]				
Gabon	59 076	11,241	37 816	7,508
Brazil	12 468	2,512	19 935	4,023
South Africa	43 051	5,620	10 746	2,011
United States	5 147	2,194	3 158	1,209
Mexico	4	1	-	-
French Africa	-	-	-	-
Total	119 746	21,568	71 655	14,751
Manganese metal				
South Africa	9 684	11,990	430	769
United States	383	582	201	341
People's Republic of China	224	333	150	204
Other countries	80	132	-	-
Total	10 371	13,037	781	1,314
Ferromanganese, including spiegeleisen[2]				
United States	15 995	18,190	11 319	11,243
South Africa	16 344	8,314	11 335	5,985
France	290	296	1 693	675
Mexico	229	126	541	433
Norway	3 798	3,351	200	120
Total	36 656	30,277	25 088	18,456
Silicomanganese, including silicospiegeleisen[2]				
Norway	2 476	1,601	1 537	866
South Africa	4 563	2,167	960	482
United States	4 396	3,740	380	372
Other countries	1 234	588	-	-
Total	12 669	8,096	2 877	1,720
Exports				
Ferromanganese[2]				
United States	56 584	24,989	11 440	4,549
Puerto Rico	217	99	157	81
Jamaica	92	72	-	-
Other countries	147	85	141	17
Total	57 040	25,245	11 738	4,647
Consumption				
Manganese ore				
Metallurgical grade	284 607	..	..	..
Battery and chemical grade	4 301	..	..	..
Total	288 908	..	..	..

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

[1] Mn content; [2] Gross weight.
P Preliminary; - Nil; .. Not available.

South Africa remained the largest supplier of manganese in the western world by producing about 4 million t of ore in 1982. This amount is down about 20 per cent from the previous year.

Australian production from the Groote Eylandt Mining Company Proprietary Ltd. mine decreased by 18 per cent to 1.12 million t following a planned reduction of operations, which was announced in 1981, because of depressed demand. Output fell to less than 50 per cent of the 2.3 million tpy production capacity.

Brazil continued with development plans for the huge manganese ore deposits in the Carajas area. Manganese reserves have been estimated in the order of 40 million t of high grade ore suitable for ferromanganese production.

USES

The excellence of manganese as a desulphurizer has made this metal an irreplaceable input in the steel industry. Steels containing excess sulphur are not homogeneous and tend to crack and tear during rolling and forming. Manganese combines with the sulphur to produce a manganese sulphide slag, which is readily separated from the steel. The metal also acts as a deoxidizer during the steelmaking process.

Manganese is usually added to steel in the form of a ferroalloy such as ferromanganese or silicomanganese. Steel mills in Canada use about 5.8 kilograms (kg) of manganese per t of crude steel produced.

Specialty steels frequently contain manganese to increase strength and hardness. Manganese metal is normally used in preference to ferromanganese in making these specialty steels because it provides better control of the manganese and impurities content.

Hadfield steel, a type of specialty steel, contains between 10 and 14 per cent manganese. These steels are extremely hard and tough, and are particularly suited for applications such as rock crusher parts and teeth in earth-moving machinery.

Iron used for castings is desulphurized with manganese. Otherwise, the sulphur causes surface imperfections and makes precision casting difficult.

Also, manganese is used to form alloys with nonferrous metals: aluminum-manganese alloys are noted for their strength, hardness and stiffness; manganese-magnesium alloys are hard, stiff and corrosion resistant; and manganese bronzes have properties desirable in specific applications such as ship propellers.

TABLE 2. CANADA, MANGANESE IMPORTS, EXPORTS AND CONSUMPTION, 1970, 1975, 1978-82

	Imports			Exports	Consumption	
	Manganese Ore[1]	Ferro-Manganese	Silico-Manganese	Ferro-Manganese	Ore	Ferromanganese and Silicomanganese
	(gross weight, tonnes)					
1970	115 052	17 891	975	510	153 846	97 952
1975	69 773	35 701	5 732	1 168	160 976	95 869
1978	136 446	26 812	15 842	19 924	201 320	69 349
1979	45 150	83 700	21 876	12 043	64 699	89 429
1980	95 161	26 704	20 901	11 278	157 680r	95 796
1981	119 746	36 656	12 669	57 040	288 908	83 958
1982P	71 655	25 088	2 877	11 738	..	..

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

[1] Mn content.
P Preliminary; r Revised; .. Not available.

Manganese has many nonmetallurgical applications including its use in dry-cell batteries. In this role, manganese dioxide provides oxygen to combine with hydrogen, which permits the battery to operate at maximum efficiency. Manganese ores used for batteries must grade above 85 per cent manganese dioxide and have a low iron content. Very few natural manganese dioxide ores can meet these specifications, and most batteries consequently contain a blend of natural ore and synthetic manganese dioxide.

A common classification of manganese ore gives rise to the following ore types: (1) Manganese ores containing more than 35 per cent manganese: these are used in the manufacture of both low- and high-grade ferromanganese. Although battery-grade ores are included in this class, these ores must contain no less than 85 per cent manganese dioxide. (2) Ferruginous manganese ores containing 10 to 35 per cent manganese and used in the manufacture of spiegeleisen. (3) Manganiferous iron ores containing 5 to 10 per cent manganese and used to produce manganiferous pig iron.

All types of manganese ores can be employed in the production of manganese chemicals such as: potassium permanganate, a powerful oxidant used in the purification of public water supplies; manganese oxide, an important addition to welding rods and fluxes; and an organometallic form of manganese, which inhibits smoke formation and improves the combustion of fuel oil. Various manganese chemicals are employed to produce colour effects in face bricks and, to a lesser extent, to colour or decolour glass and ceramics.

TABLE 3. WORLD PRODUCTION OF MANGANESE ORES, 1979-81

	Mn	1979[r]	1980[p]	1981[e]
	(%)		(000 tonnes)	
U.S.S.R.	35	10 244	9 750	9 398
Republic of South Africa	30-48+	5 182	5 695	5 039
Brazil	38-50	2 259	2 360	1 896
Gabon	50-53	2 300	2 147	1 488
Australia	37-53	1 698	1 961	1 409
India	10-54	1 755	1 645	1 497
People's Republic of China[e]	20+	1 497	1 588	1 597
Mexico	35+	493	447	578
Ghana	30-50	272	252	225
Morocco	50-53	136	131	110
Hungary	30-33	83	88	82
Japan	24-28	88	80	87
Thailand	46-50	35	54	11
Bulgaria	30-	42	49	50
Other countries[1]	..	141	142	106
Total	..	26 225	26 389	23 573

Source: U.S. Bureau of Mines, **Mineral Yearbook**, 1981.

[1] Includes 15 countries, each producing less than 42 000 tpy.
P Preliminary; [e] Estimated; [r] Revised; .. Not available.

PRICES

Price negotiations for metallurgical grade manganese ore are normally concluded from April to June of each year. However, in 1982, negotiations were concluded in early February as ore producers, facing a weak market, made price concessions to consumers in order to maintain market share.

The trend-setting negotiation for 1982 occurred when Cie Minière de Ogoové (COMILOG) (Gabon) reduced its ore price by $US 5 a t to $US 82.36 a t c.i.f. Japan. Industria e Comercio de Minerios S.A. (ICOMI) (Brazil) followed by reducing the price of its ore to $US 81.30 a t c.i.f. Japan.

The South African producers initially offered a reduction of $US 3 a t. However, the reduction was quickly increased to $US 5.30-6.00 a t to bring prices in line with other producers.

Ferromanganese prices were quoted at the nominal levels of $US 4.98 a t during 1982. However, spot sales were reported at $US 3.90-4.15 a t throughout the year.

Manganese metal prices weakened from $US 1.76 a kg to $US 1.54 a kg during the year. The depressed aluminum market, which consumes about 40 per cent of manganese metal production, was the main reason for the depressed prices.

OUTLOOK

The outlook for manganese is closely linked to steel production forecasts because 95 per cent of manganese produced is used by the steel industry.

The short-term demand for manganese is forecast to continue in a depressed state due to the slow recovery expected in the world steel industry. There is considerable uncertainty as to the outcome of manganese ore contract negotiations in 1983. Manganese consumers achieved reductions in the real price of ore during 1982 when producers attempted to protect their market share. At year-end, consumer inventories were not excessive and ore producers could regain some of their price loss if steel demand increases.

There is a growing trend toward expanding ferroalloy production in ore-producing countries because oil price increases deter the shipping of low value-to-bulk cargoes, particularly to countries which are also dependent on oil for the electrical power used in their ferroalloy industries.

In the longer term, the rising consumption of coals with higher sulphur content will tend to increase the amount of manganese required in steelmaking. However, technological improvements in desulphurization could offset this trend.

PRICES

United States prices in U.S. currency, as published by **Metals Week,**

	December 1981	December 1982
	$	
Manganese ore, per long ton unit (22.4 lb) cif U.S. ports, Mn content		
Min. 48% Mn (low impurities)	1.66-1.75	1.58-1.68
Ferromanganese, fob shipping point, carload lots, lump, bulk		
Standard 78% Mn, per long ton	490.00-530.00	490.00
	(cents)	
Medium-carbon, 80-85% Mn, per lb Mn	46.00	46.00
Silicomanganese, per lb. of alloy, fob shipping point, 65-68% Mn, 16-18.5% Si, 0.2% P, 2% C	26.50	24.50
Manganese metal, per lb of product, fob shipping point		
Regular, minimum 99.5% Mn	70.00	70.00
6% N, minimum 93.7% Mn	70.00-80.00	80.00

fob Free on board; cif Cost, insurance and freight.

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
32900-1	Manganese ore	free	free	free	free
33504-1	Manganese oxide	free	free	free	free
35104-1	Electrolytic manganese metal	free	free	20%	free
37501-1	Ferromanganese, spiegeleisen and other alloys of manganese and iron, not more than 1% Si, on the Mn content, per lb.	free	0.5¢	1.25¢	free
37502-1	Silicomanganese, silicospiegel and other alloys of manganese and iron, more than 1% Si, on the Mn content, per lb.	free	0.74¢	1.75¢	free

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
			(cents)			
37501-1	0.5	0.5	0.4	0.4	0.4	0.4
37502-1	0.74	0.73	0.73	0.72	0.71	0.70

UNITED STATES (MFN)

601.27	Manganese ore, including ferruginous manganese ore and manganiferous iron ore, all the foregoing containing over 10% Mn	free
632.30	Manganese metal, unwrought	14.0%

		1982	1983	1984	1985	1986	1987
				(%)			
606.26	Ferromanganese, not containing over 1% C, per lb Mn content	2.6	2.6	2.5	2.4	2.4	2.3
606.28	Ferromanganese containing 1 to 4% C, per lb. Mn content	1.4	1.4	1.4	1.4	1.4	1.4
606.30	Ferromanganese containing over 4% C, per lb. Mn content	1.6	1.6	1.6	1.5	1.5	1.5
632.28	Manganese metal waste and scrap	10.9	9.8	8.8	7.7	6.7	5.6

Sources: The Customs Tariff and Commodities Index, January 1982, Revenue Canada; Tariff Schedules of the United States Annotated 1982 USITC Publication 1200; U.S. Federal Register Vol. 44, No. 241.

Mineral Aggregates

D.H. STONEHOUSE

SUMMARY 1982

The construction industry in Canada in 1982 used in the order of 270 million t of sand, gravel and stone. Consumption of lightweight aggregate materials was down about 25 per cent from the amounts used in 1981, a reduction consistent with the consumption of most materials of construction during the year. If the relation between the tonnage of aggregate material used by construction and the value of construction remains steady, there is little reason to expect aggregate consumption to increase through 1984.

The constraints to development of aggregate properties have not lessened. Property owners do not want quarries or gravel pits nearby nor would they like to see the prices increase to compensate for greater hauling distances. An awareness of the importance of mineral aggregates to the construction industry has been heightened by an appreciation of the extent and rate of urban expansion and the realization that already large deposits of aggregate material have been made inaccessible by the growth of towns and cities or by legislation.

In Ontario, where urban growth has been both rapid and large scale and where aggregate reserves are decreasing, it has been necessary to revise legislation pertaining to the aggregate industry with a new Aggregates Act which was to have been presented to the legislature for approval in 1982. The province also increased the rehabilitation security deposit under the Pits and Quarries Control Act from 2 cents a ton to 8 cents a tonne in order to assure acceptable rehabilitation programs. The provincial Ministry of Natural Resources provides advice and guidance to municipalities relative to planning for the exploitation of aggregate resources within their region. Ontario's experience in dealing with the problems of mineral aggregate resource planning in order to assure future supplies and to reclaim quarry lands for sequential use can be of great value to other provinces not yet in situations of such critical nature.

Surveys to determine the quality and quantity of construction aggregate deposits within easy reach of many rapidly-expanding, major communities in Canada are either planned, in progress or completed. The industry has been hesitant to invest in new plant sites or major new equipment in face of the uncertain economic conditions and the uncertain impact of some new and pending legislation.

CANADIAN SCENE

SAND AND GRAVEL

During 1982, production of sand and gravel was about 207 million t reducing per capita consumption to about 8.5 tpy. Higher labour and transportation costs are reflected in the increased average unit value assigned to the 1982 shipments of sand and gravel.

Sand and gravel deposits are widespread throughout Canada, and large producers have established "permanent" plants as close to major consuming centres as possible. In addition to large aggregate operations usually associated with some other phase of the construction industry such as a ready-mix plant or an asphalt plant, there are many small producers serving localized markets. These are often operated on a seasonal or part-time basis. Many larger operations are short-term, intermittently serving as a supply arm of a heavy construction company, and provide material for a given project. Provincial departments of highways operate regional or divisional quarries to supply roadbed material for new and repair work. Exploitation by such a large number of widely diversified groups not only makes control difficult, it also provides great obstacles to the collection of accurate data concerning both production and consumption of sand, gravel and stone.

Estimates have indicated that available sand and gravel supplies in some regions of southern Ontario will be depleted by the

TABLE 1. CANADA, TOTAL SHIPMENTS OF STONE, 1980-82

	1980		1981		1982P	
	(000 tonnes)	($ 000)	(000 tonnes)	($ 000)	(000 tonnes)	($ 000)
By province						
Newfoundland	948	2,688	519	2,074	490	2,058
Nova Scotia	1 809	7,308	825	4,244	800	4,320
New Brunswick	3 054	11,029	2 688	10,665	2 500	10,425
Quebec	54 657	161,766	44 961	154,594	23 301	94,823
Ontario	31 529	106,300	30 707	116,931	30 200	120,752
Manitoba	2 088	9,705	1 845	9,853	1 800	10,098
Alberta	193	1,034	271	2,017	325	2,542
British Columbia	9 088	41,326	5 044	20,668	2 513	9,930
Canada	103 366	341,156	86 860	321,046	61 929	254,948
By use						
Building stone						
Rough	289	4,242	376	6,047	..	..
Monumental and ornamental stone	28	2,547	27	3,207	..	..
Other (flagstone, curbstone, paving blocks, etc.)	49	1,950	33	1,134	..	..
Chemical and metallurgical						
Cement plants, foreign	1 293	2,147	1 584	3,000	..	..
Lining, open-hearth furnaces	32	110	20	71	..	..
Flux in iron and steel furnaces	1 068	3,377	757	2,779	..	..
Flux in nonferrous smelters	212	1,710	151	1,339	..	..
Glass factories	237	2,661	188	2,370	..	..
Lime kilns, foreign	306	1,102	303	1,239	..	..
Pulp and paper mills	330	2,942	353	2,992	..	..
Sugar refineries	101	394	79	378	..	..
Other chemical uses	110	1,112	148	2,277	..	..
Pulverized stone						
Whiting (substitute)	32	1,513	35	1,812	..	..
Asphalt filler	53	403	41	176	..	..
Dusting, coal mines	6	159	8	167	..	..
Agricultural purposes and fertilizer plants	1 109	8,695	1 032	9,910	..	..
Other uses	576	2,830	596	973	..	..
Crushed stone for						
Manufacture of artificial stone	34	253	36	240	..	..
Roofing granules	306	15,849	266	15,931	..	..
Poultry grit	53	943	25	745	..	..
Stucco dash	25	1,410	21	1,291	..	..
Terrazzo chips	5	159	2	50	..	..
Rock wool	2	32	1	23	..	..
Rubble and riprap	15 284	25,899	11 275	25,761	..	..
Concrete aggregate	7 472	24,236	6 737	24,330	..	..
Asphalt aggregate	5 482	17,552	4 549	16,761	..	..
Road metal	30 750	102,064	21 749	70,820	..	..
Railroad ballast	3 233	14,470	5 528	29,944	..	..
Other uses	34 889	100,395	30 940	95,999	..	..
Total	103 366	341,156	86 860	321,046	..	..

P Preliminary; .. Not available.

TABLE 2. CANADA, PRODUCTION OF SAND AND GRAVEL BY PROVINCE, 1980-1982

	1980		1981		1982P	
	(000 tonnes)	($000)	(000 tonnes)	($000)	(000 tonnes)	($000)
Newfoundland	3 279	6,066	2 818	9,074	2 775	9,380
Prince Edward Island	889	2,340	330	1,616	400	2,054
Nova Scotia	9 578	24,423	9 548	23,047	9 550	24,206
New Brunswick	6 492	12,399	6 282	9,450	6 100	9,635
Quebec	64 806	77,593	74 729	99,471	34 209	46,479
Ontario	102 174	191,000	77 502	145,587	75 000	148,207
Manitoba	9 794	22,454	11 716	25,425	12 800	27,900
Saskatchewan	9 828	18,204	7 909	18,405	8 200	20,037
Alberta	24 334	55,219	26 465	97,323	29 000	111,978
British Columbia	45 278	98,666	42 362	87,604	29 193	64,345
Canada	276 452	508,364	259 661	517,002	207 227	464,221

P Preliminary.

1990s. This could make outlying deposits not only attractive but necessary to the continued operation of the Canadian construction industry in certain areas. Transportation charges represent from 35 to 58 per cent of consumer costs for over 75 per cent of sand and gravel consumption in southern Ontario, where 90 per cent is moved by truck, according to the Ontario Ministry of Natural Resources. Predicted shortages could also encourage development of underwater deposits.

CRUSHED STONE

The large number of stone-producing operations in Canada precludes describing within this review individual plants or facilities. Many are part-time or seasonal operations, many are operated subsidiary to construction or manufacturing activities by establishments not classified to the stone industry, and some are operated directly by municipal or provincial government departments producing stone for their own direct use. Quarries removing solid rock by drilling, blasting and crushing are not likely to be operated for small, local needs as are gravel pits and are, therefore, usually operated by large companies associated with the construction industry. 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.

Detailed information about the aggregates industries can be obtained through the individual provincial departments of mines or equivalent. Most provinces have accumulated data relative to occurrences of stone of all types and in many cases have published such studies. The federal government, through the Geological Survey of Canada, has also gathered and published a great number of geological papers pertaining to stone occurrences.

LIGHTWEIGHT AGGREGATES

Four categories generally used to classify the lightweight aggregates combine elements of source, processing methods and end-use. Natural lightweight aggregates include materials such as pumice, scoria, volcanic cinders and tuff. Manufactured lightweights are bloated or expanded products obtained by heating certain clays, shales and slates. Ultra-lightweights are made from natural mineral ores, such as perlite and vermiculite, which are expanded or exfoliated by the application of heat and used mainly as plaster aggregate or as loose insulation. Fly ash, which is obtained from the combustion of coal and coke and slag, which is obtained from metallurgical processes, are classed as byproduct aggregates.

Perlite Perlite is a variety of obsidian or glassy volcanic rock that contains 2 to 6 per cent of chemically combined water. When the crushed rock is heated rapidly to a suitable temperature (760°C to 980°C) it expands to between 4 and 20 times its original volume. Expanded material can be manufactured to

TABLE 3. AVAILABLE DATA ON CONSUMPTION OF SAND AND GRAVEL, BY PROVINCE, 1980 AND 1981

		Atlantic Provinces	Quebec	Ontario	Western Provinces	Canada
				(000 tonnes)		
Roads	1980	14 959	39 646	38 750	35 151	128 506
	1981	12 631	34 944	38 110	47 599	133 284
Concrete aggregate	1980	971	3 614	9 321	8 274	22 180
	1981	1 018	4 268	11 688	10 538	27 512
Asphalt aggregate	1980	1 580	3 879	4 867	4 715	15 041
	1981	1 446	3 020	3 653	7 492	15 611
Railroad ballast	1980	101	391	210	2 354	3 056
	1981	199	348	82	2 299	2 928
Mortar sand	1980	43	427	888	288	1 646
	1981	18	409	1 332	426	2 185
Backfill for mines	1980	27	93	1 391	603	2 114
	1981	19	204	1 404	152	1 779
Other fill	1980	308	16 315	8 746	9 682	35 051
	1981	828	24 884	8 160	7 468	41 340
Other uses	1980	154	210	962	1 107	2 433
	1981	167	6 652	1 232	1 477	9 528
Total sand and gravel	1980	18 143	64 575	65 135	62 174	210 027
	1981	16 326	74 729	65 661	77 451	234 167

weigh as little as 30 to 60 kg/m^3, with attention being given to preblending of feed to the kiln and retention time in the kiln.

In Canada, imported perlite is expanded and used mainly by gypsum products manufacturers in plaster products such as wallboard or drywall, and in fibre-perlite roof insulation board, where its value as a lightweight material is augmented by its fire-resistant qualities. It is also used as a loose insulation and as an insulating medium in concrete products. Perlite, vermiculite, and expanded shale and clay are becoming more widely used in agriculture as soil conditioners and fertilizer carriers.

Imports of crude perlite for consumption in Canada are from New Mexico and Colorado deposits, worked by such companies as Manville Corporation, United States Gypsum Company, United Perlite Corp. and Grefco, Inc.

Perlite occurs in British Columbia but no commercial deposits have as yet been located.

Pumice Pumice is a cellular, glassy lava, the product of explosive volcanism, usually found near geologically-recent or active volcanoes. It is normally found as a loosely compacted mass composed of pieces ranging in size from large lumps to small particles. It is not the lightest of the lightweight aggregates, but when utilized as a concrete aggregate, particularly for the manufacture of concrete blocks, it exhibits strength, density and insulating values that have made it a preferred material.

In Canada, a number of concrete products manufacturers use pumice imported from Greece or from the northwestern United States, mainly in the manufacture of concrete blocks. A major use for pumice, as yet unexplored in Canada, has been in highway construction, where lightweight aggregate surfaces have been shown to have exceptional skid resistance.

Pumicite, distinguished from pumice by its finer size range (usually minus 100 mesh), is used in concretes mainly for its pozzolanic qualities. (A pozzolan is a sili-

TABLE 4. CANADA, EXPORTS AND IMPORTS OF SAND AND GRAVEL AND CRUSHED STONE, 1980-82

	1980		1981		1982P	
	(tonnes)	($)	(tonnes)	($)	(tonnes)	($)
Exports						
Sand and gravel						
United States	344 660	744,000	239 642	649,000	168 179	624,000
Bermuda	25 800	85,000	78 889	262,000	16	2,000
Indonesia	-	-	5	25,000	-	-
St. Pierre and Miquelon	25	2,000	37	11,000	-	-
France	16	1,000	49	4,000	335	34,000
Other countries	13 032	92,000	13	2,000	162	25,000
Total	383 533	924,000	318 635	953,000	168 692	685,000
Crushed limestone						
United States	2 214 036	6,175,000	1 758 299	6,007,000	1 516 896	8,475,000
St. Pierre and Miquelon	454	1,000	-	-		
Sweden	-	-	-	-	602	8,000
Total	2 214 490	6,176,000	1 758 299	6,007,000	1 517 498	8,483,000
Imports						
Sand and grave, nes						
United States	1 206 228	4,469,000	1 439 694	6,068,000	1 172 707	5,248,000
West Germany	3 354	11,000	7 178	16,000	2 219	5,000
Denmark	-	-	-	-	18	3,000
Sweden	-	-	-	-	4 341	10,000
Total	1 209 582	4,480,000	1 446 872	6,084,000	1 179 285	5,266,000
Crushed limestone						
United States	2 418 209	12,137,000	2 526 482	14,769,000	1 485 428	9,003,000
France	100	2,000	215	8,000	-	-
West Germany	21	5,000	179	4,000	-	-
Total	2 418 330	12,144,000	2 526 876	14,781,000	1 485 428	9,003,000
Crushed stone, nes						
United States	38 088	1,434,000	33 108	1,266,000	71 313	1,239,000
Sweden	-	-	342	6,600	-	-
Other countries	313	32,000	676	49,000	67	5,000
Total	38 401	1,466,000	34 126	1,381,000	71 380	1,244,000

Source: Statistics Canada.
P Preliminary; - Nil; nes Not elsewhere specified.

ceous material possessing no cementitious qualities until finely ground, in which form it will react with calcium hydroxide in the presence of moisture to form insoluble calcium silicates.)

Extensive beds of pumicite have been noted in Saskatchewan and British Columbia.

Vermiculite The term vermiculite refers to a group of micaceous minerals, hydrous magnesium-aluminum silicates, that exhibit a characteristic lamellar structure and expand or exfoliate greatly upon being heated rapidly. Mining is normally by open-pit methods, and beneficiation techniques include the use of hammer mills, rod mills, classifiers, screens, dryers and cyclones. Exfoliating is done in oil- or gas-fired, vertical or inclined furnaces, usually close to the consuming facility to obviate the higher costs associated with shipping the much-bulkier expanded product. Required temperatures can vary from 1 100° C to 1 650°C depending on the type of furnace in use. A controlled time and temperature relation is critical in order to produce a product of minimum bulk density and good quality.

TABLE 5. LIGHTWEIGHT AGGREGATE PLANTS IN CANADA 1982

Company	Location	Commodity	Remarks
Atlantic Provinces			
Annapolis Valley Peat Moss Co. Ltd.	Berwick, N.S.	Perlite, Vermiculite	Processed mainly for use in horticulture.
Avon Aggregates Ltd.	Minto, N.B.	Expanded Shale	Processed for concrete products industry.
Quebec			
Masonite Canada Inc.	Gatineau	Perlite	Processed for use in ceiling tile manufacture.
Domtar Inc.	Montreal	Perlite, Vermiculite	Processed material purchased for use in gypsum plaster and wallboard at all company plants.
F. Hyde & Company, Limited	Montreal	Vermiculite	Processed for use in horticulture and as loose insulation.
Miron Inc.	Montreal	Pumice	Purchased for concrete block manufacture.
Perlite Industries Inc.	Ville St. Pierre	Perlite	Processed for use in horticulture and as industrial filler.
V.I.L. Vermiculite Inc.	Lachine	Vermiculite	Processed for use in horticulture and as loose insulation.
Ontario			
CGC Inc.	Hagersville	Perlite	Processed for use in gypsum plaster.
National Slag Limited	Hamilton	Slag	Used in concrete blocks and as slag cement.
V.I.L. Vermiculite Inc.	Rexdale	Vermiculite	Processed for use in horticulture and as loose insulation.
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 and in horticulture.
Prairie Provinces			
Apex Aggregate	Saskatoon, Sask.	Expanded clay	Processed for concrete block manufacture.
Cindercrete Products Limited	Regina, Sask.	Expanded clay	Processed for concrete products industry.
Consolidated Concrete Limited	Calgary, Alta.	Expanded shale	Processed for concrete products industry.
	Edmonton, Alta.	Expanded clay	Processed for concrete products industry.
Genstar Corporation, Edcon Block Division	Edmonton, Alta.	Expanded clay	Processed for concrete block manufacture.
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 Ltd.	Vancouver	Pumice	Purchased for concrete block manufacture.

TABLE 6. CANADA, IMPORTED RAW MATERIALS PURCHASED, 1981 AND 1982

	1981		1982	
	(tonnes)	($)	(tonnes)	($)
Pumice, perlite and vermiculite[1]	63 285	7,271,988	40 617	5,733,961

Source: Company data.
[1] Combined to avoid disclosing confidential company data.

TABLE 7. CANADA, PRODUCTION OF LIGHTWEIGHT AGGREGATES, 1981 AND 1982

	1981[r]		1982	
	(m^3)	($)	(m^3)	($)
From domestic raw materials				
Expanded clay, shale and slag	519 809	7,091,079	260 247	5,832,343
From imported crude materials				
Expanded perlite and exfoliated vermiculite[1]	481 152	13,851,233	395 540	12,991,301
Total	1 000 961	20,942,312	655 787	18,823,644

Source: Company data.
[1] Combined to avoid disclosing confidential company data.
[r] Revised.

The expansion process has been improved technologically to enable production of various grades of expanded vermiculite as required. The uses to which the product is put depend on its low thermal conductivity, its fire-resistance and, more recently, on its lightweight qualities.

Canadian consumption is mainly as loose insulating material, with smaller amounts being used as aggregate in the manufacture of insulating plaster and concrete. The energy situation will undoubtedly result in continued increases in domestic fuel costs, and greater use of insulation in both new construction and older buildings will continue to tax the production capability of manufacturers for some time.

The major producer of vermiculite is the United States. The principal company supplying Canada's imports is W.R. Grace and Company, from operations at Libby, Montana and from the Enoree region of South Carolina. Canada also imports crude vermiculite from the Republic of South Africa, where Palabora Mining Co. Ltd. is the major producer. Minor amounts of vermiculite are produced in Argentina, Brazil, India, Kenya and Tanzania.

Vermiculite occurrences have been reported in British Columbia, and deposits near both Perth and Peterborough in Ontario have been investigated but, as yet, no commercial deposits have been developed in Canada.

Clay, shale and slag Common clays and shale are used throughout Canada as raw material for the manufacture of 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 demands from the construction industry. The raw materials are usually quarried adjacent to the plant sites at which they are expanded. Clays receive little beneficiation other than drying before being introduced to the kiln in which they are heated. Shales are crushed and screened before burning.

In steelmaking, iron ore, coke and limestone flux are melted in a furnace. When the metallurgical process is completed, lime has combined with the silicates and aluminates of the ore and coke and formed a nonmetallic product (slag) which can be subjected to controlled cooling from the molten state to yield a porous, glassy

TABLE 8. CANADA, CONSUMPTION OF SLAG, PERCENTAGE BY USE, 1980-82

Use	1980	1981	1982
Concrete block manufacture	52.0	46.0	38.0
Ready-mix concrete	2.0	2.0	4.0
Loose insulation	1.0	1.0	1.0
Slag cement	45.0	51.0	57.0

Source: Company data.

TABLE 9. CANADA, CONSUMPTION OF EXPANDED CLAY AND SHALE, PERCENTAGE BY USE, 1979-82

Use	1979	1980	1981	1982
Concrete block manufacture	74.7	79.2	76.7	78.7
Precast concrete manufacture	6.4	4.3	6.5	11.5
Ready-mix concrete	13.7	13.3	14.6	4.3
Horticulture and miscellaneous uses	5.2	3.2	2.2	5.5

Source: Company data.

TABLE 10. CANADA, CONSUMPTION OF EXPANDED PERLITE, PERCENTAGE BY USE 1980-82

Use	1980	1981	1982
Insulation			
in gypsum products	17.5	11.3	20.6
in other construction materials	42.4	46.9	34.9
Horticulture and agriculture	23.8	23.9	33.7
Loose insulation and miscellaneous uses	16.3	17.9	10.8

Source: Company data.

TABLE 11. CANADA, CONSUMPTION OF EXFOLIATED VERMICULITE, PERCENTAGE BY USE 1980-82

Use	1980	1981	1982
Insulation			
loose	57.7	55.2	45.8
in concrete and concrete products	10.2	8.8	0.5
in gypsum products	3.4	3.0	1.7
Horticulture	19.8	23.3	48.2
Miscellaneous uses	8.9	9.7	3.8

Source: Company data.

material. Slag has many applications in the construction industry. The statistics relative to expanded slag production are included in those of clay and shale.

Although Canada does not produce large amounts of fly ash, the technology of fly ash processing and utilization is well advanced. The largest single use for fly ash is as a cementitious material, in which application its pozzolanic qualities are utilized. Use of fly ash as a lightweight aggregate could become increasingly important. Ontario Hydro produces over 400 000 tpy of fly ash from three coal-fired stations. Experimentation continues toward successful utilization of this material.

PRICES

There is no standard price for sand, gravel and crushed stone. In addition to supply-demand factors, prices are determined regionally, or even locally, by production and transportation costs, by the degree of processing required for a given end use and by the quantity of material required for a particular project. Increased land values, reduction of reserves and added rehabilitation expenditures should result in higher prices.

Prices for graded, washed and crushed sand, gravel and crushed stone will show a slow but steady increase, based on greater property costs, more sophisticated operating techniques and equipment, pollution and environmental considerations, and higher labour and transportation costs.

USES

The principal uses for sand and gravel are in highway construction and as concrete aggregate. Individual home construction triggers the need for about 300 t of aggregate per unit while apartment construction requires only about 50 t per unit, according to an Ontario Ministry of Natural Resources study.

TABLE 12. ROCK- MINERAL- AND GLASS-WOOL PRODUCERS, CANADA, 1982

Company	Location	Remarks
Atlantic Provinces		
Fiberglas Canada Inc.	Moncton, N.B.	New in 1975. Capacity 15 000 tpy. Raw materials include limestone, dead-burned magnesia, silica, borax.
Quebec		
Fiberglas Canada Inc.	Candiac	Expanded in 1977.
Manville Canada Inc.	Brossard	15 000 tpy capacity.
Ontario		
Fiberglas Canada Inc.	Sarnia	Expanded in 1978. New electric furnace is largest of kind.
	Toronto	New plant in 1979.
CGC Inc.	Mount Dennis (Toronto)	Using slag from Hamilton
Holmes Insulations Inc.	Sarnia	Slag - Detroit
Bishop Building Materials Ltd.	Toronto	Slag - Hamilton
Graham Fiber Glass Limited	Erin	New by 1979. Capacity 10 000 tpy
Roxul Company	Milton	A division of Standard Industries Ltd.
Ottawa Fibre Industries Ltd.	Ottawa	
Prairie Provinces		
Fiberglas Canada Inc.	Clover Bar, Alta. (Edmonton)	Expanded in 1977.
Manville Canada Inc.	Innisfail, Alta.	New in 1978. Capacity 6 000 t per month. New energy-efficient mechanical fiberizing technology in use.
Alberta Rockwool Corporation	Calgary, Alta.	
British Columbia		
Fiberglas Canada Inc.	Mission	New in 1980. Capacity 45 000 tpy.
Pacific Enercon Inc.	Grand Forks	

TABLE 13. CANADA, VALUE OF CONSTRUCTION[1] BY PROVINCE, 1981-83

	1981			1982			1983		
	Building Construction	Engineering Construction	Total	Building Construction	Engineering Construction	Total	Building Construction	Engineering Construction	Total
					($000)				
Newfoundland	449,744	584,714	1,034,458	399,131	797,298	1,196,429	429,579	1,010,474	1,440,053
Nova Scotia	703,274	601,938	1,305,212	627,338	884,530	1,511,868	668,280	1,097,108	1,765,388
New Brunswick	598,748	423,569	1,022,317	570,115	498,826	1,068,941	571,098	443,574	1,014,672
Prince Edward Island	82,732	70,835	153,567	91,536	70,444	161,980	90,106	56,054	146,160
Quebec	5,787,061	4,521,719	10,308,780	5,330,316	5,018,167	10,348,483	5,655,742	4,821,108	10,476,850
Ontario	9,351,968	4,836,498	14,188,466	8,657,087	5,687,399	14,344,486	8,749,495	5,211,675	13,961,170
Manitoba	864,922	674,106	1,539,028	775,844	649,473	1,425,317	830,915	658,977	1,489,892
Saskatchewan	1,207,783	1,391,803	2,599,586	1,113,910	1,338,345	2,452,255	1,138,025	1,320,210	2,458,235
Alberta	6,378,099	8,112,208	14,490,307	5,977,214	8,025,352	14,002,566	5,405,653	8,025,362	13,431,015
British Columbia, Yukon and Northwest Territories	6,112,925	4,129,286	10,242,211	4,664,244	4,566,626	9,230,870	4,562,538	4,797,645	9,360,183
Canada	31,537,256	25,346,676	56,883,932	28,206,735	27,536,460	55,743,195	28,101,431	27,442,187	55,543,618

Source: Statistics Canada.

[1] Actual expenditures 1981, preliminary actual 1982, intentions 1983.

TABLE 14. CANADA, VALUE OF CONSTRUCTION[1] BY TYPE, 1981-83

	1981	1982	1983
		($ millions)	
Building Construction			
Residential	16,365	13,342	14,414
Industrial	3,498	2,966	2,569
Commercial	6,986	6,868	5,979
Institutional	2,571	2,896	3,114
Other building	2,117	2,135	2,026
Total	31,537	28,207	28,102
Engineering Construction			
Marine	377	459	465
Highways, airport runways	4,092	4,304	4,306
Waterworks, sewage systems	2,145	2,295	2,421
Dams, irrigation	300	260	264
Electric power	4,801	5,428	5,722
Railway, telephones	1,870	2,067	1,977
Gas and oil facilities	7,110	7,440	8,186
Other engineering	4,652	5,283	4,101
Total	25,347	27,536	27,442
Total construction	56,884	55,743	55,544

Source: Statistics Canada.
[1] Actual expenditures 1981, preliminary actual 1982, intentions 1983.

Housing starts in Canada in 1982 were only 125,860, the lowest since 1961 and nearly 30 per cent fewer than starts in 1981.

The construction industry utilizes 95 per cent 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 the intended use, and many tests are required to determine the acceptability of aggregates for certain applications. Particle size distribution of aggregates, as assessed by grading tests or sieve analysis, affects the uniformity and workability of a concrete mix as well as the strength of the concrete, the density and strength of an asphalt mix, and the durability, strength and stability of the compacted mass when aggregates are used as fill or base-course material. Of importance also are tests to determine the presence of organic impurities or other deleterious material, the resistance of the aggregate to abrasion and to freeze-thaw cycles, the effects of thermal expansion, absorption, porosity, reactivity with associated materials and surface texture.

The use of sand and gravel as backfill in mines continues, along with increasing use of cement and mill tailings for this purpose. Abrasive sands, glass sand, foundry sands and filter sands are also produced.

The use of lightweight concrete in commercial and institutional projects has facilitated the construction of taller building and the use of longer clear spans in bridges and buildings. Additional advantages from the use of lightweight aggregates lie in the fact that they supply thermal and acoustical insulation, fire resistance, good freeze-thaw resistance, low water absorption and a degree of toughness to the concrete product. Disadvantages stem from the fact that in production of both manufactured and ultra-lightweight aggregates heat processing is required. As the cost of fuel increases, the competitiveness of these types will be reduced unless the insulation values more than offset the heat units consumed in processing.

All types of lightweight aggregates are used in Canada, but only expanded clays, shale and slag are produced from materials of domestic origin. Vermiculite is imported mainly from Montana, although a small amount is brought in from the Republic of South Africa. Perlite is imported mainly from New Mexico and Colorado, and pumice is imported from Oregon and Greece. Most processed lightweight aggregate is utilized in the construction industry, either as loose insulating material or as aggregate in the manufacture of lightweight concrete units. The scope of such applications has not yet been fully investigated.

Any lightweight material with acceptable physical and chemical characteristics could substitute for the mineral commodities generally used. The most significant substitute for vermiculite, for instance, is styrofoam or polyurethane, which offers insulating value and comparable strength. However, these materials are petroleum-based and higher fuel prices could limit their use. Mineral wool is a competitive insulation material but its manufacture requires a pyroprocessing stage, as does the production of perlite and vermiculite. Transportation costs for high-bulk, lightweight materials are high; those materials, such as perlite and vermiculite, that can be transported to a consuming centre prior to expansion, have obvious advantages.

There are as yet no Canadian Standards Association (CSA) 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 332-66 - Lightweight Aggregates for Insulating Concrete; C 330-75a - Lightweight Aggregates for Structural Concrete; and C 331-69 - Lightweight Aggregates for Concrete Masonry Units.

OUTLOOK

Urban expansion has greatly increased demand for sand and gravel in support of major construction. Paradoxically, urban spread has not only tended to overrun operating pits and quarries, but has extended at times to areas containing mineral deposits, thereby precluding the use of these resources. Further complications have arisen in recent years as society has become increasingly aware of environmental problems and the need for planned land utilization. Municipal and regional zoning must be designed to determine and regulate the optimum utilization of land, but must not be designed to provide less than optimum resources utilization. Industry must locate its plants so as to minimize any adverse effects on the environment from their operations. Also, provision must be made for rehabilitation of pit and quarry sites in order to ensure the best sequential land use. The frequency with which small quarries and pits materialize to supply short-lived, local demands, leaving unsightly properties, has prompted action by municipal and provincial governments to control or to prohibit such activity.

Ideally, the exploitation of sand, gravel and stone deposits should be done as part of the total land-use planning package, such that excavations are designed to conform with a master plan of development and even to create new land forms. Inventories indicating the potential available reserves of sand, gravel and stone should be prerequisite to legislation regulating land use. Surveys to locate such resources are being carried out in many provinces in order to optimize their use and to choose the best possible distribution routes to consuming centres. It should be observed that controls and zoning can reduce reserves of these resources significantly.

On average, total aggregate consumption will rise in line with population increases, housing requirements and construction in general. Sand and gravel consumption will continue in competition with crushed stone and, in some applications, with lightweight aggregates. New reserves must be located, assessed and made part of any community development planning or regional zoning, with optimum land and resource utilization in mind. In the search for new sources of sand and gravel some countries are turning to their seabeds. The use of huge pumps and specially equipped ships to draw gravel from the seafloor and deposit it in attendant barges is already common practice in Britain. Such methods of obtaining aggregates can have far-reaching environmental effects, if not properly managed.

Molybdenum

D.G. FONG

SUMMARY

Western world molybdenum production in 1982, estimated at 78 900 t, was down by 18 per cent compared to 1981 while consumption slumped to about 56 000 t from 69 800 t. The sharp decline in output was largely due to major production cutbacks, especially by the primary producers, as a result of weak markets and accumulating inventories.

Curtailed output in 1982 was especially evident in the United States and Canada. Production in the United States dropped by 40 per cent compared with 1981 while Canadian output was reduced by 19 per cent. Chile, on the other hand, registered a 33 per cent output increase in 1982 despite the depressed market.

The sagging demand for molybdenum was largely due to the poor performance in the steel industry worldwide, particularly in regard to the alloy steel sector. The U.S. steel industry, the world's largest consumer of molybdenum, showed the largest annual percentage loss in consumption within the last decade. On the other hand, molybdenum demand in Japan was at an all time high during the first half of 1982, but slipped during the second half due to a 10 per cent drop in steel production.

DOMESTIC DEVELOPMENTS

Canadian molybdenum production declined by 25 per cent in 1982 to 14 263 t. The decline was largely due to the lengthy suspension of mining operations in British Columbia, especially among the primary producers.

Placer Development Limited closed its Endako mine and roaster in British Columbia on June 5, in response to deteriorating markets. The shutdown of the mine was initially planned for 13 weeks but was later extended for an indefinite period because of a further deterioration of the molybdenum market. The roaster, on the other hand, was re-started on September 8 for toll-roasting. At the company's lubricant additive plant, also located at the mine site, production was continued.

Mining at Gibraltar Mines Limited, British Columbia, a Placer subsidiary, was halted during the year and milling was switched to low-grade ores from stockpiles. Gibraltar was developing the Pollyanna pit for Stage II mining in 1984, but this work was suspended along with the suspension of mining activities. Molybdenum recovery at Gibraltar has improved significantly from 25 per cent to over 50 per cent during the past three years. Part of the improvement was due to changes in the flotation process in which nitrogen was substituted for air. The introduction of nitrogen in the flotation process improved the separation of molybdenum from copper, resulting in a better recovery and lower operating cost.

Amax of Canada Limited closed the Kitsault mine, located in British Columbia, from August 6 to September 7 and for an additional three months starting November 5 due to poor demand and large inventories. The mine had been operating on a four-day work week prior to the second closure.

Noranda Mines Limited curtailed production in 1982 at all three of its molybdenum producers in British Columbia and Quebec. In July, the company reduced the rate of operation to 50 per cent of capacity at the Boss Mountain mine in British Columbia. Boss Mountain had completed a mine and mill expansion program at the end of 1981, which doubled the output capacity to 907 tpy of molybdenum. Noranda announced late in December that the mine will be closed for an indefinite length of time starting February 15, 1983.

Mines Gaspé, a copper-molybdenum division of Noranda at Murdochville, Quebec, was closed for one month from June 20 to July 21. The mine resumed operations at one-third capacity but was not returned to full production by October 30 as had been

TABLE 1. CANADA, MOLYBDENUM PRODUCTION AND TRADE, 1981 AND 1982, AND CONSUMPTION, 1980 AND 1981

	1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)
Production (shipments)[1]				
British Columbia	11 874	266,570r	14 942	320,858
Quebec	976	21,903	290	6,219
Total	12 850	288,473r	15 232	327,077
Exports				
Molybdenum in ores, concentrates and scrap[2]				
Japan	2 744	60,247	3 185	53,492
Belgium-Luxembourg	3 470	76,749	3 000	48,578
Netherlands	1 659	29,427	3 344	43,104
United States	1 002	14,301	2 249	31,341
West Germany	2 080	39,325	2 314	23,207
United Kingdom	1 904	43,752	1 574	21,215
U.S.S.R.	-	-	663	8,648
Chile	119	1,405	468	3,928
Other countries	686	13,566	647	4,605
Total	13 664	278,772	17 444	238,118
Imports				
Molybdic oxide (containing less than 1 per cent impurities)	423	6,517	193	2,740
Molybdenum in ores and concentrates (Mo content)	2 118	41,025	3 027	40,119
Ferromolybdenum alloys	517	7,684	77	1,017
	1980		**1981**	
	(kilograms)	($)	(kilograms)	($)
Consumption (Mo content)				
Addition agents	760 169r	..	889 911	..
Electrical and electronics	2 045	..	1 379	..
Other Uses[3]	292 893	..	420 573	..
Total	1 055 107r	..	1 311 863	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Producers' shipments (Mo content of molybdenum concentrates, molybdic oxide and ferromolybdenum). [2] Includes molybdenite and molybdic oxide in ores and concentrates. [3] Alloy, pigment and ceramics.
P Preliminary; r Revised; .. Not available; - Nil.

planned. On December 18, Noranda closed its operations at Murdochville again; the company announced that the closure would last for at least six months.

Brenda Mines Ltd., also a subsidiary of Noranda, suspended production for six weeks from July 27 to August 31 at its copper-molybdenum mine at Peachland, British Columbia. Although the rated annual capacity at Brenda is 3 850 t of contained molybdenum, output has dropped to below 2 700 t in recent years. The shutdown in 1982 further reduced molybdenum output by about 386 t.

Highmont Mining Corporation, a British Columbia mine controlled by Teck Corporation, commenced production in January 1981 and operated at an average milling rate of 23 000 tpd of ore during 1982, compared to design capacity of 22 680 tpd. In October, Teck reached an agreement with Redclay Holdings Limited, an investment agency of the Kuwait government, to sell about 30 per cent interest in the Highmont project. Upon completion of the transaction, Teck would own a 50.001 per cent interest, Redclay 29.999 per cent and H.V. Mining Ltd. (Metallgesellschaft Canada Limited) 20 per cent.

At year-end 1981, Cominco Ltd. suspended production from the molybdenum recovery circuit at the Jersey mine, British Columbia, previously operated by Bethlehem Copper Corporation. Mining operations at the Jersey mine were terminated on June 30, 1982. Cominco is developing an adjacent property, the Lake Zone orebody, through its subsidiary Valley Copper Mines Limited. Ores from the Lake Zone will be treated at the Bethlehem mill, starting in January 1983.

Molybdenum output from Lornex Mining Corporation Ltd., a copper-molybdenum producer in the Highland Valley of British Columbia, increased by 30 per cent as a result of a 68 per cent capacity expansion in 1981. While tonnage milled during the year was 34 per cent higher, average mill recoveries for molybdenum were lower than in 1981. The company is contemplating a molybdenum roaster which, if built, would enable it to ship molybdenum in oxide form.

Development work at the Mount Pleasant mine in New Brunswick was completed and a tune-up phase of production began at the end of the year. The 2 000 tpd mine-mill complex, jointly owned by the Sullivan Mining Group Ltd. and Billiton Canada Ltd., was completed at a cost of $120 million. The ore has an average grade of 0.393 per cent tungsten oxide and 0.204 per cent molybdenite (MoS_2). While primarily a tungsten mine, Mount Pleasant will also produce 600 tpy of molybdenite.

Tintina Mines Limited provided $1.5 million for a 1982 drilling program at the Red Mountain molybdenum deposit in the Yukon, about 100 km northeast of Whitehorse. By committing the funds, Tintina increased its interest in the property to 50 per cent from 30 per cent. Amoco Canada Petroleum Company Ltd. is the other partner in the joint venture. The 1982 drilling program, which included four deep holes, was designed to test molybdenum mineralization at depth. Earlier drilling results have indicated an ore reserve of 72 million t grading 0.223 per cent molybdenite.

WORLD DEVELOPMENTS

The decline in western world molybdenum output was especially pronounced in the United States, where production dropped to about 60 per cent of the 1981 level. By comparison, Chile, which has been expanding its mine capacity to compensate for declining copper ore grades, achieved a 33 per cent

TABLE 2. CANADA, MOLYBDENUM PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975 AND 1977-82

	Production[1]	Exports[2]	Imports: Molybdic oxide[3]	Imports: Ferro-molybdenum[4]	Consumption[5]
			(kilograms)		
1970	15 318 593	13 763 800	33 500	29 619	1 036 940
1975	13 323 144	15 710 300	56 400	269 281	1 436 883
1977	16 567 555	15 326 100	192 100	74 330	1 149 736
1978	13 943 405	13 421 000	329 500	55 294	1 268 640
1979	11 174 586	11 481 900	335 900	153 945	1 249 944
1980	11 889 000	14 584 500	361 700	53 618	1 055 107r
1981	12 850 000	13 664 000	423 000	36 069	1 311 863
1982P	15 232 000	17 444 000	193 000	6 840	..

Sources: Energy, Mines and Resources Canada; Statistics Canada; except where noted.
[1] Producers' shipments (Mo content of molybdenum concentrates, oxide and ferromolybdenum). [2] Mo content, ores and concentrates. [3] Gross weight. [4] United States exports to Canada, reported by the U.S. Bureau of Commerce, Exports of Domestic and Foreign Merchandise (Report 410), over 50 per cent molybdenum. [5] Mo content of molybdenum products reported by consumers.
P Preliminary; .. Not available; r Revised.

TABLE 3. CANADA, MINE PRODUCTION, 1982

Company and Mine Name	Location	Type of Producer	Mill Capacity	Ore Milled		Concentrates Produced		
				Tonnes	Grade	Tonnes	Grade	Contained Mo
			(tpd)		(% Mo)		(% Mo)	(tonnes)
Amax of Canada Limited Kitsault Mine	Alice Arm B.C.	Primary	10 886	2 228 832	0.121	4 343	54.13	2 351
Brenda Mines Ltd.	Peachland, B.C.	Coproduct	27 200	9 484 562	0.032	4 368	56.13	2 452
Gibraltar Mines Limited	McLeese Lake, B.C.	Byproduct	37 195	13 378 535	0.012	1 355	54.04	732
Highmont Mining Corporation	Highland Valley, B.C.	Coproduct	22 680	8 887 325	0.030	3 700	54.14	2 003
Lornex Mining Corporation Ltd.,	Highland Valley, B.C.	Byproduct	72 575	27 842 549	0.015	5 361	53.70	2 879
Noranda Mines Limited, Boss Mountain Division	Williams Lake, B.C.	Primary	2 631	404 111	0.154	987	54.65	539
Mines Gaspé Division Needle Mountain and Copper Mountain	Holland Twp. Gaspé, Que.	Byproduct	32 800	5 328 913	0.023	725	51.17	371
Placer Development Limited, Endako Mine	Endako, B.C.	Primary	29 937	2 948 000	0.091	2 432	53.85	1 310
Utah Mines Ltd., Island Copper Mine	Port Hardy, B.C.	Byproduct	38 100	15 291 656	0.017	3 594	45.25	1 626
Total								14 263

Sources: Energy, Mines and Resources Canada; Company annual reports.

increase in molybdenum output during 1982. Mexico and Peru also expanded their production of molybdenum during the year.

A number of molybdenum producing companies in the United States made drastic cutbacks in production during 1982. The most significant reductions were those by AMAX Inc. and Duval Corporation, the two largest U.S. molybdenum producers. AMAX closed its two Colorado mines (Climax and Henderson) during the summer and from September for the rest of the year. As a result, 1982 molybdenum output by AMAX dropped to about 17 700 t compared to a capacity of 50 000 tpy.

Duval closed all three of its copper-molybdenum mines (Sierrita, Esperanza and Mineral Park) on December 14, 1981. The company reopened the Sierrita mine on April 1 but kept the other two closed throughout 1982. With Sierrita operating at only 35 per cent capacity during the second half of 1982, Duval's total molybdenum output was reduced to about 3 175 t, one-third of its 1981 production.

Anaconda Minerals Corporation brought the Tonopah molybdenum mine into operation in 1982. The new mine has an annual production capacity of 6 800 t of contained Mo, and produced about 2 268 t during 1982. Mining, however, was halted in the third quarter as a result of the depressed market condition. In November, the company announced that milling operations at the mine would be suspended in 1983.

Two new molybdenum mines are scheduled to come on-stream in the United States in 1983. These include the Goat Hill underground mine, owned by Molycorp, Inc. and the Thompson Creek open-pit mine, owned by Amoco Minerals Company. The Goat Hill mine will have an annual capacity of 9 070 tpy of molybdenum and is expected to begin production in July 1983. The mine is located adjacent to the company's old Questa open-pit which was closed two years ago because of ore depletion. Ore from the mine will be treated at the recently renovated and expanded Questa mill.

Amoco Minerals continued to do pre-production development at the Thompson Creek mine near Challis, Idaho. The new mine, expected to come on-stream in late-1983, could add 6 800 tpy of molybdenum to U.S. production.

United States Borax & Chemical Corporation proceeded with development work at its Quartz Hill molybdenum deposit near Ketchikan, Alaska. The company is constructing an access road, with completion scheduled for July 1983, which will permit U.S. Borax to begin a bulk sampling program. Although a final decision to commence production will not be made until 1984, the company was considering a mining operation capable of producing 18 000 to 22 700 t of contained molybdenum, and a roasting plant in Washington State.

Corporacion Nacional del Cobre de Chile (Codelco-Chile), the world's largest co-product molybdenum producer, operates four copper-molybdenum mines: Chuquicamata, El Teniente, El Salvador and Andina mines. Chuquicamata mine is by far the largest, accounting for about 68 per cent of CODELCO'S total molybdenum production.

TABLE 4. WORLD PRODUCTION OF MOLYBDENUM IN ORES AND CONCENTRATES, 1980-82

Country[1]	1980[r]	1981[r]	1982[p]
	(tonnes Mo content)		
United States	68 350	63 458	37 671
Canada	11 889	12 850	14 263
Chile	13 668	15 105	20 048
U.S.S.R.[e]	10 387	10 886	11 022
People's Republic of China[e]	1 996	1 996	4 300
Peru	2 658	2 488	2 565
Republic of Korea	300	314	96
Bulgaria[e]	150	150	150
Japan[e]	95	79	80
Philippines	59	94	57
Mexico	102	349	3 175
Mongolia	441	599	900
Total	110 096	108 368	94 327

Sources: Energy, Mines and Resources Canada; United States Bureau of Mines, Minerals Yearbook, Preprint, 1982; U.S. Bureau of Mines, Mineral Commodity Summaries, 1983;
[1] In addition to the countries listed, Niger, North Korea, Romania, Turkey and Yugoslavia are believed to produce molybdenum, but output is not reported quantitatively.
[p] Preliminary; [r] Revised; [e] Estimated.

TABLE 5. PRINCIPAL MOLYBDENUM PRODUCERS IN THE WESTERN WORLD, 1982

Company	Country	Per cent of Western World production
AMAX Inc.	United States	26
Corporacion Nacional del Cobre de Chile (Codelco-Chile)	Chile	25
Duval Corporation	United States	6
Placer Development Limited	Canada	3
Anaconda Minerals Corporation	United States	6
Noranda Mines Limited	Canada	4
Kennecott Corporation	United States	4
Southern Peru Copper Corporation	Peru	3
Lornex Mining Corporation Ltd.	Canada	4
Mexicana de Cobre S.A.	Mexico	4
Highmont Mining Corporation	Canada	3
Others		12
Total		100

Sources: Company annual reports; Energy, Mines and Resources Canada; U.S.B.M.

In 1982, CODELCO registered a significant increase in molybdenum output, up 33 per cent to 20 048 t. The increase was primarily the result of expansion programs undertaken at the mines to compensate for falling copper grades. Because the molybdenum grade of its ore is not falling as fast as copper, the expansion of mining and milling has resulted in a significant increase of molybdenum output.

CODELCO has also installed a new roaster at the Chuquicamata mine at a cost of $US 16 million. The roaster began production in September 1982 and has capacity to produce about 10 000 t of molybdic oxide.

Mexico and Peru have become important molybdenum producers in recent years. The new molybdenum recovery plant of La Caridad copper mine, Mexico, started production in late-1981 and produced about 3 175 t of molybdenum in 1982, much higher than the 1 814 t originally planned. The mine is operated by Mexicana de Cobre S.A., and has a capacity to produce about 5 440 tpy of molybdenum.

Southern Peru Copper Corporation (SPCC) operates two major copper molybdenum mines in Peru: the Toquepala and Cuajone mines. In 1982, SPCC produced about 2 565 t of molybdenum, a 3 per cent increase from 1981. The company was planning a plant expansion at the Toquepala mine to raise milling capacity by 30 per cent from the present 40 000 tpd. However, the expansion project was postponed because of low copper prices and rapidly rising capital costs.

Construction of a new mill was under way at the Jinduicheng mine, located in Shaanxi province in central China. The new mill, with a capacity of 15 000 tpd, will bring total milling capacity at the mine to over 20 000 tpd. Construction work is expected to be completed in 1983 and full operation is scheduled for 1984. Output capacity at Jinduicheng, China's largest molydenum mine, will be raised to 12 000 tpy of concentrate, equivalent to approximately 5 500 tpy of molybdenum.

PRICES

Continuing high inventories and weak markets had a severe impact on molybdenum prices in 1982. Through a round of price reductions by leading producers, molybdenum prices receded to the 1977 level.

The merchant market price for technical grade oxide, which was $US 10.14-10.80 a kg at the beginning of the year, rallied to $US 11.02-12.24 in early April before plunging to $US 6.17-6.94 in October. This price held for the remainder of the year.

North American producer prices were quoted at $US 15.43 a kg until October 1 when Climax Molybdenum Company reduced its list price to $US 13.23 a kg and other producers followed. Placer and Noranda reduced their prices from $US 15.21 to $US 13.01 for drummed oxide and from $US 15.43 to $US 13.23 for canned oxide. Corporacion Nacional del Cobre de Chile (Codelco-Chile), which has been selling 50 per cent of its molybdenum oxide at a producer price and the remaining portion at the dealer price, revised its producer price from $US 11.99 per kg to $US 11.

PRICES

Prices in $US per kilogram of contained molybdenum, fob shipping point unless indicated otherwise, December 31.

	1981	1982
	($)	
Molybdenum concentrates[1]		
95% MoS_2	17.42	LPS
Molybdic oxide[1] (MoO_3)		
in cans	18.74	LPS
Ferromolybdenum, minimum		
60% Mo		
Climax[1]	20.72	LPS
Dealer export[2] (fas port)	12.13-13.45	7.28-7.94

[1] Climax quotation; [2] Metals Week quotation.
fob Free on board, fas Free alongside ship.
LPS List Price Suspended.

OUTLOOK

Despite current high inventories and the deterioration of the molybdenum market, world production capacity will continue to increase because of earlier decisions made in response to the peak demand and record high prices of the late 1970s. However, the market is expected to become more stable as a result of efforts by major producers to hold production and inventories at levels that are consistant with demand. Prices are not expected to recover significantly until demand improves, and supply and demand are brought into balance. In the longer term, prices are forecast to increase marginally due to rising costs. Existing and new capacity will provide a stable supply to meet the increase in demand well into the late-1980s.

TARIFFS

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
CANADA					
32900-1	Molybdenum ores and concentrates	free	free	free	free
33505-1	Molybdenum oxides	10.0	14.1	25.0	9.0
37506-1	Ferromolybdenum	free	4.8	5.0	free
35120-1	Molybdenum metal in powder, pellets, scrap, ingots, sheets, strips, plates, bars, rods, tubing or wire, for use in Canadian manufactures	free	free	25.0	free
92847-1	Molybdates	10.0	12.8	25.0	8.5
	Temporary reduction, June 3, 1980 to June 30, 1987	free			free
92856-1	Molybdenum carbides	9.4	9.4	25.0	6
	Temporary reduction, June 3, 1980 to December 31, 1986	free			free

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
			(%)			
33505-1	14.1	13.8	13.4	13.1	12.8	12.5
37506-1	4.8	4.7	4.5	4.3	4.2	4.0
92847-1	12.8	12.1	11.4	10.7	9.9	9.2
92856-1	9.4	7.5	5.6	3.8	1.9	free

TARIFFS (cont'd)

Item No.		1982	1983	1984	1985	1986	1987
		(%)					
UNITED STATES							
601.33	Molybdenum ore (per lb on Mo content)	10.9¢	10.5¢	10.1¢	9.8¢	9.4¢	9.0¢
419.60	Molybdenum compounds	3.8	3.7	3.5	3.4	3.3	3.2
606.31	Ferromolybdenum	6.3	5.9	5.6	5.2	4.9	4.5
628.70	Molybdenum metal, waste and scrap	8.8	8.3	7.7	7.1	6.6	6.0
628.72	Molybdenum metal, unwrought	8.6¢/ lb on Mo con- tent +2.6	8.1¢/ lb on Mo con- tent +2.5	7.6¢/ lb on Mo con- tent +2.3	7.2¢/ lb on Mo con- tent +2.2	6.7¢/ lb on Mo con- tent +2.0	6.3¢/ lb on Mo con- tent +1.9
628.74	Molybdenum metal, wrought	10.3	9.6	8.8	8.1	7.3	6.6
417.28	Ammonium molybdate	5.5	5.3	5.0	4.8	4.5	4.3
418.26	Calcium molybdate	4.8	4.8	4.8	4.8	4.7	4.7
421.10	Sodium molybdate	4.6	4.4	4.2	4.1	3.9	3.7
423.88	Molybdenum carbide	3.3	3.2	3.1	3.0	2.9	2.8

EUROPEAN ECONOMIC COMMUNITY (MFN)		1982	Base Rate	Concession Rate
			(%)	
26.01	Molybdenum ores and conc.	free		
28.28	Molybdenum oxides and hydroxides	7.0	8.0	5.3
73.02	Ferromolybdenum	6.7	7.0	4.9
81.02	Molybdenum metal			
	A. Unwrought: powder	6		
	other	5		
	B. Wrought: bars, angles, plates, sheets, strip, wire	8		
	C. Other	10		
28.47	Molybdates	9.5	11.2	6.6
28.56	Molybdenum carbides	8.6	9.6	8.0

JAPAN (MFN)				
26.01	Molybdenum ores and conc.			
	A. Quota	free		
	B. Other	4.7	7.5	free
28.28	Molybdenum trioxide	3.8	5.0	3.7
73.02	Ferromolybdenum	5.3	7.5	4.9
81.02	Molybdenum metal			
	A. Unwrought, powders and flakes	3.8	5.0	3.7
	B. Waste and scrap	3.8	5.0	3.7
	C. Other	5.3	7.5	4.9
28.47	Molybdates	5.3	7.5	4.9
28.56	Molybdenum carbides	3.8	5.0	3.7

Sources: The Customs Tariff and Commodities Index, 1982, Revenue Canada; Tariff Schedules of the United States Annotated 1982, USITC publication 1200; U.S. Federal Register, Vol. 44, No. 241; Official Journal of the European Communities, Vol. 24, No. L335, 1981; Customs Tariff Schedules of Japan, 1982.

Nepheline Syenite and Feldspar

B.W. BOYD

SUMMARY

Canada is the world's foremost producer of nepheline syenite as an industrial raw material for the manufacture of glass and ceramics. Its two producers -- Indusmin Limited, a subsidiary of Falconbridge Limited, and IMC Industry Group (Canada) Ltd., controlled by International Minerals & Chemical Corporation (Canada) Limited (IMCC) -- mine from extensive deposits in Methuen Township, about 40 km northeast of Peterborough, Ontario.

For three years ending in 1980, sales of Canadian nepheline syenite were maintained at about 600 000 tpy. However, in 1981 sales slipped by 12 000 t and in 1982 they fell a further 70 000 t.

Exports account for 80 per cent of sales and 90 per cent of Canadian exports in 1982 went to the United States. All the same, shipments to that country were down by 6 per cent or over 25 000 t in 1982 as a result of the recession. The hardest blow to Canadian exports though was the 25 299 t or

TABLE 1. CANADA, NEPHELINE SYENITE PRODUCTION, EXPORTS AND CONSUMPTION, 1981 AND 1982

	1981		1982P	
	(tonnes)	($)	(tonnes)	($)
Production (shipments)	588 000	16,770,000	518 000	17,338,000
Exports				
United States	399 071	13,423,000	373 930	13,557,000
Italy	12 203	435,000	6 834	495,000
Australia	11 295	408,000	1 537	121,000
Netherlands	8 654	358,000	24 490	1,014,000
United Kingdom	3 740	175,000	4 751	256,000
France	1 149	121,000	821	93,000
Taiwan	311	72,000	526	36,000
Other countries	39 858	266,000	1 896	193,000
Total	476 281	15,258,000	414 785	15,765,000
Consumption[1]				
Glass and glass fibre	66 591			
Ceramic products	16 217			
Insulation	11 368			
Paints	2 039			
Rubber products	689			
Others[2]	830			
Total	97 734	..	..	..

Sources: Statistics Canada; Energy, Mines and Resources, Canada.
[1] Available data, as reported by consumers. [2] Includes frits and enamel, foundry, plastics, electrical apparatus and other minor uses.
P Preliminary; .. Not available.

40 per cent fall in exports to western Europe.

As with most minerals, nepheline syenite production was lower in 1982 than in 1981. The 15 per cent fall in shipments affected both mines, but was most discouraging for IMC which had just completed an 80 000 t expansion in September 1981. To reduce production without layoffs, work weeks of 4 days and 5 days were alternated during the latter part of the year at the IMC mine and mill. There were partial layoffs three times during the year at the Indusmin mine.

Feldspar production was limited to a few small mines for potassium-rich dental spar, exported to the United States, and production of high quality feldspar by Thunderbrick Limited for their own use in tiles.

CONSUMPTION

The glass industry accounts for about 70 per cent of nepheline syenite consumption. Use of finely ground material in the ceramics industry, and as a filler in plastics, paint, rubber and paper, has grown more rapidly than consumption for glassmaking. Further diversification and growth of the former markets is expected.

The current recession had a deep negative impact on the United States glassmaking industry and the high interest rates were particularly onerous for the commercial and residential construction sector.

TABLE 2. CANADA, NEPHELINE SYENITE PRODUCTION AND EXPORTS, 1970, 1975-82

	Production[1]	Exports
	(tonnes)	
1970	454 110	351 940
1975	468 427	356 629
1976	540 121	418 975
1977	574 558	443 763
1978	599 121	420 962
1979	605 699	471 056
1980	600 000	448 468
1981	588 000	476 281
1982[p]	518 000	414 785

Sources: Energy, Mines and Resources, Canada; Statistics Canada.
[1] Producers' shipments.
[p] Preliminary.

TABLE 3. CANADA, ESTIMATED FELDSPAR CONSUMPTION, 1980 and 1981

	1980	1981
	(tonnes)	
Consumption		
Whiteware	3 981	4 410
Other products[1]	70	196
Total	4 051	4 606

[1] Includes porcelain enamel, artificial abrasives and other minor uses.

TABLE 4. CANADA, IMPORTS AND CONSUMPTION OF CRUDE OR GROUND FELDSPAR, 1975-82

	Imports	Consumption
	($)	(tonnes)
1975	..	5 630
1976	106,000	4 053
1977	275,000	4 271
1978	762,000	4 586
1979	501,000	4 588
1980	385,000	4 051
1981	642,000	4 606
1982	251,000	..

Sources: Statistics Canada; Energy, Mines and Resources Canada.
.. Not available.

TABLE 5. WORLD PRODUCTION OF FELDSPAR, 1981 and 1982

	1981	1982[e]
	(tonnes)	
United States	603 000	526 000
West Germany	381 000	345 000
Brazil	127 000	118 000
Italy	336 000	308 000
France	199 000	181 000
Mexico	127 000	118 000
Spain	109 000	100 000
Other countries	1 242 000	1 116 000
Total	3 124 000	2 812 000

Source: United States Bureau of Mines (USBM), Mineral Commodity Summaries, 1983.
[e] Estimated.

PRICES

The value of exports of nepheline syenite increased by 3 per cent in response to an average price increase of 19 per cent. The price per tonne ranges from about $20 to over $120, depending on the quality of the product. Some of the increase in average value was due to sales of a higher quality product made available from improvements at the IMC mill.

PRICES OF FELDSPAR IN U.S. CURRENCY

(per short ton, bulk, fob mine or mill, carload lots depending on grade)

	($)
North Carolina	
40 mesh, flotation	51.00
20 mesh, flotation	27.50
200 mesh, flotation	70.25
Georgia	
200 mesh	69.25
40 mesh, granular	51.00
Connecticut	
200 mesh	50.50
20 mesh, granular	37.25

Source: Engineering and Mining Journal, December 1982.
fob - Free on board.

USES

Over the years, nepheline syenite has become preferred to feldspar as a source of alumina and alkalis for glass manufacture. Its use results in more rapid melting of the batch at lower temperatures than with feldspar, thus reducing fuel consumption, lengthening the life of furnace refractories and improving the yield and quality of glass. Other industrial uses for nepheline syenite include ceramic glazes, enamels, and fillers in paints, papers, plastics and foam rubber.

Feldspar is the name of a group of minerals consisting of aluminum silicates of potassium, sodium and calcium. It is used in glassmaking as a source of alumina and alkalis, in ceramic bodies and glazes, in cleaning compounds as a moderate abrasive and as a flux coating on welding rods. High calcium feldspars, such as labradorite, and feldspar-rich rocks, such as anorthosite, find limited use as building stones and for other decorative purposes. Potash feldspar is an essential ingredient in the manufacture of high voltage porcelain insulators. Dental spar, which is used in the manufacture of artificial teeth, is a pure white potash feldspar, free of iron and mica.

OUTLOOK

Competition for Canadian nepheline syenite comes from feldspar and aplite produced in the United States. The substitutability of these inputs for glass and ceramics and the high cost of transport relative to unit value has created fairly stable market areas, the borders of which are as much dependent on freight rates as on prices. The wider range of products, especially very fine grades, now offered by both IMC and Indusmin should increase sales in the short-term. The total capacity of the two plants amounts to over 800 000 t of products; the 35 per cent unused capacity in 1982 will be available to meet growth in the markets. However, any large scale increase in shipments will depend on the performance of the glass and ceramics industry, which in turn is dependent on the performance of the North American economy in general.

Exports offshore should continue to grow with expansion of European consuming industries since the only western European nepheline syenite producer, Norsk Nefelin, works division of Elkem A/S of Norway is already operating at capacity.

TARIFFS

CANADA

Item No.		British Preferential (%)	Most Favoured Nation (%)	General (%)	General Preferential (%)
29600-1	Feldspar, crude	free	free	free	free
29625-1	Feldspar, ground but not further manufactured	free	6.8	30	free
29640-1	Ground feldspar for use in Canadian manufactures	free	free	30	free

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
	(%)					
29625-1	6.8	6.5	6.3	6.0	5.8	5.5

UNITED STATES

522.31	Crude feldspar	free					
		1982	1983	1984	1985	1986	1987
		(%)					
522.41	Feldspar, crushed, ground or pulverized	3.2	3.2	3.1	3.0	2.9	2.8

Sources: The Customs Tariff and Commodities Index, January 1982, Revenue Canada; Tariff Schedules of the United States, Annotated 1982, USITC Publication 1200. U.S. Federal Register Vol. 44, No. 241.

Nickel

R.G. TELEWIAK

Reduced capital expenditures in most major industrialized markets and particularly the United States and the EEC, resulted in a decline in western world nickel consumption of an estimated 7 per cent over the 1981 level. This was the third consecutive year of declining consumption, a situation which, with the exception of World War II, has not occurred since the early 1930s.

Western world producers curtailed output sufficiently to reduce producer stocks by approximately 15 000 t (to 200 000 t), despite increased exports from the Comecon bloc. Production cutbacks, however, did not stop prices from coming under severe pressure and they fell from a realized producer price of $US 2.75-3.00 in the first quarter to less than $2.00 in the fourth quarter. Prices on the London Metal Exchange hit a record low of $1.42 on November 26.

Increased exports of low-priced nickel from Comecon countries, and particularly the Soviet Union, were a major disruptive factor in the marketplace during the year. The Comecon countries increased their share of western markets from 7 per cent in 1981 to close to 10 per cent in 1982. The critical factor in 1982 was not so much the volume of sales, but instead the price. The Soviets were highly aggressive sellers and were an important factor in driving the price to levels at which virtually no producers could cover operating costs.

Substantial losses were recorded by most producers. Inco Limited and Falconbridge Limited reported losses for 1982 of $247 million and $85 million, respectively. In proportion to production, Marinduque Mining & Industrial Corporation of the Philippines reported one of the largest losses for its nickel operations, $120 million. Governments in many countries provided subsidies and other forms of assistance to keep their nickel industry operating, although usually production was at a reduced rate.

CANADIAN DEVELOPMENTS

Extensive shutdowns were undertaken by both Inco and Falconbridge, resulting in Canadian production being the lowest in decades. Preliminary figures indicate that production was 88 700 t, compared with 160 200 t in 1981 and an average annual rate of 227 000 t during the 1970s.

The Sudbury operations of Inco were closed, except for some processing of stockpiled copper concentrate, from June 1 through the end of the year. Initially the operations were closed for one month due to a management-labour dispute. A three-year contract was signed in early July which provided for improved wages and benefits worth about $4.00/hour over the life of the contract and allowed for a reopening of the contract if nickel sales and Inco's realized price exceed certain values.

Relatively high nickel inventories in combination with poor market conditions persuaded Inco to keep the Sudbury operations closed for the remainder of the year, despite the strike settlement. Finished nickel inventories were reported to be 71 200 t on June 30 and 64 900 t on September 30. A desirable level of inventories, in face of the prevailing market conditions, was probably somewhat less than 30 000 t. Reopening of the operations is scheduled for April 4, 1983 for the nickel smelter and refinery, and April 18 for the remaining facilities.

Inco's Port Colborne refinery and Shebandowan mine are closely associated with the Sudbury complex and both were closed for the same period as Sudbury. Port Colborne is scheduled to reopen ahead of the other operations in Ontario. The refinery will open on February 7 to produce S-rounds, which are running in short supply.

TABLE 1. CANADA, NICKEL PRODUCTION, TRADE AND CONSUMPTION, 1981 AND 1982

	1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)
Production[1]				
All forms				
Ontario	130 268	1,159,747	63 065	412,930
Manitoba	29 979	254,996	25 680	168,144
Total	160 247	1,414,743	88 745	581,074
Exports				
Nickel in ores, concentrates and matte[2]				
Norway	31 437	233,563	19 737	136,888
United Kingdom	22 394	168,034	7 299	50,925
Japan	10	30	2	5
Total	53 841	401,627	27 038	187,818
Nickel in oxides				
EEC	2 031	19,811	5 285	40,599
United States	7 678	60,308	4 733	36,363
Other countries	4 681	41,229	3 109	23,888
Total	14 390	121,348	13 127	100,850
Nickel and nickel alloy scrap				
United States	2 188	8,191	2 123	7,141
South Korea	36	164	92	630
West Germany	264	1,299	180	183
Japan	50	166	49	140
Other countries	240	525	826	1,882
Total	2 778	10,345	3 270	9,976
Nickel anodes, cathodes, ingots, rods				
United States	49 937	378,906	38 320	260,775
EEC	14 753	96,575	12 974	88,295
Other countries	15 245	107,229	12 403	84,437
Total	79 935	582,710	63 697	433,507
Nickel and nickel alloy fabricated material, n.e.s.				
United States	10 156	83,202	8 385	65,751
Netherlands	509	6,850	423	4,507
United Kingdom	326	2,580	259	2,133
Japan	266	2,107	460	1,769
Belgium-Luxembourg	1 008	8,100	256	1,427
India	315	2,535	10	78
Other countries	798	6,455	615	5,606
Total	13 378	111,829	10 408	81,271
Imports				
Nickel in ores, concentrates and scrap				
Australia	4 580	28,368	4 496	20,867
United States	9 095	15,393	9 324	12,568
Belgium-Luxembourg	5 488	7,503	5 744	5,733
South Africa	1 936	4,668	1 848	2,434
Other countries	2 661	3,274	943	1,030
Total	23 760	59,206	22 355	42,632

TABLE 1. (cont'd.)

	1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)
Nickel anodes, cathodes, ingots, rods				
Norway	1 266	9,970	1 603	11,106
United States	816	6,664	908	5,454
United Kingdom	51	316	37	314
U.S.S.R.	191	1,428	-	-
Other countries	11	94	40	247
Total	2 335	18,472	2 588	17,121
Nickel alloy ingots, blocks, rods and wire bars				
United States	545	5,172	969	6,891
West Germany	2	33	1	6
United Kingdom	43	142	-	-
Belgium-Luxembourg	-	-	-	-
Total	590	5,347	970	6,897
Nickel and alloy plates, sheet, strip				
United States	617	8,532	934	8,411
West Germany	498	4,118	388	2,802
Netherlands	15	33	-	-
Other countries	1	16	2	40
Total	1 131	12,699	1 324	11,253
Nickel and nickel alloy pipe and tubing				
Sweden	600	9,282	600	6,881
United States	973	13,587	314	5,329
West Germany	227	5,142	108	1,752
Other countries	23	445	48	466
Total	1 823	28,456	1 070	14,428
Nickel and alloy fabricated material, n.e.s.				
United States	779	24,474	582	14,172
United Kingdom	21	444	212	2,133
West Germany	59	741	34	381
Austria	27	320	2	22
Other countries	10	76	288	63
Total	896	26,055	1 118	16,771
Consumption[3]	9 440	..	..	..

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] For refining and re-export. [3] Consumption of nickel, all forms (refined metal and in oxides and salts) as reported by consumers.
P Preliminary; - Nil; .. Not available; n.e.s. Not elsewhere specified.

At Thompson, Inco's operations were closed in November and December, and will be reopening in late-January 1983. Commercial-scale testing was completed on the modified fluid bed roaster-electric furnace process and the evaluation of these results should be completed in early-1983. The major advantage of the process lies in the potential to recover 80 per cent of the sulphur in a high strength, continuous SO_2 gas stream suitable for the production of sulphuric acid. Results to date have been encouraging and the next step will be to conduct tests using roasters at the iron ore recovery plant in Sudbury. These tests will commence when production resumes in April.

Inco announced various measures to improve the productivity of its operations and to prepare for a somewhat lower production rate once operations resume. Included in this program are the redesigning of the upper portion of the Levack mine for lower cost bulk mining methods, closure of the leaching section of the Sudbury iron ore recovery plant, reopening the Copper Cliff North mine as a commercial scale research facility to develop new mining methods and equipment, and a reduction in the workforce. When operations resume in 1983, the workforce will be approximately 3,000 fewer than it was at the beginning of 1982.

Falconbridge closed its operations at Sudbury on June 27 for a 13-week period but this was later extended until January 2, 1983. The contract with the Mine, Mill and Smelter Workers expired on August 21 and a new contract was not signed before the end of the year. The company and union agreed to work under the terms of the old contract when production resumed on January 2, while continuing negotiations for a new one. The work force was reduced from 4,000 at the beginning of 1982 to 2,600 at year-end.

Near-capacity production was recorded at the 17 500 tpy refinery of Sherritt Gordon Mines Limited at Fort Saskatchewan, Alberta, despite production being lowered in the second quarter due to problems with the hydrogen generating equipment and the electrical power system. The decline in third quarter nickel prices resulted in Sherritt writing down the value of its inventories. This was the major factor in a third quarter loss of $3.4 million being recorded in the metal refining division. Inco's Thompson division, continued to supply the majority of refinery feed and after Thompson closed in November, Sherritt drew from concentrate which had been stockpiled at the refinery.

Exploration continued on the nickel-copper property of New Quebec Raglan Mines Limited in the Ungava area of northern Quebec. A total of 4 160 m were drilled and geological mapping was completed over a 450 sq km area. Resources were recalculated at 10.9 million t grading 3.11 per cent nickel and 0.79 per cent copper. The isolated location is one of the major deterrents to the development of these relatively high-grade deposits.

Wasabi Resources Ltd. announced that an agreement in principle had been reached with Kerr Addison Mines Limited regarding the Norton Lake nickel-copper property in northwestern Ontario. Kerr Addison can earn up to 80 per cent interest in the property with an expenditure of $2 million. Work in 1980 and 1981 indicated one deposit containing 1.3 million t grading 0.72 per cent nickel and 0.56 per cent copper, and also identified numerous geophysical anomalies which have yet to be tested.

Late in the year the Ontario-Canada Task Force report on Sudbury smelters was released. The study indicated that there are technical solutions for Inco and Falconbridge to implement at Sudbury which would substantially reduce sulphur dioxide emissions. For Inco, the report claimed that not only would emissions be reduced but there would be substantial operating savings in labour, energy and maintenance costs if a new smelter was built. However, the cost of a new smelter was calculated at about $500 million and it was not the mandate of the Task Force to determine how Inco could raise the necessary fund. The Ontario Ministry of Environment indicated that it will make an announcement within several months for more controls on Inco, and that it may require more than a 50 per cent reduction in sulphur dioxide emissions.

Subsequent to the release of the Task Force report, Falconbridge announced that it planned to implement one of the abatement alternatives at Sudbury on a full-scale experimental basis, when production resumes in January. The increased sulphur containment during roasting of nickel/copper concentrate was said by the company to have produced "promising" results in preliminary testing. Falconbridge currently captures over 83 per cent of the sulphur in the ore.

TABLE 2. CANADA, NICKEL PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975, 1978-82

	Production[1]	Exports				Imports[2]	Consumption[3]
		In Matte etc.	In Oxide Sinter	Refined Metal	Total		
				(tonnes)			
1970	277 490	88 805	39 821	138 983	267 609	10 728	10 699
1975	242 180	84 391	38 527	91 164	214 082	12 847	11 308
1978	128 310	39 077	27 792	105 663	172 532	1 439	11 790
1979	126 482	42 735	17 190	84 809	144 734	2 516	8 336
1980	184 802	42 647	16 989	88 125	147 761	4 344	9 676r
1981	160 247	53 841	14 390	79 935	148 166	2 335	9 440
1982P	88 745	27 038	13 127	63 697	103 862	2 588	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Refined metal and nickel in oxide and salts produced, plus recoverable nickel in matte and concentrates exported; [2] Refined nickel, comprising anodes, cathodes, ingots, rods and shot; [3] Consumption of nickel, all forms (refined metal, and in oxides and salts), as reported by consumers.
P Preliminary; .. Not available; r Revised.

Nickel consumption in Canada declined to 6 500 t in 1982 from 7 600 t the previous year. Recessionary economic conditions accounted for part of the decline but another important factor was the greater use of scrap by Atlas Steels, division of Rio Algom Limited, the only Canadian producer of stainless steel. Scrap prices were low relative to those for primary nickel and this encouraged increased scrap consumption.

WORLD DEVELOPMENTS

Most producers throughout the western world reacted to the weak market conditions by operating well below capacity and some facilities were closed either temporarily or indefinitely. This reduced production, however, was partially offset by increased supplies from the Soviet Union and to a lesser extent from some new facilities in Colombia, Yugoslavia and Brazil.

An expansion and modernization program was completed at the Norilsk complex in the Soviet Union in late-1981 and this enabled the Soviets to increase sales to the west in 1982. Additional future supplies could be available for export to the west if plans to further expand the Norilsk operation are carried out. The Soviet Union was by far the world's largest producer in 1982, followed by Canada, Australia and New Caledonia.

Australian producers operated near capacity but late in the year, Metals Exploration Ltd. announced that the Nepean mine in Western Australia would be closed for at least 12 months, starting in early-1983. The closure will remove about 4 000 t of nickel from the market.

The oil-to-coal conversion at the Greenvale operation of Metals Exploration Queensland Pty. Ltd. and Freeport Queensland Nickel Inc. was completed during the year, and 60 per cent of the oil formerly used at the facility has been displaced by coal. Operating costs have been substantially reduced. Also in Australia, Western Mining Corporation Holdings Ltd. announced the signing of a 10-year contract with Sumitomo Metal Mining Co. Ltd. of Japan, to supply an annual base quantity of 15 000 t of contained nickel in nickel matte. Sumitomo has been a major customer of Western Mining since the start of operations at Kambalda in 1967.

In Japan, Shimura Kako Company, Limited permanently closed its 6 000 tpy ferronickel plant in mid-December. Shimura planned to supply its customers with utility nickel shot from a subsidiary, Tokyo Nickel Company, Ltd. Production is expected to be at a rate of 4 000 to 5 000 tpy. Both companies are partly owned by Inco Limited.

A stockpile equivalent to 10 days consumption of several metals, including nickel, was accumulated during the year by the private sector in Japan, with government

TABLE 3. CANADIAN NICKEL MINES AND MILLS, 1982 AND (1981)

Companies and Mines	Mills	Mill Capacity	Grade of Ore		Ore Milled	Contained Nickel in Ore Milled	Remarks
			Nickel	Copper			
		(tonnes ore/day)	(%)	(%)	(tonnes)	(tonnes)	
Ontario							
Falconbridge Limited	Total	10 300	1.25	1.02	1 559 500	16 278	The Onaping mine did not reopen in January 1983, when other operations resumed after the 6-month shutdown.
East, Falconbridge, Fraser, North, Lockerby, Onaping and Strathcona mines Falconbridge	(Falconbridge)	2 700	(1.25)	(1.01)	(2 759 700)	(29 480)	
	(Strathcona)	7 600					
Inco Limited	Total	53 600[2]	1.35	1.33	3 991 600[1]	48 187[1]	The Coleman mine was placed on standby in March 1982.
Copper Cliff, South, Creighton, Frood, Garson, Levack, Little Stobie, McCreedy West and Stobie mines Sudbury	(Clarabelle)	31 800	(1.35)	(1.28)	(9 220 000)	(109 587)	
	(Frood-Stobie)	21 800					
Shebandowan mine		2 250	..	..	See above[1]	See above[1]	
Shebandowan			(..)	(..)	(See above)[1]	(See above)[1]	
Umex Inc.		3 600	0.12	0.85	217 200	42	Closed in April 1982.
Thierry mine			(0.12)	(0.85)	(903 400)	(172)	
Manitoba							
Inco Limited		12 700	0.14	1.89	1 764 300	30 055	
Pipe No. 2 and Thompson Thompson			(0.13)	(1.77)	(1 801 400)	(28 906)	

[1] Includes Shebandowan. [2] In addition to the Clarabelle and Frood-Stobie mills, a bulk copper-nickel concentrate produced by them is further milled at Copper Cliff to produce separate copper and nickel concentrates.
.. Not available.

TABLE 4. PROSPECTIVE CANADIAN NICKEL MINES

Company and Location	Tonnage and Ore Grade (%)	Year Production Expected	Remarks
Quebec			
New Quebec Raglan Mines Limited	10.9 million Ni(3.11) Cu(0.79)	..	A total of 4 159 m of drilling completed in 1982.
Ontario			
Falconbridge Limited Falconbridge	.. Ni(..) Cu(..)		
Craig		1990	Development work commenced in 1981, then deferred.
Lindsley		..	Development deferred.
Onex mine			Development deferred.
Thayer mine			Development deferred.
Inco Limited, Sudbury	.. Ni(..) Cu(..)		
Clarabelle		..	Placed on standby, 1980.
Coleman		..	Placed on standby, 1982.
Copper Cliff North mine		..	Placed on standby, 1978.
Crean Hill mine		..	Placed on standby, 1978.
Levack East mine		..	Development deferred.
Murray mine		..	Placed on standby, 1971.
Totten mine		..	Development suspended, on standby.
Great Lakes Nickel Limited, Pardee Township	66 million Ni(0.20) Cu(0.40)	..	Development for a rate of 2.25 million tpy suspended and project put on standby, 1974.
Teck Corporation, Montcalm Township	4.5 million Ni(1.4) Cu(0.66)	..	Feasibility study completed. Development decision deferred pending an improvement in nickel markets.
Manitoba			
Inco Limited, Thompson	.. Ni(..) Cu(..)		
Birchtree		..	Production suspended and placed on standby, 1977.
Pipe No. 1 mine		..	Development suspended 1977, on standby.
Soab		..	Placed on standby, 1971.
Thompson Open Pit		1986	Thompson crown pillar being developed to replace Pipe No. 2 mine which will be exhausted by 1985.

.. Not available.

TABLE 5. CANADIAN PROCESSING CAPACITY, 1982

	Inco			Falconbridge	Sherritt Gordon
	Port Colborne	Sudbury	Thompson	Sudbury	Fort Saskatchewan
Smelter (tpy of contained nickel)	n.a.	127 000[1]	81 600	45 000	n.a.
Refinery (tpy of contained nickel)	65 000	56 700	55 000	n.a.	17 500

[1] Reduced from 154 200 t due to a government regulation on SO_2 emissions imposed on September 2, 1980.
n.a. Not applicable.

assistance in the form of interest rate subsidies. The government announced late in the year that it will buy an additional five days of consumption for this stockpile in fiscal 1983. An earlier government plan was for a 60-day stockpile to be built up over five years by accumulating 12 days of consumption each year, but this plan was later changed to reduce government expenditures.

In the Philippines, Marinduque reduced its operating rate to less than 40 per cent of capacity and then closed in early December for a scheduled two-month period. This laterite operation has very high costs due to its low-grade ore and the use of oil for energy. A $160 million oil-to-coal conversion project is expected to be completed by April and this should considerably reduce operating costs. Coal is to be imported initially from Australia and Indonesia, but later is expected to be mined domestically. The Philippine government has been converting substantial portions of Marinduque's debt into equity and it is now the majority shareholder in Marinduque.

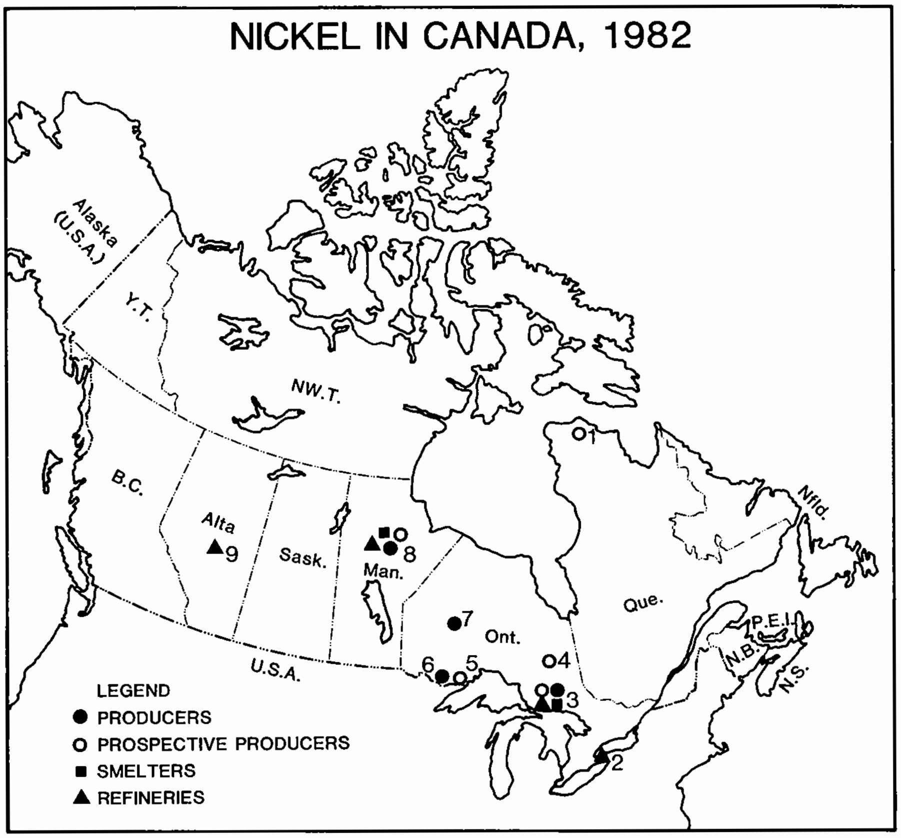
P.T. International Nickel Indonesia, a 97 per cent owned subsidiary of Inco, operated only one of its three furnaces from February 1 to year-end. P.T. Aneka Tambang, the Indonesian government owned corporation, was studying the possibility of expanding its ferronickel plant. The results of this study were not released before year-end but it is believed that nickel market conditions will have to improve substantially before the expansion can proceed on a profitable basis, despite the deposit having certain favourable characteristics, including relatively high grade.

In the Dominican Republic, Falconbridge Dominicana C. por A. closed its operations in mid-January in response to high inventories of ferronickel. In mid-September inventories were reduced sufficiently to permit production to be resumed at an annual rate of 14 300 t of nickel, or one-half of capacity. The workforce was reduced from 1,900 to 1,200.

TABLE 6. WORLD PRODUCTION OF NICKEL, 1981 AND 1982

	1981	1982
	(tonnes)	
Canada[1]	160 200	88 700
U.S.S.R.	150 000	170 000
New Caledonia	78 100	60 100
Australia	74 400	88 600
Indonesia	45 500	48 500
Philippine Republic	29 200	19 700
Cuba	40 300	37 600
South Africa	25 000	20 500
Dominican Republic	17 900	6 000
Zimbabwe	15 100	13 400
Botswana	18 300	17 800
Greece	11 800	5 500
United States	11 000	2 900
People's Republic of China	11 000	12 000
Other	20 100	33 900
Total	707 900	625 200

Sources: Energy, Mines and Resources Canada; World Bureau of Metal Statistics; United States Bureau of Mines.
[1] Refined nickel and nickel in oxide and salts produced, plus recoverable nickel in matte and concentrates produced.



Producers, prospective producers, smelters and refineries
(numbers refer to locations on map above)

Producers

3. Falconbridge Limited
   (East, Falconbridge, Fraser, Lockerby, North, Onaping, Strathcona)
   Inco Limited
   Copper Cliff South, Creighton, Frood, Garson, Levack, Little Stobie, McCreedy West and Stobie)
6. Inco Limited (Shebandowan mine)
7. Umex Inc. (Thierry mine)
8. Inco Limited (Pipe open pit and Thompson)

Prospective Producers

1. New Quebec Raglan Mines Limited
3. Falconbridge Limited
   (Craig, Lindsley, Onex and Thayer mines)
   Inco Limited (Clarabelle, Coleman, Copper Cliff North, Crean Hill, Murray, Totten)
4. Teck Corporation (Moncalm Township)
5. Great Lakes Nickel Limited (Pardee Township)
8. Inco Limited (Thompson open pit, Soab, Birchtree, Pipe No. 1)

Smelters

3. Falconbridge Limited (Falconbridge)
8. Inco Limited (Sudbury)
   Inco Limited (Thompson)

Refineries

2. Inco Limited (Port Colborne)
3. Inco Limited (Sudbury)
8. Inco Limited (Thompson)
9. Sherritt Gordon Mines Limited
   (Fort Saskatchewan)

TABLE 7. WORLD CONSUMPTION OF NICKEL, 1981 AND 1982

	1981	1982
	(tonnes)	
U.S.S.R.	130 000	138 000
Japan	105 000	106 700
United States	131 300	94 300
West Germany	62 000	57 700
France	33 600	31 800
Italy	20 000	24 000
United Kingdom	28 800	23 500
People's Republic of China	19 000	19 000
Sweden	16 300	15 000
India	9 500	11 000
Czechoslovakia	10 000	10 000
East Germany	10 000	10 000
Finland	7 300	9 500
Spain	6 800	7 900
Canada	7 600	6 500
Other	55 900	60 500
Total	653 100	624 400

Sources: World Bureau of Metal Statistics; Energy, Mines and Resources.

The Hanna Mining Company in May indefinitely closed its mine and processing plant in Oregon. The operation has a capacity of 11 800 t of nickel contained in ferronickel, and is the only fully integrated nickel operation in the United States. Low ferronickel prices in combination with increased power and labour costs forced the shutdown. A major increase in the price of nickel will be needed before this operation can be reopened and generate a profit.

AMAX Inc. continued its aggressive pricing policy adopted in mid-1981 and was able to further reduce inventories. The refinery was operated at or slightly above rated capacity, and this in combination with a reduction in matte from Botswana resulted in matte inventories being reduced to more normal levels. Finished nickel inventories were also believed to have been brought close to normal. AMAX could run short of matte by mid-1983 unless additional supplies are obtained.

Some Botswana matte was diverted from AMAX under an agreement with BCL Ltd. in early-1982, and part of this was treated by Rio Tinto Mining (Zimbabwe) Ltd. Rio Tinto signed a new agreement with BCL in the fourth quarter to take additional matte. Rio Tinto was scheduled to close the Empress mine at the end of December 1982, and this additional matte from Botswana will at least partially offset the loss from the mine closure.

The Cerro Matoso S.A. ferronickel complex in Colombia was commissioned in June and significant production started in August. The 22 600 tpy operation utilizes low-priced hydro power for 75 per cent of its energy requirements, with the remainder being largely from domestically produced natural gas. Average grade of the 21 million t deposit is 2.7 per cent nickel. Operating costs of the laterite operation are relatively low due to the combination of inexpensive energy and high ore grade.

In Brazil, production from the Tocantins laterite deposit started in the spring. The initial capacity of the plant is 5 000 tpy but this can be doubled if market conditions warrant. An unusual feature of

TABLE 8. NICKEL PRICES IN UNITED STATES DOLLARS PER POUND, 1982

	1st Quarter Average	2nd Quarter Average	3rd Quarter Average	4th Quarter Average	Annual Average
Cathodes					
- New York dealer[1]	2.66	2.55	2.32	1.79	2.33
- major producer	3.20	3.20	3.20	3.20	3.20
LME	2.57	2.39	2.16	1.65	2.19
Briquettes	3.20	3.20	3.20	3.20	3.20
Falconbridge, ferronickel[1]	3.18	3.18	3.18	3.18	3.18
Hanna, ferronickel[1]	3.16	3.16	3.16	3.16	3.16

Source: **Metals Week.**
[1] Per pound of contained nickel.

the operation is that the main source of energy is charcoal produced from locally grown eucalyptus trees.

The 19 000 tpy FENI - Rudnici I Topilnica ferronickel plant at Kavadarci, in Yugoslavia, started production in the third quarter of the year. It is not expected to reach full capacity for two or more years. Problems were reported with irregular supplies of electricity and quality of the product.

Two further meetings, involving Australia, Canada, Federal Republic of Germany, France, Japan and the United States, were held on the proposed Intergovernmental Nickel Discussion Group. This statistical organization, if formed, is expected to improve data on nickel production, consumption, stocks and trade. Some 30 other major producing and consuming countries were surveyed during the year to test their interest in establishing such an organization and their ability to supply the data indicated. The response was generally favourable and most countries indicated that they would be willing to supply statistics. Another meeting is scheduled for April at which time a decision could be made to proceed with a formational meeting late in the year.

Nickel consumption in the world, including the Comecon bloc, decreased to 624 000 t, compared to 653 000 t a year earlier. The country which had the largest decrease was the United States, where consumption fell by 28 per cent to 94 000 t.

STOCKS

Production cutbacks by many western world producers resulted in a decline in non-communist producer inventories of about 12 000 t to 200 000 t. An increase in Comecon bloc exports of 7 000 t limited the reduction. Producers consider three months of supply to be a normal level of inventories, and in 1982, this would have represented about 110 000 t. Inventories held by both Inco and Falconbridge, fell substantially. At year-end, Inco reported inventories of 48 000 t compared to 712 000 t at mid year and 65 000 t at the end of 1981. Falconbridge reported a drop in inventories, which include ferronickel, to 18 000 t from 23 000 t at year-end 1981.

Western world consumer inventories declined to about 61 000 t from 64 000 t the previous year. Consumers reduced their inventories only modestly despite the slowdown in orders for their products and the willingness of producers to supply nickel to consumers on very short notice.

LAW OF THE SEA

On December 10 in Montego Bay, Jamaica, 119 states including Canada signed the 321-article United Nations Law of the Sea Convention. Another 32 states did not sign but the convention remains open for two years and it is expected that at least some other nations will also join. The most important non-signatures to date include the United States, United Kingdom, Federal Republic of Germany and Japan, although only the United States has stated it will not sign.

The seabed contains vast resources of nodules containing nickel, cobalt, copper and manganese. Under terms of the convention, private and state-owned mining companies could be operating alongside the Enterprise, an entity scheduled to be set up by the International Seabed Authority to mine the seabed. Funds for the Enterprise would be provided by the Authority and technology would be obtained from the other mining groups.

Mining of the nodules remains many years into the future. Changing nickel consumption patterns along with substantial overcapacity of the land-based industry indicates that there is not likely to be any need for seabed nickel for some time. No commercial nodule mining is likely before the end of this century.

PRICES

In late 1981, major producers lowered their list prices (all prices in US funds) for plating grade to $3.29 a pound and melting grade to $3.20. Realized nickel prices during the first quarter of 1982 were about $3 per pound and these decreased through to November, and then rebounded somewhat in December.

Prices on the LME averaged $2.20 for 1982. The price averaged $2.57, $2.39, $2.17 and $1.63 for the four quarters, respectively. Several traders on the LME called for a widening of products sold and in late November, Billiton N.V. nickel briquettes were listed for trade on the Exchange, to add to the cathodes and pellets already approved for trade.

Production was cut by many producers but weak demand, particularly in the stainless steel sector, put downward pressure on prices. Aggressive marketing by certain producers, and in particular the Soviet Union and AMAX Inc., was the other major factor putting downward pressure on prices.

In the United States, an investigation was launched by the Federal Trade Commission (FTC) into alleged price fixing by Inco, Falconbridge, Société Métallurgique Le Nickel (SLN) and Western Mining. The investigation was prompted by a pricing policy announced by the producers in late-1981 to try to keep nickel at close to $3.20 per pound. Substantial amounts of documentation had been submitted to the FTC but by year-end there had been no decision reported. Realized nickel prices were well below $3.20 for most of 1982.

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. The largest use is in stainless steels, which account for close to 50 per cent of consumption, followed by nickel base alloys, electroplating, alloy steels, foundry and copper-based alloys. The proportion of nickel used in stainless steels has been growing steadily in recent years.

Close to two-thirds of nickel consumption is in capital goods with the remainder used in consumer products. Nickel is used in chemical and food processing, nuclear power plants, aerospace equipment, motor vehicles, oil and gas pipelines, electrical equipment, machinery, batteries, as a catalyst, and in many other applications.

Relatively new end-use markets that will contribute to nickel's consumption growth in the future are nuclear generating plants, pollution abatement equipment, cryogenic containers, barnacle-resisting copper-nickel alloy plating for boathulls, and nickel-cadmium batteries for standby power applications. The use of nickel-zinc batteries in electric cars was earlier considered to be an important nickel market which would develop in the late 1980s, but the large scale production of electric cars has been deferred. The fledgling solar energy industry could provide a market for increasing amounts of nickel alloys where there is a need for durability and corrosion resistance.

OUTLOOK

Nickel consumption is highly dependent upon capital expenditures and it is anticipated that there will be a small increase in capital spending in 1983, in response to improved economic conditions. Various factors including low operating rates in the manufacturing sector and the high debt load of many corporations, will limit the increase in capital spending. However, consumer spending is expected to be relatively strong. The result is likely to be that nickel consumption in 1983 will rise by 8 to 9 per cent over 1982. Some rebuilding of consumer inventories, however, could cause orders to producers to be greater than actual consumption. A further increase in demand is expected in 1984 as economic activity continues to revive.

From 1946 to 1973, nickel consumption grew at an average annual compound rate of 6 per cent but since then has averaged slightly less than zero. With the maturing of some major economies and changes in consumption patterns, a return to historic rates of 6 per cent is highly improbable. Some developing countries can expect to experience high nickel growth rates owing to rising demand for capital goods, but since their current consumption is low they are not expected to become major consumers within at least the next decade.

Many of the markets for nickel are considered mature and will face a much slower growth rate than experienced in the past, but there are also some areas which show promise. High-temperature and certain other speciality alloys are cases in point. For example, a typical commercial aircraft gas turbine contains about 30 per cent nickel by weight but this proportion is increasing and, by 1990, a gas turbine could contain 40 per cent nickel. The increased use of nickel will mainly be at the expense of iron and titanium.

The key aspect to nickel growth rates in the 1980s will be the pace at which real economic growth occurs in the major OECD countries. The effectiveness of certain economic policies currently being implemented in some of these countries will be a major determining factor in this regard.

CANADA

Item No.		General Preferential	British Preferential	Most Favoured Nation	General
32900-1	Nickel ores	free	free	free	free
33506-1	Nickelous oxide	9%	10%	14.1%	25%
35500-1	Nickel and alloys containing 60% or more nickel by weight, not otherwise provided for, viz: ingots, blocks and shot; shapes or sections, billets, bars and rods, rolled, extruded or drawn (not including nickel processed for use as anodes); strip; sheet and plate (polished or not); seamless tube	free	free	free	free
35505-1	Rods containing 90% or more nickel, when imported by manufacturers of nickel electrode wire for spark plugs, for use exclusively in manufacture of such wire for spark plugs in their own factories	free	free	free	10%
35510-1	Metal alloy strip or tubing, not being steel strip or tubing, containing not less than 30% by weight of nickel and 12% by weight of chromium, for use in Canadian manufactures	free	free	free	20%
35515-1	Nickel and alloys containing 60% by weight or more of nickel, in powder form	free	free	free	free
35520-1	Nickel or nickel alloys, namely: matte, sludges, spent catalysts and scrap and concentrates other than ores	free	free	free	free
35800-1	Anodes of nickel	free	free	free	10%
37506-1	Ferronickel	free	free	4.8%	5%
44643-1	Articles of nickel or of which nickel is the component material of chief value, of a class or kind not made in Canada, when imported by manufacturers of electric storage batteries for use exclusively in manufacture of such storage batteries in own factories.	5.5%	8.8%	8.8%	20%

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
			(%)			
33506-1	14.1	13.8	13.4	13.1	12.8	12.5
37506-1	4.8	4.7	4.5	4.3	4.2	4.0
44643-1	8.8	8.4	8.0	7.6	7.2	6.8

TARIFFS (cont'd)

UNITED STATES

Item No.		
419.72	Nickel oxide	free
423.90	Mixtures of two or more inorganic compounds in chief value of nickel oxide	free
601.36	Nickel ore	free
603.60	Nickel matte	free
606.20	Ferronickel	free
620.03	Unwrought nickel	free
620.04	Nickel waste and scrap	free
620.32	Nickel powders	free
620.47	Pipe and tube fittings if Canadian article and original motor vehicle equipment	free

		1982	1983	1984	1985	1986	1987
				(%)			
419.70	Nickel chloride	4.5	4.4	4.2	4.0	3.9	3.7
419.74	Nickel sulfate	4.3	4.1	3.9	3.7	3.4	3.2
419.76	Other nickel compounds	4.5	4.4	4.2	4.0	3.9	3.7
426.58	Nickel salts: acetate	4.5	4.4	4.2	4.0	3.9	3.7
426.62	Nickel salts: formate	4.5	4.4	4.2	4.0	3.9	3.7
426.64	Nickel salts: other	4.5	4.4	4.2	4.0	3.9	3.7
620.08	Nickel plates and sheets, clad	9.8	9.0	8.3	7.5	6.8	6.0
620.10	Other wrought nickel, not cold worked	4.4	4.3	4.1	3.9	3.7	3.5
620.12	Other wrought nickel, cold worked	6.1	5.9	5.6	5.3	5.0	4.7
620.16	Nickel, cut, pressed or stamped to nonrectangular shapes	7.7	7.3	6.8	6.4	5.9	5.5
620.20	Nickel rods and wire, not cold worked	4.5	4.4	4.2	4.0	3.9	3.7
620.22	Nickel rods and wire, cold worked	6.1	5.9	5.6	5.3	5.0	4.7
620.26	Nickel angles, shapes and sections	7.7	7.3	6.8	6.4	5.9	5.5
620.30	Nickel flakes, per pound	3.1¢	2.5¢	1.9¢	1.2¢	0.6¢	free
620.40	Pipes, tubes and blanks, not cold worked	2.8	2.8	2.7	2.6	2.6	2.5
620.42	Pipes, tubes and blanks, cold worked	3.6	3.5	3.4	3.3	3.1	3.0
620.46	Pipe and tube fittings	7.0	6.3	5.6	5.0	4.3	3.6
620.50	Electroplating anodes, wrought or cast, of nickel	4.5	4.4	4.2	4.0	3.9	3.7
642.06	Nickel wire strand	6.1	5.9	5.6	5.3	5.0	4.7
657.50	Articles of nickel, not coated or plated with precious metal	7.7	7.3	6.8	6.4	5.9	5.5

Sources: The Customs Tariff and Commodities Index, January 1982, Revenue Canada; Tariff Schedules of the United States Annotated 1982, USITC Publication 1200; U.S. Federal Register, Vol. 44, No. 241.

Phosphate

G.S. BARRY

Naturally occurring rock deposits are the most common source of phosphorus; other sources are bones, guano, and some types of iron ores that yield byproduct basic slag containing sufficient phosphorus to warrant grinding and marketing.

Phosphate rock, contains one or more suitable phosphate minerals, usually calcium phosphate, in sufficient quantity for use, either directly or after beneficiation, in the manufacture of phosphate products. Sedimentary phosphate rock, or phosphorite, is the most widely used phosphate raw material. Apatite, which is second in importance, occurs in many igneous and metamorphic rocks.

Phosphate rock is graded either on the basis of its P_2O_5 equivalent (phosphorus pentoxide) or its $Ca_3(PO_4)_2$ content (tricalcium phosphate of lime or bone phosphate of lime - TPL or BPL). For comparative purposes, 0.458 unit P_2O_5 equals 1.0 unit BPL, and 1 unit of P_2O_5 contains 43.6 per cent phosphorus.

Approximately 80 per cent of world phosphorus production goes into fertilizers; other products which require the use of phosphorus include organic and inorganic chemicals, soaps and detergents, pesticides, insecticides, alloys, animal-food supplements, motor lubricants, ceramics, beverages, catalysts, photographic materials, and dental and silicate cements.

After five consecutive years of substantial increases, world demand for phosphatic fertilizers declined substantially in 1981 and 1982. Phosphate rock production decreased 12.6 per cent to 122.9 million t and producer stocks stayed at a high level. Among the traditional large producers and exporters, Nauru, Morocco, Togo, Tunisia, Senegal and the United States experienced cutbacks where as the U.S.S.R., Israel, Jordan and Syria managed to increase production. By far the most significant reduction was that of the United States which had an unprecedented drop of 30 per cent from 53.6 million t in 1981 to 37.4 million t in 1982.

Western world export sales of phosphate rock decreased 6.8 per cent from 40.0 to 37.2 million t between 1981 and 1982. Of the 11 principal exporters only four increased exports marginally in that period.

OCCURRENCES IN CANADA

Known Canadian deposits are limited and fall into three main categories: apatite deposits within Precambrian metamorphic rocks in eastern Ontario and southwestern Quebec; apatite deposits in some carbonate- alkaline complexes (carbonatites) in Ontario and Quebec; and Late Paleozoic-Early Mesozoic sedimentary phosphate rock deposits in the southern Rocky Mountains. Phosphatic mineralization was also reported in the layered rocks of the Athabasca series.

The deposit of greatest economic significance is the Kapuskasing (Cargill) phosphate deposit, where early studies indicated the presence of about 60 million t of ore grading 20.2 per cent P_2O_5. The property was optioned by Sherritt Gordon Mines Limited in 1979 from International Minerals & Chemical Corporation (Canada) Limited (IMCC). Preliminary designs for an open pit at Cargill, based on IMCC's grades and tonnages, allowed for the production of 450 000 t/y of 39 per cent P_2O_5 concentrates for a minimum of 17 years. Additional drilling, test pits and bulk sample pilot plant testing confirmed the technical viability of this deposit. At present Sherritt Gordon has the property under option until early 1984. The decision on whether to put the property into production had to be postponed due to depressed conditions in the fertilizer industry.

Another important deposit was discovered by Shell Canada Resources Limited near Martison Lake north of Hearst,

TABLE 1. CANADA, PHOSPHATE ROCK IMPORTS, 1981 AND 1982, AND CONSUMPTION, 1980 AND 1981

	1981		1982P	
	(tonnes)	($)	(tonnes)	($)
Imports				
United States	3 245 413	132,982,000	2 482 568	101,704,000
Other countries	33	20,000	29 140	1,503,000
	3 245 446	133,002,000	2 511 708	103,207,000
	1980		1981	
	(tonnes)		(tonnes)	
Consumption[1]				
Eastern Canada	1 602 484		1 364 839	
Western Canada	1 944 152		2 217 847	
Total	3 546 636		3 582 686	

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

[1] Breakdown by Energy, Mines and Resources Canada.
P Preliminary.

Ontario. It contains more than 140 million t of material with phosphate grades averaging about 20 per cent P_2O_5 and niobium 0.35 per cent Nb_2O_5. In December 1982 the deposit was sold to Camchib Resources Inc., which plans for a large scale drilling program in 1983. The deposit is overlain by deep overburden and may be difficult to mine by open pit. Underground mining methods based on symmetrical caving of large tonnages of residuum phosphate (free flowing), which accumulated in sink hole type depressions may be an acceptable technical solution.

Additional details on the Canadian phosphate deposits and industry were provided in the 1980 annual review and in the publication MR 193, "Phosphate Rock, an Imported Mineral Commodity".

CANADIAN PHOSPHATE INDUSTRY

Phosphate Rock. In 1982, Canada imported only 2.5 million t of phosphate rock. The general economic recession was responsible for this abnormally low import. Imports averaged 3 058 463 t from 1975 to 1981. Approximately 77 per cent of this is utilized in fertilizer production, 16 per cent in elemental phosphorus production and 6 per cent in calcium phosphate production.

About 70 per cent of Canada's imports of phosphate rock from the United States has been from Florida since the late 1970s. The remainder was from western states. Purchase practices, which include commercial factors as well as the characteristics of rock used by the fertilizer plants, point to the continuation of this pattern of supply for at least several years.

Currently, eastern Canada is supplied from Florida. From 850 000 t to 950 000 t are transported by sea, with two-thirds of this total being used for elemental phosphorus production and the remainder for fertilizer production in New Brunswick.

Approximately 650 000 t to 700 000 t of phosphate rock is shipped annually by rail from Florida mines to Ontario fertilizer plants because for this part of Canada direct unit train rail service is more advantageous than ocean shipping combined with short overland hauls. The fact that shipments in Florida do not have to be routed via the congested port of Tampa is another positive factor. Another advantage is that railroad shipments can be maintained at a schedule that allows for very low inventories.

Florida is the source of phosphate rock for about 45 to 50 per cent of the six western Canadian fertilizer plants and western U.S. states for some 50 to 55 per cent. However, with expansions in capacity at the Esso Chemical Canada and Sherritt Gordon plants, supplies from Florida and the western states are going to be more evenly distributed in the early 1980s. Rock shipped from Florida via the Panama Canal to Vancouver is mainly transported as back-haul to Canadian lumber (to United States) and potash (to South America) exports. The inland rail haul from Vancouver to the Edmonton area is a back-haul to exports of potash. Total shipping costs are competitive with rail haul from mines in the western U.S. states.

Belledune Fertilizer (Canada Wire and Cable Limited) a subsidiary of Noranda Mines Limited produced 152 000 t of DAP in 1982 (139 000 t in 1981) at its New Brunswick fertilizer plant. Operations were shut down for 2½ months for maintenance and control of product inventory. The company reports that sales were up 6 per cent but prices for DAP were much lower than in 1981.

International Minerals & Chemical Corporation operated its Port Maitland fertilizer plant at about 70 per cent capacity. Operating levels were adjusted to match quantities of sulphuric acid available from nonferrous smelters. Normally the

TABLE 2. CANADA, PHOSPHATE FERTILIZER PLANTS, 1982

Company	Plant Location	Annual Capacity	Principal End Products	Source of Phosphate Rock	Basis for H_2SO_4 Supply for Fertilizer Plants
		(tonnes)	(P_2O_5 eq.)		
Eastern Canada					
Canada Wire and Cable Limited	Belledune, N.B.	150 000	am ph	Florida	SO_2 smelter gas
C-I-L Inc.	Courtright, Ont.	90 000	am ph	Florida	SO_2 smelter gas, pyrrhotite roast and waste acid
International Minerals & Chemical Corporation (Canada) Limited (IMCC)	Port Maitland Ont.	118 000	H_3PO_4, ss ts, ca ph	Florida	Sulphur and SO_2 smelter gas
		358 000			
Western Canada					
Cominco Ltd.	Kimberley, B.C.	86 700	am ph	Montana and Utah	SO_2 pyrite roast
	Trail, B.C.	77 300	am ph	Utah	SO_2 smelter gas
Esso Chemical Canada	Redwater, Alta.	204 000*	am ph	Florida	Sulphur
Sherritt Gordon Mines Limited	Fort Saskatchewan, Alta.	50 000	am ph	Florida	Sulphur
Western Co-operative Fertilizers Limited	Calgary, Alta.	140 000	am ph	Idaho	Sulphur
	Medicine Hat, Alta.	65 000**		Idaho	
		622 000			
Total, phosphate fertilizer		980 000			

P_2O_5 eq. Phosphorus pentoxide equivalent; am ph Ammonium phosphates; ss Single superphosphate; ts Triple superphosphate; ca ph Food supplement calcium phosphate; H_3PO_4 phosphoric acid for commercial sales.
* Expansion to 370 000 is ongoing.
** Shutdown for an indefinite period in May 1982.

TABLE 3. CANADA, PHOSPHATE FERTILIZER SHIPMENTS, 1977-82[1]

	1977/78	1978/79	1979/80	1980/81	1981/82	1982 July-December
	(tonnes P_2O_5 equivalent)					
Domestic markets:						
Atlantic provinces	28 578	18 867	19 441	24 481	26 261	1 609
Quebec	34 935	23 540	20 992	28 610	34 915	8 639
Ontario	78 158	63 379	54 602	82 496	71 033	14 157
Manitoba	81 687	89 576	110 382	97 529	75 239	26 503
Saskatchewan	110 351	131 636	131 500	135 534	144 998	49 949
Alberta	121 531	140 880	131 413	149 116	152 906	45 185
British Columbia	9 879	12 440	14 204	13 308	9 034	1 430
Total Canada	465 120	480 318	482 533	531 074	514 385	147 472
Export markets:						
United States	153 305	144 670	146 813	194 565	141 411	43 984
Offshore	31 120	46 814	44 999	77 328	20 305	-
Total exports	184 425	191 484	191 812	271 893	161 716	43 984
Total shipments	649 545	671 803	674 344	802 968	676 101	191 456

Source: Canadian Fertilizer Institute.
[1] Fertilizer year: July 1 to June 30; not 100% industry coverage.
Note: Totals may not add due to rounding.

plant uses 1/3 smelter acid and 2/3 acid produced by burning elemental sulphur, but during 1982 about 90 per cent of the acid came from sulphur. A weak market for fertilizers did not justify the purchase of commercial acid from other than traditional suppliers.

Cominco Ltd. reported a loss for 1982 from its phosphate operations in Kimberley, British Columbia. The company produced 112 100 t of ammonium phosphates in 1982 compared to 155 900 t in 1981. The decrease was due mainly to a three-month shutdown to control inventories. The Trail plant was shut down for a five-week period at mid-year.

Esso Chemical Canada continued its $400 million fertilizer plant expansion project at Redwater, Alberta. Within this project $50 million was for the expansion of the phosphate plant. The plant was completed in 1982 but the company decided to delay its start-up because of particularly depressed phosphate fertilizer market conditions. The expansion raised the nominal capacity from 204 000 t P_2O_5 to 270 000 t P_2O_5.

Western Co-operative Fertilizers Limited experienced greatly reduced sales during 1982 and had to shut down their Medicine Hat plant on May 1st. It remained closed for the rest of the year and into 1983. Their Calgary plant was shut down between April 15 and September 27 for inventory control.

Elemental phosphorus. ERCO Industries Limited operates two thermal reduction plants in Canada where elemental phosphorus is produced by the smelting of a mixture of phosphate rock, coke and silica. One tonne of phosphorus requires the input of about 10 t of phosphate rock (60 to 67 per cent BPL), 2 t of coke and 3 t of silica.

ERCO has plants at Varennes, Quebec with a 22 500 t annual capacity (P_4) and at Long Harbour, Newfoundland with an effective capacity of about 50 000 tpy. Until recently the elemental phosphorus production from Long Harbour was almost exclusively reserved for Albright & Wilson, Inc. derivative plants in Europe, but in 1982 a proportion was sent to Buckingham, Quebec and Port Maitland, Ontario to supplement supplies from Varennes, Quebec. During the year one of two main furnaces at Varennes was closed. ERCO however, installed another furnace at Varennes to recover about 2 000 t annually of phosphorus from the "mud" stored on site over the decades. The Newfoundland plant operated

TABLE 4. CANADA, TRADE IN SELECTED PHOSPHATE PRODUCTS, 1981 AND 1982

	1981		1982P	
	(tonnes)	($)	(tonnes)	($)
Imports				
Calcium phosphate				
United States	19 112	9,180,000	18 216	9,917,000
Other countries	88	64,000	52	37,000
Total	19 200	9,244,000	18 268	9,954,000
Fertilizers:				
Normal superphosphate, 22% or less P_2O_5				
United States	3 080	184,000	188	56,000
Triple superphosphate, over 22% P_2O_5				
United States	38 095	8,173,000	31 948	7,143,000
Phosphatic fertilizers, nes				
United States	263 498	70,622,000	216 588	61,344,000
Belgium-Luxembourg	1 467	788,000	901	547,000
Israel	342	251,000	183	149,000
United Kingdom	19	11,000	1	--
Singapore	-	-	4	10,000
Netherlands	-	-	16	8,000
Total	265 326	71,673,000	217 693	62,057,000
Chemicals:				
Potassium phosphates				
United States	1 251	1,315,000	1 243	1,322,000
France	94	101,000	110	118,000
Israel	87	93,000	131	115,000
Netherlands	-	-	8	10,000
Total	1 432	1,508,000	1 492	1,566,000
Sodium phosphate, tribasic				
United States	306	185,000	408	281,000
France	304	129,000	177	65,000
Belgium-Luxembourg	36	12,000	-	-
Netherlands	-	-	51	21,000
Total	646	326,000	636	367,000
Exports				
Nitrogen phosphate fertilizers, nes				
United States	362 616	74,567,000	272 090	62,198,000
Thailand	21 987	3,961,000	-	-
France	12 594	3,495,000	-	-
Yugoslavia	9 935	2,957,000	-	-
Kenya	7 653	1,699,000	-	-
Portugal	5 053	1,122,000	-	-
Italy	5 433	712,000	-	-
Australia	5	8,000	-	-
Belgium-Luxembourg	-	-	-	-
People's Republic of China	-	-	-	-
Taiwan	-	-	-	-
Japan	-	-	-	-
Total	425 276	82,521,000	272 090	62,198,000

Source: Statistics Canada.
P Preliminary; - Nil; nes Not elsewhere specified; -- too small to be expressed.

very efficiently in 1982, producing over 40 000 t of phorphorus and the prospect for an increase to 50 000 t in 1983 is good. In total, the ERCO plants use from 600 000 to 650 000 tpy of Florida phosphate rock. Since the low-grade phosphate rock acceptable for thermal reduction cannot be used by the fertilizer industry, it can be purchased at relatively lower prices (per P_2O_5 unit value).

Production from Varennes, Quebec is 90 per cent or more oriented toward Canadian markets. The elemental phosphorus (P_4) produced at Varennes is shipped to two ERCO plants, one at Buckingham, Quebec and the other at Port Maitland, Ontario. At Buckingham about 9 000 tpy of P_4 is used to produce technical and food grade phosphoric acid (95 per cent H_3PO_4) and 1 000 t to produce amorphous red phosphorus and phosphorus sesquisulphide.

ERCO's Port Maitland plant operates on phosphorus from Varennes and Long Harbour, using about 12 000 tpy. It is all converted to technical grade phosphoric acid.

Coproducts of elemental phosphorus are ferrophosphorus, carbon monoxide and calcium silicate slag. Ferrophosphorus contains 20 to 25 per cent phosphorus and is used by the steel industry as a direct source of the phosphorus needed in some types of steel.

Phosphate fertilizers. Nine Canadian plants (Table 2) produce wet phosphoric acid by the dihydrate process in which 28 to 30 per cent P_2O_5 acid is the principal product and gypsum is the waste product. At present, there is no use for the gypsum and it accumulates in large settling ponds near all the plants except one in New Brunswick where it is disposed of in the sea.

Canadian phosphoric acid plants are designed to operate on phosphate rock which grades between 69 and 72 per cent BPL (31.1 to 33.0 per cent P_2O_5). The first stage of acid production, which is digestion and filtration, produces "filter acid" grading 28 to 30 per cent P_2O_5. This product is then upgraded by evaporation to about 40 to 44 per cent acid for most in-plant use, or to 52 to 54 per cent P_2O_5 for commercial sales or specialized uses. The evaporation step is energy intensive, and the provenance of sulphuric acid has a bearing on energy consumption. Plants using elemental sulphur as the source of in-plant sulphuric acid production have their evaporation energy requirements met by heat generated in the sulphuric acid plants since the process is exothermic, (i.e., 1 t of sulphur has a BTU content equivalent to about 2 barrels of oil). Plants using commercial sulphuric acid, (e.g., produced from SO_2 smelter gases) have to generate vapour requirements with natural gas or coal-fired boilers. To balance energy requirements, an efficient dihydrate WPA plant could theoretically operate using elemental sulphur for 70 to 75 per cent of its requirements and purchased sulphuric acid for the remainder.

Most phosphate rock contains uranium. It is in small enough quantities not to present any problems for fertilizer production. In Canada, Earth Sciences Inc. (ESI) completed a uranium recovery plant in Calgary in 1980. It treats phosphoric acid from the adjoining plant of Western Co-operative Fertilizers Limited, and returns the acid to the owner. The plant was placed on standby in November 1981. During 1982 the plant was undergoing modification with the prospect of re-opening in late 1983. In September 1982 Urangesellschaft Canada Limited bought 49 per cent interest in the Calgary operation of ESI. The recovered yellow cake is shipped to the United States. Since uranium prices are currently substantially below peak levels achieved a few years ago, construction of similar uranium recovery plants at other fertilizer plants in Canada is not now economic.

Capacity of Canadian phosphoric acid plants is expressed in 100 per cent P_2O_5 equivalent and the total annual capacity is currently estimated at 980 000 t. The capacity increases in the western plants are not going to come on-stream before 1983. Efficient plants can consistently operate at 90 to 95 per cent of nameplate capacity. Most Canadian plants, gauge their annual production levels to corporate marketing strategies and fertilizer demand forecasts. At times when agricultural demand is low Canadian production capacities are seriously underutilized.

Calcium Phosphate. Two fertilizer plants in Canada use phosphoric acid for the production of calcium phosphates that are used mainly for supplementing the calcium and phosphorus content of animal and poultry feedstocks. The two products are: monocalcium phosphate (21 per cent phosphorus) or dicalcium phosphate (18.5 per cent phosphorus).

The phosphoric acid used for calcium phosphate production in eastern Canada is all produced by IMCC in Port Maitland, Ontario. The company uses more than half for its own requirements and sells the remainder to Cyanamid Canada Inc. which has a nearby plant at Welland.

All of the nine phosphoric acid plants in Canada are integrated to produce phosphatic fertilizers, mainly ammonium phosphates. Ammonium phosphates are produced by a neutralization reaction of phosphoric acid with ammonia and, depending on the proportions of the original constituents, either diammonium phosphate (DAP) (18-46-0) or mono-ammonium phosphate (MAP) (range from 11-48-0 to 11-55-0) are produced.

Six western Canadian fertilizer plants produce annually between 780 000 t and 850 000 t of mono-ammonium phosphates (MAP) and between 110 000 t and 130 000 t of diammonium phosphates (DAP). Another popular grade in the west is an ammonium phosphate-sulphate having a composition 16-20-0 or actually 16-20-0-14 if the sulphur content, which is also a nutrient, is taken into account.

WORLD DEVELOPMENTS

World phosphate rock production in 1982 was estimated at 122.9 million t, a decrease of 12.6 per cent from 1981. Western world production was 84.0 million t, a decrease of 17.5 per cent from the year before. The continuance of high levels of production during a falling market in 1981 resulted in a very major increase in phosphate rock inventories in producer's hands, particularly in the United States. In 1982, however, sales were slightly higher than production resulting in a marginal decrease in inventories.

The decline in production in the United States is principally due to cutbacks in Florida which affected all producers. Nevertheless total nominal capacity was raised substantially in 1982 with two new mines on-stream. The Grace-IMC partnership development of the Four Corners mine at 4.6 million tpy (a net increase of 3.1 million tpy for the two companies) and the Beker Industries Corp. new mine of 1.1 millon tpy that started production in late 1981.

Agrico Chemical Co. will open a 3.6 million tpy mine in North Carolina by

TABLE 5. WORLD PHOSPHATE ROCK PRODUCTION, 1980-82

	1980	1981	1982^e
	(000 tonnes product)		
WORLD TOTAL	**140 189**	**140 718**	**122 940**
West Europe	**238**	**380**	**306**
Finland	125	201	231
France	10	12	13
Sweden	82	124	131
Turkey	21	43	30
East Europe	**25 300**	**25 600**	**26 100**
U.S.S.R.	25 300	25 600	26 100
North America	**54 415**	**53 624**	**37 414**
United States	54 415	53 624	37 414
Central America	**330**	**262**	**415**
Mexico	330	262	415
South America	**2 939**	**2 791**	**2 760**
Brazil	2 921	2 764	2 732
Colombia	4	15	15
Peru	14	12	..
Africa	**33 383**	**33 485**	**30 004**
Algeria	1 036	916	947
Egypt	658	720	711
Morocco/Sahara	18 824	19 696	17 754
Senegal	1 752	2 153	975
South Africa	3 282	3 034	3 173
Togo	2 933	2 244	2 128
Tunisia	4 768	4 596	4 196
Zimbabwe	130	126	120
Asia	**21,489**	**22 818**	**24 370**
China	10 726	11 981	12 500
Christmas Island	1,638	1 336	1 328
India	523	549	560
Indonesia	11	11	12
Iraq	-	-	363
Israel	2,611	2 372	2 711
Jordan	3,906	4 244	4 431
North Korea	450	500	500
Philippines	5	5	10
Syria	1,219	1 320	1 455
Vietnam	400	500	500
Oceania	**2,095**	**1 504**	**1 571**
Australia	8	24	212
Nauru	2,087	1 480	1 359

Totals may not add due to rounding.
Sources: Phosphate Rock Statistics, 1982, ISMA Ltd.; United States Bureau of Mines (USBM), Mineral Commoditiy Summaries 1983. EMR estimates for some countries in 1982.
^{e} Estimated; .. not available.

1985-86. A $350 million phosphate fertilizer plant near Rock Springs, Wyoming is still planned by Chevron Chemical Company. The project will include an increase in mine output from the Vernal mine in Utah and a 140 km slurry pipeline which will transport the crude phosphate rock. The plant will have a capacity of 450 000 tpy P_2O_5 but a decision to proceed was put on hold during 1982. The plant will not be completed in 1985 as originally announced but much later.

Morocco's production declined by 9.6 per cent in 1982 mainly on account of a decline in exports of rock to western Europe and to Romania.

Jordan continued its mine expansion program and increased output by 0.2 million t. Exports amounted only to 3.6 million t. Stocks were increased in the anticipation of domestic production of phosphoric acid. A new fertilizer plant of 413 000 tpy P_2O_5 was completed in the fall of 1981 and started commercial production in mid-1982. Almost all output of DAP, MAP and phosphoric acid will be exported.

Mexico began construction in 1981 on the 1.5 million tpy Santo Domingo mine in Baja California; major delays occurred during 1982 when it was discovered that suction-type dredging is severely inhibited by indurated sandstone beds.

PRICES

Most phosphate rock is purchased under producer-consumer negotiated prices which depart from listed prices in consideration of volume, transportation conditions and local competitive conditions. Phosrock Ltd., a Florida-based marketing organization which represents about two thirds of producers for export markets lists prices as shown in Table 6. Soft international markets resulted in a price decline in 1982 and many transactions during the year were carried out substantially below listed prices. International prices are also quoted by Office Cherifien des Phosphates (OCP) fob ports of Safi or Casablanca. These are usually $2 to $4 above Tampa prices, the difference reflecting competitive conditions, for "landed" prices to most European destinations.

TABLE 6. LISTED EXPORT PRICES[1] FOR FLORIDA PHOSPHATE ROCK, 1981-83

Grade	January 1981	January 1982	Mid[2] 1982	Early[2] 1983
	($US per tonne fob Tampa or Jacksonville)			
73/75% BPL	57	57	45	35
70/72% BPL	53	53	36	31
68/70% BPL	50	50	39	28
66/68% BPL	48	48	32	26
64/66% BPL	46	46	28	29

Source: Phosphate Rock Export Association, Tampa, U.S.A.
[1] These prices do not include the charge for severance tax in Florida. [2] List prices for 1982 and early 1983 were not posted but indicative prices for the two periods are available.

OUTLOOK

The outlook for the first half of 1983 is for a continuation of conditions that transpired in 1982. Soft phosphate markets will continue for all products as low agricultural prices, high interest rates and the Payment in Kind Program will compel farmers to be skimpy with fertilizer application. However much better prospects for fertilizer application are forcast for the second half of 1983 and for 1984. An annual application of phosphates is not as necessary as nitrogen since a delay of one year may have a slight detrimental effect on yields as long as the deficiency is made up within the two following seasons. Most experts forecast a consumption growth fluctuating between 3.6 per cent and 5.0 per cent for the next few years.

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
93100-2	Phosphate rock	free	free	free	free
66345-1	Defluorinated calcium phosphates for use in the manufacture of animal or poultry feeds	free	free	free	free
93103-1	Calcium phosphate dibasic	free	free	free	free
93103-2	Calcium phosphate, disintegrated, calcined, thermophosphates, fused phosphates; superphosphates	free	free	free	free
92840-1	Phosphites, phosphorus, hypophosphites and phosphates	10	14.1	25	9.0
	Sodium phosphate disbasic, and monobasic, pharmacopoeial tribasic, commercial grade; sodium pyrophosphate; sodium tripolyphosphate (temporary rate reduction 3/06/80 to 30/06/87)	free	14.1	25	free
92840-2	Di-calcium phosphate	9.4	9.4	25	6.0
	(temporary rate reduction 3/06/80 to 31/12/86)	free	9.4	25	free
93100-1	Fertilizers; goods for use as fertilizers	free	free	free	free
93105-1	Ammonium phosphates	free	free	free	free

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
			(%)			
92840-1	14.1	13.8	13.4	13.1	12.8	12.5
92840-2	9.4	7.5	5.6	3.8	1.9	free

UNITED STATES, Customs Tariffs (MFN)

		1982	1983	1984	1985	1986	1987
				(%)			
420.92	Sodium phosphate containing over 45% water	2.9	2.8	2.7	2.7	2.6	2.5
421.22	Pyrophosphates	4.5	4.4	4.2	4.0	3.9	3.7
606.33	Ferrophosphorus	4.7	4.2	3.8	3.3	2.9	2.4

Sources: The Customs Tariff and Commodities Index, 1982, Revenue Canada; Tariff Schedules of the United States Annotated (1982), USITC Publication 1200; U.S. Federal Register Vol. 44, No. 241.

Platinum Metals

S.A. HAMILTON

CANADIAN OPERATIONS AND DEVELOPMENTS

Canadian production of platinum-group metals depends on that of nickel, as most Canadian production is a byproduct from processing the nickel-copper ores of the Sudbury Basin.

Platinum-group metals (platinum, palladium, rhodium, iridium, ruthenium and osmium) are industrial metals, although platinum has taken on some of the investment and speculative attributes of the precious metals, gold and silver. In 1982, the most severe recession since the 1930s affected the demand for, price of and production of the PGMs. Inco Limited, which normally accounts for 80 to 90 per cent of Canadian PGM output, was shut down by a strike in May 1982. Although a new labour contract was ratified in June, the Sudbury complex remained closed throughout the remainder of the year due to poor world market conditions in nickel. Inco's Thompson, Manitoba operations, which produce minor amounts of PGM, were closed during November and December. Falconbridge Limited, the other Canadian platinum producer, remained closed from June 27 until the end of the year.

Canadian production of platinum-group metals declined 27.8 per cent in volume and 27.4 per cent in value in 1982. Because PGMs are the last metals to be recovered in the smelting-refining process, some refining sludges remained to be processed following the shut down. Similarly, PGM production will not resume in 1983 until some months after the start-up of the main complex. Dealer prices for PGMs were weak during the first half of 1982 but improved toward the end of the year as the first signs of economic recovery became evident.

The residue from the refining of nickel and copper ores containing the platinum-group metals is shipped by Inco to its refinery at Acton, England for the extraction and refining of platinum metals. Falconbridge Nikkelverk A/S ships a nickel-copper matte that contains platinum metals to its copper-nickel refinery in Kristiansand, Norway. The sludge from this operation is shipped to the United States for recovery of the platinum-group metals.

In April 1982, Umex Inc. closed its Thierry copper mine near Pickle Lake, Ontario, due to poor world copper prices. Some platinum metals as well as some nickel were contained in the copper concentrates produced at the 3 600 tpd concentrator and shipped to Noranda, Quebec for smelting. The PGMs were then recovered at a copper refinery in Montreal East.

Platinum-group metals recovered from Canadian ores consist on average of about 43 per cent platinum, 45 per cent palladium and 12 per cent other platinum metals. For reasons of corporate confidentiality, data on Canadian consumption of platinum-group metals are not available.

FOREIGN DEVELOPMENTS

The major world producers of platinum-group metals in 1982, in decreasing order of production volume, were the U.S.S.R., the Republic of South Africa and Canada. Minor producers included Japan, Colombia, Australia and the United States.

World primary production of platinum-group metals is estimated by the United States Bureau of Mines (USBM) to have declined to 200 499 kg in 1982 from 211 688 kg in 1981 (Table 3). Estimated production in the Soviet Union increased by 4 666 kg in 1982, reflecting increasing production from the Noril'sk complex. Production from the Republic of South Africa declined by 12 441 kg as producers, saddled with growing inventories and declining sales, cut back output to an estimated two thirds of capacity by the end of the year. The U.S.S.R. and South Africa together accounted for 94.6 per cent of world output while Canada accounted for about 4.3 per cent.

TABLE 1. PLATINUM METALS, PRODUCTION AND TRADE, 1981 AND 1982

	1981		1982P	
	(grams)	($)	(grams)	($)
Production[1]				
Platinum, palladium, rhodium, ruthenium, iridium	11 902 283	136,186,021	8 590 000	98,889,000
Exports				
Platinum metals in ores and concentrates				
United Kingdom	10 080 419	103,237,000	7 057 000	52,621,000
United States	14 090	343,000	104 000	882,000
Total	10 094 509	103,580,000	7 161 000	53,503,000
Platinum metals, refined				
United States	731 398	6,508,000	519 000	4,591,000
United Kingdom	58 226	441,000	220 000	821,000
Japan	202 173	254,000	140 000	161,000
Brazil	7 962	52,000	32 000	81,000
Other countries	156	3,000	34 000	117,000
Total	999 915	7,258,000	945 000	5,771,000
Platinum metals in scrap				
United States	2 078 770	19,400,000	25 358 000	14,925,000
United Kingdom	1 008 655	8,091,000	376 000	3,266,000
West Germany	133 869	706,000	16 000	200,000
Total	3 221 294	28,197,000	25 750 000	18,391,000
Re-export[2]				
Platinum metals, refined and semiprocessed	498	10,000	8 242	170,000
Imports				
Platinum lumps, ingots, powder and sponge				
United Kingdom	165 159	4,229,000	98 000	1,595,000
United States	78 754	1,390,000	140 000	2,010,000
Total	243 913	5,619,000	238 000	3,605,000
Other platinum-group metals				
United States	365 341	2,502,000	183 000	602,000
United Kingdom	78 350	452,000	16 000	40,000
West Germany	-	-	25 000	76,000
Total	443 691	2,954,000	224 000	718,000
Total platinum and platinum-group metals				
United Kingdom	243 509	4,681,000	114 000	1,635,000
United States	444 095	3,892,000	323 000	2,612,000
West Germany	-	-	25 000	76,000
Total	687 604	8,573,000	462 000	4,323,000
Platinum crucibles[3]				
United States	570 655	11,403,000	448 000	6,615,000

TABLE 1. (cont'd)

	1981		1982P	
	(grams)	($)	(grams)	($)
Platinum metals, fabricated materials, not elsewhere specified				
United States	644 060	5,829,000	521 000	3,518,000
United Kingdom	160 929	2,268,000	259 000	4,307,000
Belgium-Luxembourg	-	-	43 000	4,083,000
West Germany	-	-	8 000	24,000
Switzerland	-	-	1 000	15,000
Total	804 989	8,097,000	832 000	11,947,000

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Platinum metal, content of concentrates, residues and matte shipped for export. [2] Platinum metals, refined and semiprocessed, imported and re-exported in the same form as when imported. [3] Includes spinners and bushings.
P Preliminary; - Nil.

Platinum metals consumption remained depressed throughout 1982. Use in catalytic converters to control automotive exhaust emissions was reduced as the entire North American automotive industry remained in a prolonged and severe slump. The jewellery manufacturing industry, a major consumer of platinum, did not expand during 1982 despite the fact that the price of platinum fell below that of gold and the prices of all precious metals fell to levels that made jewellery purchases attractive.

Despite cutbacks by major South African producers and reduced output from Canada, the surplus of platinum metals that developed toward the end of 1981 increased during 1982. Speculative activity in platinum-group metals remained low during the first half of 1982 and dealer prices fell to levels not seen since 1978. Industrial offtake, except by the jewellery industry, also was far below that of previous years as the automotive industry, petroleum refining, the chemical industry and textiles all remained mired in the recession.

Japan and the United States remained the leading consumers of platinum metals in the non-communist world. Over the years, Japan has been the world's major consumer of platinum, in part because of the popularity of platinum jewellery in Japan, while the United States is the leading consumer of the full platinum metals group. The effects of the world-wide recession impacted on the Japanese economy in 1982 and consumption of platinum declined 9.6 per cent compared to 1981. However, consumption of palladium increased by 9 per cent.

The USBM estimated platinum-group metals sales in 1982 to United States industry at 49 765 kg compared with 59 749 kg in 1981.

Republic of South Africa. The Republic of South Africa is the only country among the major producers that mines platinum metals-bearing ores primarily for the recovery of these metals. The deposits, which occur in the Merensky Reef of the Bushveld Complex near Rustenburg, also contain some gold, nickel and copper. The platinum-group metals recovered are estimated to be in the following proportion: platinum, 61 per cent; palladium, 26 per cent; and other platinum-group metals, 13 per cent. Small amounts of osmium and iridium are recovered as a by-product from the treatment of Witwatersrand gold ores.

The two leading South African producers have suspended expansion plans and have specified that they will relate expansion to contracts with North American and Japanese automakers.

Rustenburg Platinum Holdings Limited, the largest producer of platium-group metals in the non-communist world, operated three major mines, a smelter and two refineries in the Transvaal district of the Republic of South Africa. Its subsidiary, Atok Platinum Mines (Proprietary) Limited near Pieterburg, operates a mine with a capacity of 1 200 kg of platinum metals a year.

The refining of copper, nickel and platinum metals is carried out in the Republic of South Africa and in the United

TABLE 2. CANADA, PLATINUM METALS, PRODUCTION AND TRADE, 1970, 1975 AND 1978-82

	Production[1]		Exports				Imports[4]	
			Domestic[2]		Re-exports[3]			
	(grams)	($)	(grams)	($)	(grams)	($)	(grams)	($)
1970	15 005 188	43,556,597	15 327 731	44,174,000	634 480	2,365,735	1 889 381	3,123,000
1975	12 417 099	56,493,077	15 530 930	50,244,000	538 899	2,928,000	1 896 410	6,061,000
1978	10 768 428	65,292,791	11 468 007	58,803,000	169 234	334,000	1 747 051	4,643,000
1979	6 156 716	56,333,561	6 641 432	54,686,000	43 172	359,000	826 886	6,546,000
1980	12 776 000	159,088,000	13 524 725	191,569,000	9 176	68,000	1 064 578	14,347,000
1981	11 902 283	136,186,021	11 094 424	110,838,000	498	10,000	687 604	8,573,000
1982P	8 590 000	98,889,000	8 106 000	59,274,000	8 242	170,000	462 000	4,323,000

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

[1] Platinum metals, content of concentrates, residues and matte shipped for export. [2] Platinum metals in ores and concentrates and platinum metals, refined. [3] Platinum metals, refined and semiprocessed, imported and re-exported after undergoing no change or alteration. [4] Imports, mainly from United States and United Kingdom, of refined and semiprocessed platinum metals, derived from Canadian concentrates and residues, a large part of which is re-exported.
P Preliminary.

TABLE 3. WORLD MINE PRODUCTION OF PLATINUM METALS, 1980-82

	1980	1981e	1982e
	(grams)		
U.S.S.R.e	101 086 300	104 196 647	108 862 000
Republic of South Africae	96 420 778	93 310 430	80 869 000
Canada	12 776 000	11 902 283	8 590 000
Japan	1 285 631	1 119 725	..
Colombia	446 179	466 552	..
Australia	303 259	296 727	..
United States	104 134	191 286	187 000
Other countries	205 376	204 505	1 991 000
Total	212 627 657	211 688 155	200 499 000

Sources: U.S. Bureau of Mines, Minerals Yearbook Preprint 1981; U.S. Bureau of Mines, Mineral Commodity Summaries, January 1983; and Energy, Mines and Resources Canada.
e Estimated; .. Not available.

Kingdom by Matthey Rustenburg Refiners (Pty) Limited, a company owned jointly by Rustenburg Platinum Mines Ltd. and Johnson Matthey Public Limited Company, the marketing agent for Rustenburg's products. Revenue reported from sales was substantially less than the previous year's record level due to lower prices and sales volumes for all the company's major products. Consolidated after tax profit was one third of the previous year. Prices were helped by a favourable rand-dollar exchange rate. Production at the three major sections, Amandelbult, Rustenburg and Union, has been adjusted in response to weaker demand and the rate of production was equivalent at year-end to some 24 882 kg of platinum per annum. Plans to expand the Amandelbult section have been deferred.

The results of the March 1982 stocktake at the Wadeville refinery of Matthey Rustenburg Refiners revealed a loss of platinum-group metals and gold, the value of which was finally placed at R11 million. Efforts were made to recover the stolen material.

While all of Rustenburg's production has come from the Merensky Reef, a second reef which contains chrome associated with the platinum group metals and known as the Upper Group No. 2 Reef (UG2), occurs beneath the Merensky Reef. Rustenburg is continuing an exploration and research program to evaluate mining costs and to develop a process to economically recover both chromium and platinum metals from this reef.

Impala Platinum Limited, the second-largest platinum metals producer in the non-communist world, operates a mine-concentrator-smelter complex and a refinery near Rustenburg. Operating levels, which were reduced 10-15 per cent during 1981, were further reduced during 1982. By year-end, it was estimated that Impala was operating at 21 150 kg/y, at least one-third below its rated capacity of 29 548 kg/y. The mine expansion that was to bring production up to 31 000 kg has been deferred.

In the Transvaal district of South Africa, Western Platinum Limited - jointly owned by Lonrho Limited, Falconbridge Limited and Superior Oil Company - operates a mine-concentrator-smelter-refinery complex having an annual capacity of 3 224 kg of platinum metals. It is the only producer continuing with its expansion program despite the poor market. Production capacity will be increased to 4 665 kg. This will involve the mining, milling and treatment of ore from the UG 2 reef. Despite the weak market conditions, Western continued to produce at capacity during 1982.

U.S.S.R. In the U.S.S.R., platinum metals are derived mainly as a byproduct of the processing of nickel-copper ores in the Noril'sk region of northwestern Siberia and the Kola Peninsula of northwestern Russia. Some platinum metals are recovered from placer deposits in the southern Urals, once the major source of U.S.S.R. output. A major expansion program is under way to develop nickel-copper deposits in the Noril'sk region. The overall program is targeted for completion by 1984 and should result in substantial increases in the production of platinum and palladium. The U.S.S.R. ores are believed to contain a higher proportion of palladium than of platinum. The percentages of platinum metals recovered have been estimated at about 60 per cent palladium, 30 per cent platinum and 10 per cent other platinum metals.

Colombia. Platinum metals in Columbia are recovered as a co-product from gold-platinum placer operations in the Chaco and Narimo districts. Annual production is estimated at about 435 kg.

United States. Primary platinum metals in the United States are derived as a byproduct of copper refining and from a platinum placer mining operation in Alaska. Production remained below normal in 1982 due to the effect of weak economic conditions on the demand for and production of copper. The United States also recovered 6 562 kg of platinum metals from secondary sources.

Work continued on the platinum-group metal occurrences of the Stillwater Complex in Montana. The Anaconda Company, a subsidiary of Atlantic Richfield Company, is considering a 900 tpd operation yielding 9 tpd of concentrate. The permit process was begun in 1982 but market and cost factors were still being studied. Chevron Resources Company and Manville Corporation are completing an evaluation of their property in the same area and do not expect to make a decision until 1984. Should the decision be to develop the property, production could not be achieved until 1988.

In early 1981, the United States government identified platinum-group metals as of strategic importance for national defence and expressed concern that stockpile levels were well below the target levels. This gives the United States government an incentive to encourage domestic production from the Stillwater Complex. The General Services Administration announced that purchases to build up the platinum, palladium and iridium stockpiles were under consideration and in late 1981 it was announced that the rebuilding program would begin with purchases of iridium. In 1982, a number of purchases of grade B iridium were made.

RECYCLING

Recyling of platinum metals, especially platinum, is important in the supply of these metals. It is estimated that over 80 per cent of the platinum metals consumed by industry is recycled, a major portion of it being toll-refined. This is important to those industries that use platinum metals in their processes for purposes such as catalysts, as it reduces the effect of high platinum metals prices on the cost of the goods produced.

The recovery of platinum group metals from scrap has increased steadily since 1977. Nineteen eighty-one was the first year in which recovery of platinum group metals increased while the price decreased. Industrial scrap is now more important in the recycling industry than jewellery scrap, and industrial users generally offer their scrap for recycling regardless of the price. A program of the United States Defence Department contributes substantially to the amount of platinum-group metal scrap refined each year. Chemical and petroleum companies maintain ownership of the platinum-group metals contained in spent catalysts that they have toll-refined. One major source of platinum-group metals scrap, the catalytic exhaust converters on automobiles, has not yet developed. These converters were first installed in 1975 and cars from this model year are now being scrapped in substantial numbers. Due to the recession and higher car prices, cars have been kept on the road longer than was common during the 1960s. A major problem with recovering the platinum metals is the high cost of collecting and transporting the spent or scrapped converters.

USES

The main applications for platinum-group metals are in the automotive, electrical, chemical, dental and medical, glass, petroleum and jewellery industries. The industrial use of these metals is based on special properties such as suitability for catalytic activity, resistance to corrosion and oxidation at elevated temperatures, good electrical conductivity, high melting point, high strength, ductility and aesthetic qualities. Platinum and palladium have wide industrial applications, especially in the catalytic field. The others - iridium, rhodium, ruthenium and osmium - are used mainly as an alloying element with platinum and palladium, but small amounts are used individually in special applications.

The jewellery industry is a major consumer of platinum metals in Japan but not in the United States or Europe where gold, until this year, has been preferred because of its lower price. Major South African producers launched an aggressive campaign in the United States and Europe to promote greater use of platinum metals in jewellery fabrication, but this program was less successful than anticipated because the platinum price exceeded that for gold until December 1980, making platinum jewellery more expensive.

The development of catalytic converters for the control of automotive exhaust emissions created a major new use for platinum and palladium and was responsible for expansion of production facilities in the Republic of South Africa during the late 1970s. The Environmental Protection Agency of the United States and the Japanese government have established automotive emission standards that are best attained by the use of platinum and palladium as catalysts in converters. However, higher emission standards originally to come into force in the United States in the 1981 model year have been deferred. Actual requirements will depend on a recovery in car sales and on the ratio of small cars to large ones. Sales of platinum and palladium to the U.S. automotive industry in 1982 are estimated to be substantially below 1981 levels. Projections for growth in this sector, based on longer life and smaller size of cars, and more efficient gasoline engines, are pessimistic.

Platinum-palladium converters now in use do not control nitrogen oxide emissions and, to meet the standards for these, it appears that rhodium will be a third metal in catalytic converters. The rhodium type converter developed to date requires a relatively high amount of rhodium and could not be adopted universally because the supply of the metal cannot meet the potential requirements. Research activities are oriented toward developing a catalytic converter that contains platinum/rhodium in the same ratio as occurs in the South African ores.

Platinum catalysts are used in petroleum reforming for the production of high octane gasoline. A platinum-rhenium catalyst has been found to be effective in this application and is becoming more important with the phased elimination of tetraethyl lead in gasoline.

Platinum alloyed with other platinum-group metals finds wide application as a catalyst in the chemical industry, for example in the production of nitric acid from ammonia and oxygen. Platinum metal catalysts are also used in the production of pharmaceutical products and in the food processing industry.

Platinum is used extensively in the electronic industry in printed circuits, electrical furnaces, thermocouples and electrical contacts for telephone equipment. A palladium-silver alloy containing 60 per cent palladium and 40 per cent silver is now commonly used in these applications. Recycling of platinum-group metals used in electronics and telecommunications industries is increasing as obsolete equipment is being scrapped. However, use of platinum-group metals in new equipment is declining as equipment becomes increasingly miniaturized and more electronic switching is used.

A platinum-rhodium alloy is used in bushings and spinnerets used in the production of fibre glass, synthetic fibres and in the glass manufacturing industry. Much of the platinum metal used in this field is recycled through toll refining.

Platinum metals are used in a number of other applications: dental and medical, laboratory equipment, medical research, fuel cells for direct generation of electric current, and crucibles for the growing of laser crystals and synthetic gems. The latter applications are in expanding areas of high technology, so that the requirement for platinum-group metals is likely to increase.

PRICES[1]

During 1982, spot prices for all platinum-group metals remained below producer prices. However, producers reported that customers were taking the minimum amounts specified in long-term contracts and obtaining whatever additional metal they required on the spot market at more favourable prices. Producer cutbacks, announced about the same time, reflect the development of substantial platinum inventories. It was also reported during the year that the U.S.S.R. was attempting to establish direct sales to customers rather than selling to dealers. A large part of the dealer market is U.S.S.R. production and the price clearly illustrates the poor revenue they are obtaining for a valuable resource.

Throughout 1982, Rustenburg maintained its palladium price at $140 while Impala continued with its official price of $110. The dealer price, which at the beginning of the year was around $70 per ounce, continued to fall, reaching a low of around $53 in June.

[1] All prices are in United States dollars.

The price slowly recovered to $70 near the end of October, then commenced to move upward more strongly on indications that the U.S.S.R. intended to regulate the terms of its palladium offerings to dealers with the objective of obtaining a more realistic return for a valuable commodity. In 1983, a substantial portion of Soviet palladium is to be offered through a "frame contract" system in which dealers will sign contracts for options on given monthly amounts of metal at prices to be determined by the Soviets. Dealers may choose not to take the contracted metal in any particular month but they cannot roll forward their monthly optional allocation in hope of more acceptable prices in future months. Palladium is mainly an industrial metal with little attraction for the precious metals speculator and very limited use in the jewellery industry. Thus, the slump in demand and accompanying price weakness is tied directly to the poor state of the world economy, notably industries such as the chemical, petroleum, automotive and, to some degree, electronics industries.

Over the years, demand for rhodium has trended upwards, although the pattern has been erratic. The most important rhodium markets have been in the electrical and glass industries and continuing gains are expected in these sectors. Increased rhodium consumption in three-way catalytic converters to control automobile exhaust emissions depends on whatever modifications are made to the environmental protection requirements, whatever improvements are made in engine efficiency and ultimately, an improvement in economic conditions leading to increased car sales. While the rhodium producer price remained at $600 throughout the year, the dealer price declined steadily, from about $400 at the beginning of the year to about $270 at the end of 1982.

As mentioned, iridium has been identified as a strategic stockpile target and arrangements have been made to accept bids on lots of at least 600-700 ounces. Demand for iridium appears to be growing. One recently developed use is for crucibles used to grow crystals like the yttrium-aluminum garnet used in lasers and fake diamonds. It may also be part of a semi-secret new catalyst the petroleum industry has developed for upgrading naphtha into higher octane gas. The iridium producer price remained unchanged at $600 throughout the year, but the dealer price continued to fall, from $400-$420 in January to $320-340 in December.

A major use for ruthenium is in the anodes used in the electrolytic manufacture of chlorine and caustic soda. Because of its catalytic properties, ruthenium is also used in the production of certain specialized organic intermediaries by chemical and pharmaceutical companies. It also has uses in the electrical industry. The comparatively low price of ruthenium compared to other platinum group-metals has created interest in using it as a substitute. The producer price of ruthenium remained at $45 throughout the year but the dealer price fell from $30-$32 in January to $25-$27 in December.

There are very few uses for osmium and demand remains miniscule.

OUTLOOK

The growing demand that developed for platinum-group metals in the 1970s will likely taper off during the 1980s. The areas of industry that are major users of these metals such as the automotive industry, petroleum refining and chemicals, have been particularly hard hit by the recession. It will take some time for demand to recover to pre-recession levels and forecasts indicate that growth during the remainder of the 1980s will be below the rates experienced during the 1970s. As well, there are few major new applications for platinum group metals on the horizon. South African producers have adopted a policy of reducing output and accumulating inventory during periods of slack demand and low prices. This exercise in market control is not entirely successful but it does mean that a weak market will not be flooded with platinum group metals at distress prices. Sales by the U.S.S.R. to the west are made in accordance with its own priorities and are not always related to world demand. Such sales apparently have been decreasing in recent years and this trend has given rise to concern about supply shortages and speculation that the U.S.S.R. is trying to use its dominant position in some commodities as an economic and political lever. Other sources believe that as the level of Soviet technology improves, they require more of these materials for domestic consumption. Evidence suggests that the Soviets do not have large amounts of platinum surplus to their own requirements and that what is available is marketed. The Soviets do appear to have accumulated a substantial stockpile of palladium and the suggestion has been made that this palladium may be available for a swap for surplus material from the United States strategic materials stockpile. The Americans have not bought palladium despite the fact that the palladium stockpile is well below target level and this would be a way of obtaining the material without making a cash outlay.

The price of platinum should recover during 1983-84 and the accumulated inventory should be down to normal working levels by 1985. The South African producers estimated that when expansion plans are resumed, it will take three to four years to increase capacity and capital costs will be high. The producers have adopted a policy of seeking assurance from consumers that capital expenditures can be recovered before committing themselves to major programs.

In the medium term, the platinum metals industry faces a number of uncertainties. It is not known to what extent the recycling of platinum metals in scrapped automotive catalytic converters will affect the overall supply. Some sources suggest that 9 300 to 13 900 kg could be recovered annually from converters by the mid-1980s, while others question whether the metals can be economically recovered. Advances and improvements in catalytic converter technology could reduce the platinum metals load factor. If the price of platinum becomes excessive there is the possibility of substitution. Applications that are now in the initial stages of development may, within the decade, become major users of platinum-group metals. In particular, development of the fuel cell as an important source of electrical power could generate demand for large quantities of platinum. However, the platinum electrodes in fuel cells are recyclable, so that once initial demand is satisfied, replacement fuel cells would use recycled platinum. Other major growth areas are likely to be in the electrical and electronics industry and the chemical processing industry.

It seems likely that the United States will embark on programs to build up the strategic reserves of platinum and palladium but timing and nature of these programs have not been decided. Care will likely be taken to minimize disruption of the market.

In the long term, consumption of platinum metals should show steady growth. The large reserves of these metals contained in the Merensky Reef in the Republic of South Africa and Bophuthatswana can be developed to ensure balanced supply and demand. This of course presupposes political stability in the southern half of the African continent and the absence of meaningful sanctions against the Republic of South Africa. Failure by producers to ensure ample supplies of the platinum metals at a reasonable price would encourage consumers to find substitutes.

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
36300-1	Platinum wire and platinum bars, strips, sheets or plates; platinum, palladium, iridium, osmium, ruthenium and rhodium, in lumps, ingots, powder, sponge or scrap	free	free	free	free
48900-1	Crucibles of platinum, rhodium and iridium and covers therefore	free	free	15%	free

UNITED STATES (MFN)

601.39	Precious metals ores	free
605.02	Platinum metals, unwrought, not less than 90% platinum	free

MFN Reductions under GATT (effective January 1 of year given)		1982	1983	1984	1985	1986	1987
				(per cent)			
605.03	Other platinum metals, unwrought	15.6	14.1	12.6	11.2	9.7	8.2
605.05	Alloys of platinum, semi-manufactured, gold-plated	19.4	17.5	15.6	13.8	11.9	10.0
605.06	Alloys of platinum, semi-manufactured, silver-plated	9.9	9.3	8.6	7.9	7.2	6.5
605.08	Other platinum metals, semi-manufactured, including alloys of platinum	15.6	14.1	12.6	11.2	9.7	8.2
644.60	Platinum leaf	15.6	14.1	12.6	11.2	9.7	8.2

Sources: The Customs Tariff and Commodities Index, January 1982. Revenue Canada; Tariff Schedules of the United States Annotated 1982, USITC Publication 1200; U.S. Federal Register Vol. 44, No. 241.

Potash

G.S. BARRY

Production and shipments of potash to all markets in 1982 were much lower than in 1981 (27.3 and 19.5 per cent respectively). The volume of shipments was particularly disappointing since they had already fallen 9.6 per cent the year before. Exports to the United States were 22.5 per cent lower than last year with sales for the second half of the year particularly weak. The offshore market recorded a substantial decline of 13.5 per cent with the second half also the weakest.

Producers started 1982 with high stocks (1 307 700 t K_2O) and were soon faced with a rapid further inventory build-up to 1.85 million t K_2O by the end of March since a universally expected pick-up in spring sales did not materialize. At peak level of stocks, all covered storage facilities were full and potash had to be stored outside at some mines. These conditions necessitated a very drastic cutback in production, particularly during the summer months. A reduction of inventories was followed by a more balanced regime of production versus sales during the second part of the year. By the end of 1982 stocks were at 1 486 133 t K_2O still at least 500 000 t higher than normal levels. Layoffs during 1982 in the potash mining industry averaged about six weeks per miner.

The reported average price received for potash in 1982 by Canadian producers was C$ 120.40 per t K_2O compared to C$ 151.25 in 1981.

DOMESTIC DEVELOPMENTS

At the end of 1982 Canadian potash capacity, all in Saskatchewan, was 8 680 000 t K_2O equivalent of which Potash Corporation of Saskatchewan (PCS), a public company, accounted for 42.5 per cent. PCS had the intention of bringing a new mine on-stream at Bredenbury by 1986-87 which together with some additions to capacity in existing mines would have allowed the corporation to double its capacity by the end of this decade. PCS would have been in a position to account for more than 50 per cent of Saskatchewan potash production, thereby fulfilling a long-term objective of the New Democratic Government. The Conservative Government of Saskatchewan elected in April undertook a revision of PCS long-term mandate and plans, and announced in October that it will halt all further expansions by the corporation. The Mines Minister stated that the government will approve expansions only in the private sector in the foreseeable future and that it already holds four expansion permit applications. This announcement does not include the major on-stream expansion at the PCS Lanigan mine that will increase its capacity from 850 000 tpy to 1 740 000 tpy K_2O. The expansion started in 1981 and is expected to be completed in 1986 or 1987 depending on market conditions.

In June 1982 the Potash Corporation of Saskatchewan rescinded its previously announced decision to withdraw from Canpotex Limited, effective June 30, 1982. At the same time, Kalium Chemicals (a Division of PPG Industries Canada Ltd.) and Potash Company of Canada Limited also joined Canpotex which, as of July 1, started to serve all Canadian potash producers as an overseas marketing agency. Canpotex also intends to be much more involved in overseas agronomic demonstration programs that will promote the utilization of potash. For example, a 5-year federal-provincial-industry funded project (to be implemented by the Canadian Potash and Phosphate Institute) in China may start in 1983.

International Minerals & Chemical Corporation (IMC) announced that the 720 000 tpy K_2O expansion at the K1 Esterhazy mine (joint IMC-PCS) originally planned for the mid-1980s has been put in abeyance due to depressed market conditions.

Production cutbacks were implemented by all companies throughout 1982. Numerous

TABLE 1. CANADA, POTASH PRODUCTION, SHIPMENTS AND TRADE, 1981 AND 1982

	1981		1982P	
	(tonnes)	($)	(tonnes)	($)
Production, potassium chloride				
Gross weight	11 698 742	..	8 506 786	..
K_2O equivalent	7 146 629	..	5 197 238	..
Shipments				
K_2O equivalent	6 548 701	990,417,531	5 196 242	625,657,861
Imports, fertilizer potash				
Potassium chloride				
East Germany	7 003	882,000	-	-
United States	1 589	417,000	1 878	682,000
West Germany	2	...	-	-
United Kingdom	-	-	3	2,000
Total	8 594	1,300,000	1 881	684,000
Potassium sulphate				
United States	18 288	2,653,000	20 045	3,524,000
Potassic fertilizer, nes				
United States	52 864	5 835,000	57 651	6,258,000
Potash chemicals				
Potassium carbonate	1 265	788,000	1 113	728,000
Potassium hydroxide	3 143	2,090,000	3 407	1,776,000
Potassium nitrate	2 669	1,134,000	2 444	1,096,000
Potassium phosphate	1 432	1,508,000	1 492	1,566,000
Potassium silicates	828	617,000	686	617,000
Total potash chemicals	9 337	6,137,000	9 142	5,783,000
Exports, fertilizer potash				
Potassium chloride, muriate				
United States	6 797 124	647,387,000	4 741 204**	452,572,000*
People's Republic of China	551 874	61,613,000	66 660	8,714,000*
Japan	529 958	61,571,000	592 809	70,337,000*
Singapore	433 793	47,015,000	228 291	26,811,000*
Brazil	406 446	45,659,000	211 808	25,051,000*
South Korea	376 663	42,770,000	309 032	34,912,000*
India	350 287	39,581,000	447 700	50,121,000*
Australia	182 201	21,407,000	204 911	24,748,000*
Taiwan	142 971	14,039,000	64 040	7,535,000*
Mexico	81 908	9,268,000	21 040	2,476,000*
Other countries	214 603	24,661,000	334 000	39,604,000*
Total	10 067 828	1,014,971,000	7 221 495	742,881,000*

Sources: Statistics Canada; Energy, Mines and Resources Canada.
P Preliminary; - Nil; .. Not available; ... Too small to be expressed; nes Not elsewhere specified.
* Special note: From available industry information the 1982 export values should total approximately $600 million. The situation is presently under review by Statistics Canada, and a revision, if applicable will be incorporated in the next annual review.
** Exports to the United States are probably understated by about 500 000 tonnes.

TABLE 2. CANADA, POTASH PRODUCTION AND SALES BY GRADE[1] AND DESTINATION, 1981 AND 1982

	1982						1981
	Standard[2]	Coarse	Granular	Soluble	Chemical[3]	Total	Total
	(tonnes K_2O equivalent)						
Production	1 283 969	2 069 918	1 214 054	579 921	60 016	5 207 878	7 174 596
Sales							
Canada	11 913	164 689	83 135	13 062	..	272 799	331 636
United States	317 438	1 539 039	910 499	435 401	..	3 202 377	4 181 931
Offshore							
Australia	6 989	71 218	41 588	803	..	120 598	100 549
Bangladesh	23 145	-	-	-	..	23 145	16 745
Brazil	15 458	-	113 487	-	..	128 945	238 054
Chile	6 398	-	-	13 248	..	19 646	12 585
China	140 799	-	-	56	..	140 855	420 868
Colombia	-	-	-	-	..	-	-
Costa Rica	-	-	-	-	..	-	13 992
Denmark	-	-	-	-	..	-	-
India	223 816	-	-	-	..	223 816	274 481
Indonesia	59 148	-	-	-	..	59 148	18 274
Italy	-	-	-	-	..	-	10 223
Japan	167 091	58 713	27 941	92 362	..	346 107	269 935
Korea	203 991	-	-	13 344	..	217 335	159 057
Malaysia	83 258	-	-	-	..	83 258	56 819
Mexico	12 780	-	-	-	..	12 780	25 349
Nepal	-	-	-	-	..	-	1 458
New Zealand	27 167	-	-	-	..	27 167	12 081
Nicaragua	-	-	-	-	..	-	9 238
Philippines	39 864	-	-	-	..	39 864	39 463
Romania	23	-	-	-	..	23	-
South Africa	7 315	10 752	5 604	-	..	23 671	33 187
Sri Lanka	18 240	-	-	-	..	18 240	12 147
Swaziland	-	1 281	17 314	-	..	18 595	10 640
Taiwan	56 746	-	-	-	..	56 746	81 003
Thailand	3 025	-	-	-	..	3 025	6 151
United Kingdom	688	-	-	-	..	688	653
Belgium	9 708	-	3 013	-	..	12 721	-
Offshore total	1 105 649	141 964	208 947	119 813	..	1 576 373	1 822 954
Total sales	1 435 000	1 845 692	1 202 581	568 276	..	5 051 549	6 336 522

Source: Potash and Phosphate Institute.

[1] Common specifications are: standard -28 to +65 mesh, special standard -35 to +200 mesh, coarse -8 to +28 mesh, granular -6 to +20 mesh, each grading a minimum of 60 per cent K_2O equivalent, soluble and chemical grade a minimum of 62 per cent K_2O equivalent. [2] Standard includes Special Standard, sales of which were 72 642 t K_2O equivalent in 1981, and 125 449 in 1982. [3] Chemical sales are included in standard grade sales and totalled 54 867 t in 1982.
- Nil; .. Not available.

closures of short durations (3 days to 2 weeks) were mainly achieved with minimum lay-offs since they were matched with maintenance and vacation periods. Significant lay-offs for about half of the Saskatchewan workforce occurred in July and August and again toward the end of the year.

The Potash Corporation of Saskatchewan suspended production of finished products (i.e., closed the beneficiation plant) at the Lanigan mine for six months from March 29 to October 4 and continued to stockpile raw ore since underground development and mining operations continued, except for a two-months total stoppage in September and October. In addition, PCS and other Saskatchewan producers curtailed production for shorter periods throughout 1982 (Table 6).

The shutdowns were reflected in monthly production tonnage (Table 7) which for the months of June, July and August averaged at less than 50 per cent of existing capacity. For 1982 as a whole, Canadian potash capacity utilization was at a depressed low of 60 per cent, much below the world average.

In Manitoba, a 1981 memorandum of agreement between IMC and the government for a proposed potash mine near MacAuley was not renewed by the newly elected NDP Government in March 1982. The possibility that this deposit could be brought into production in the late 1980s as previously expected is now very remote.

In New Brunswick, Potash Company of America (PCA) continued to make very good progress at its new mine near Sussex despite some setbacks in surface construction in early spring. The second production shaft will be put into service in early 1983 and all surface installation will be completed for start-up in late July 1983. It is expected that PCA will produce up to 200 000 t of potash during 1983. Meanwhile mining of common salt and its extraction through the first shaft is in progress and deliveries to the International Salt Co. (N.Y.) started in the fall of 1982. Although PCA potash production from the Saskatchewan mine is marketed overseas through Canpotex Limited, it is not yet determined whether the company will choose to do the same with its New Brunswick output.

At the Salt Springs property of Denison-Potacan Potash Company, sinking of the exploration shaft and an underground deposit evaluation program were completed. A feasibility study by Kilborn Limited was also completed and it is understood that the company is likely to make a final positive production decision before the end of the first quarter of 1983. It would then take about 2½ to 3 years to bring the mine into full production. Some water problems were experienced during shaft sinking requiring special grouting along about 100 meters. The headframe for the second shaft was completed in December and sinking will begin in March 1983 with completion expected for mid-1985. Provincial and federal permits will be required for disposing of waste salt into the Bay of Fundy via a pipeline system.

Denison Mines Limited has a 60 per cent interest in Denison-Potacan Potash Company which is developing this deposit. Potash Company of Canada which has the remaining 40 per cent is owned by Entreprise Miniere et Chimique of France and Kali & Salz AG of West Germany.

The British Petroleum Company Limited (BP) completed nine drill holes on its Millstream concession, encountering potash at the expected depth of 1 000 m. Up to now tonnage and grade indications are very encouraging and the company should be in a position to make a decision in late 1983 on whether an underground exploration program is warranted.

Potash bearing formations are also known to occur in the Bras d'Or region of Nova Scotia and along the southwest coastal area of Newfoundland. Limited exploratory drilling over the last few years was generally disappointing but the chances of finding commercial deposits in the future cannot be completely written off.

INTERNATIONAL DEVELOPMENT

Preliminary estimates indicate that world potash production in 1982 was about 26.0 million t K_2O which corresponds to a capacity utilization of 79 per cent based on a nameplate world capacity of 32.8 million t. Demand was slightly lower at 25.6 million t resulting in a further addition to inventories which were already at a high level at the beginning of the year.

During 1982 two operations closed down in the United States: National Potash Company closed its 200 000 tpy K_2O Carlsbad mine, New Mexico, and Kerr-McGee Chemical Corporation closed its brine-derived

DISTRIBUTION, CANADIAN POTASH SALES, 1982

TABLE 3. CANADA, POTASH PRODUCTION AND TRADE, YEARS ENDED JUNE 30, 1966, 1971, 1976-1982

	Production[2]	Imports[1,2]	Exports[2]
	(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
1982P	6 042 623	25 437	5 400 662

Source: 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.
P Preliminary.

muriate of potash (KCl) mine at Trona, California. The closed capacity was equivalent to 155 000 tpy K_2O. The company will continue to produce about 40 000 tpy of potassium sulphate (equivalent to 20 000 tpy K_2O). Israel completed its first stage expansion at its Dead Sea plant raising capacity during 1982 to 1.0 million tpy K_2O. Construction in Jordan, which is bringing on-stream potash production also based on the Dead Sea brines, is on schedule with a planned start-up at the beginning of 1983.

In Brazil, PETROBRAS Mineracao S.A. (PETROMISA) is bringing into production, with French technical assistance, the Taquari-Vassouras mine, 25 km northwest of Aracaju. Two shafts were completed by a Canadian company, Patrick Harrison & Company Limited. The expected start-up is late 1985. The designed capacity is 300 000 tpy K_2O but it will not be achieved for many years.

In the United Kingdom, the Cleveland Potash Ltd. Boulby mine operated at close to its redefined capacity of 360 000 tpy K_2O as it began to overcome severe technical problems associated with unstable ground conditions.

During 1982 production of potash was well below capacity in Canada and the United States, declined moderately in West Germany and France, but did not decline in East Germany, Israel and the U.S.S.R.

The U.S.S.R. and the German Democratic Republic (GDR) are a crucial factor in potash supply. In 1970 after satisfying East Bloc (Comecon) demand, about 1 million t were available for export to the rest of the world. Exports grew fast to reach a level of 2.2 to 2.4 million tpy in the last few years. Exports from East Germany will remain stable (at 1.4-1.6 million tpy) whereas those of the U.S.S.R. should increase significantly as the result of a completion, after many delays, of two large mines.

Production in both GDR and the U.S.S.R. will always be at full levels regardless of market conditions, and very aggressive selling may be expected as the

TABLE 4. CANADA, POTASH PRODUCTION AND SALES BY QUARTERS, 1982

	1st quarter	2nd quarter	3rd quarter	4th quarter	Total 1982
			(000 tonnes)		
Production	1 593.7	1 144.5	997.4	1 472.3	5 207.9
Sales					
North America	696.4	1 034.3	797.2	674.4	3 202.3
Offshore	377.3	460.5	399.9	338.6	1 576.3
Ending Inventory	1 853.0	1 355.2	1 119.9	1 486.1	1 486.1

Source: Potash and Phosphate Institute.

TABLE 5. CANADA, POTASH SALES BY PRODUCT AND AREA, 1981 AND 1982

		Agricultural					Industrial			Total
		Standard	Coarse	Granular	Soluble	Total	Standard	Soluble	Total	Sales
		(tonnes K_2O equivalent)								
Alberta	1981	2 895	481	15 894	825	20 094	4 970	973	5 943	26 037
	1982	708	1 546	15 822	1 289	19 365	3 042	110	3 152	22 517
British Columbia	1981	26	2 071	6 720	97	8 914	20	-	20	8 934
	1982	15	1 544	3 920	3 310	8 789	-	-	-	8 789
Manitoba	1981	34	5 520	13 572	663	19 789	20	14	34	19 823
	1982	132	7 040	13 949	760	21 881	-	-	-	21 881
New Brunswick	1981	-	9 818	-	-	9 818	-	-	-	9 818
	1982	-	6 184	-	-	6 184	-	-	-	6 184
Northwest Territories	1981	-	-	-	-	-	-	-	-	-
	1982	-	-	-	-	-	-	-	-	-
Nova Scotia	1981	-	3 456	-	-	3 456	-	-	-	3 456
	1982	-	6 025	-	-	6 025	-	-	-	6 025
Ontario	1981	543	139 516	35 831	(2 463)	173 427	1 403	4 649	6 053	179 480
	1982	366	86 108	32 723	354	119 551	1 710	4 072	5 782	125 333
Prince Edward Island	1981	-	8 537	86	-	8 623	-	-	-	8 623
	1982	-	10 460	-	-	10 460	-	-	-	10 460
Quebec	1981	671	48 710	11 034	136	60 553	93	-	93	60 646
	1982	-	44 982	13 208	-	58 190	306	-	306	58 496
Saskatchewan	1981	1 618	1 823	3 288	4 652	11 382	3 366	73	3 438	14 819
	1982	1 446	800	3 513	1 446	7 205	4 188	1 721	5 909	13 114
Totals	1981	5 787	219 933	86 426	3 910	316 056	9 872	5 708	15 580	331 636
	1982	2 667	164 689	83 135	7 159	257 650	9 246	5 903	15 149	272 799

Source: Potash and Phosphate Institute.
- Nil.

TABLE 6. POTASH MINE CLOSURES IN 1982

	From	To	Remarks
Potash Corporation of Saskatchewan			
Allen*	June 25	Sept. 7	
	Dec. 19	Feb. 28(83)	
Cory	June 13	Sept. 7	
	Dec. 19	Feb. 28(83)	
Lanigan	March 29	Oct. 4	
	Dec. 29	Feb. 28(83)	Ore was stockpiled.
Rocanville	June 19	Sept. 7	
	Dec. 19	Feb. 28(83)	
Central Canada Potash (CCP)			
(div. of Noranda Mines Limited)	March	June	34 days total.
	June 30	July 21	
	Sept. 4	Jan. 3(83)	
Cominco Ltd.	July 1	Aug. 23	
International Minerals &	Dec. 22(81)	Jan. 7	
Chemical Corp.	Feb. 15	Feb. 21	
	March	May	Short production week.
	June 11	July 2	
	Dec. 22	Feb. 22(83)	
Kalium Chemicals	-- throughout	the year --	Not utilizing expanded
(div. of PPG Industries			capacity.
Canada Ltd.)	Sept. 23	Sept. 28	
Potash Company of America	-- throughout	the year --	Not utilizing expanded
			capacity.
	July 10	Aug. 3	
	Oct. 17	Oct. 29	

* Kidd Creek Mines Ltd. has 40 per cent of Allen.

TABLE 7. CANADA, POTASH INVENTORY, PRODUCTION, DOMESTIC SHIPMENTS AND EXPORTS, 1982

	Beginning Inventory	Production	Domestic Shipments Agricultural	Domestic Shipments Non-Agricultural	Exports United States Agricultural	Exports United States Non-Agricultural	Exports Offshore Total
	(000 tonnes K_2O)						
January	1 307.7	546.7	23.6	1.0	232.0	14.6	128.0
February	1 533.7	500.9	13.9	1.0	231.1	12.9	153.8
March	1 654.9	546.0	8.5	1.3	228.5	16.5	95.6
April	1 853.0	471.0	29.7	1.3	383.9	12.4	159.1
May	1 749.4	391.8	40.2	1.0	339.8	19.1	175.6
June	1 598.9	281.6	7.9	1.6	261.9	17.2	125.8
July	1 355.2	254.8	35.8	0.9	215.9	13.7	147.7
August	1 216.2	344.1	17.2	0.8	343.6	11.5	161.7
September	1 066.4	398.4	25.5	1.5	195.3	17.3	90.5
October	1 119.9	535.5	8.7	1.5	183.4	13.7	94.8
November	1 353.3	538.8	15.8	1.8	162.8	12.4	134.5
December*	1 540.8	406.8	31.1	1.2	287.6	14.4	109.7
Total 1982		5 216.4	267.9	14.9	3 065.8	175.7	1 576.8
1981		7 174.6	316.1	15.6	3 971.4	210.6	1 822.9
% change 1982/81	+10.4	(-27.3)	(-15.2)	(-4.5)	(-22.8)	(-16.7)	(-13.5)

Source: Potash and Phosphate Institute of North America.
* Inventory at the end of December 1982 is 1 486 133 t K_2O.

TABLE 8. CANADA, POTASH MINES - CAPACITY PROJECTIONS

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
					(thousand tonnes K_2O equivalent)						
PCS -											
- Allen (60%)	490	490	490	490	490	490	490	490	490	490	490
- Bredenbury	-	-	-	-	-	-	-	-	-	-	-
- Cory	830	830	830	830	830	830	830	830	830	830	830
- Esterhazy (25% of IMC)	585	585	585	585	585	585	585	585	585	585	585
- Lanigan	545	685	830	830	1 055	1 280	1 510	1 740	1 740	1 740	1 740
- Rocanville	725	750	890	1 090	1 090	1 090	1 090	1 090	1 090	1 090	1 090
Sub-total	3 175	3 340	3 695	3 825	4 050	4 275	4 505	4 735	4 735	4 735	4 735
CCP	815	815	815	815	815	815	815	815	815	815	815
Cominco	545	545	600	655	655	655	655	655	655	655	655
IMC	1 750	1 750	1 750	1 750	1 750	1 750	1 750	1 750	1 750	1 750	1 750
PPG (Kalium)	845	845	1 055	1 055	1 055	1 055	1 055	1 055	1 055	1 055	1 055
PCA	440	440	440	635	635	635	635	635	635	635	635
Kidd Creek (Allen 40%)	325	325	325	325	325	325	325	325	325	325	325
Sub-total	4 720	4 720	4 985	5 235	5 235	5 235	5 235	5 235	5 235	5 235	5 235
Total Saskatchewan	7 895	8 060	8 680	9 060	9 275	9 510	9 740	9 970	9 970	9 970	9 970
Denison, N.B.	-	-	-	-	-	-	280	500	830	830	830
PCA, N.B.	-	-	-	100	350	400	400	545	545	545	545
Total New Brunswick	-	-	-	100	350	400	680	1 045	1 375	1 375	1 375
Canada (firm)	7 895	8 060	8 680	9 160	9 625	9 910	10 420	11 015	11 345	11 345	11 345
(unspecified)	-	-	-	-	-	-	-	-	-	400	900
TOTAL	7 895	8 060	8 680	9 160	9 625	9 910	10 420	11 015	11 345	11 745	12 245

TABLE 11. CANADA POTASH, CURRENT SITUATION AND FORECAST

	Actual				Forecast		
	1979	1980	1981	1982	1983	1984	1985
	(thousand tonnes K_2O equivalent)						
Capacity	7 850	7 895	8 060	8 680	9 160	9 625	9 910
Production	6 715	7 300	7 175	5 216	5 750	6 300	7 300
Capacity Utilization	86%	92%	89%	60%	62%	65%	74%
Sales:	7 155	7 111	6 337	5 101	5 650	6 550	7 400
of which: Domestic	379	378	332	283	350	350	400
U.S.A.	4 931	4 563	4 182	3 241	3 500	4 200	4 800
Offshore	1 846	2 170	1 823	1 577	1 800	2 000	2 200
End-year stocks	378	564	1 308	1 486	1 550	1 300	1 200
World production	25 314	27 503	27 586	25 800[e]	25 900	27 500	29 500
Canada/World (production)	26.5%	26.5%	26.0%	20.1%	20.8%	22.9%	24.7%

workforce to dovetail with increases in nominal capacity will be minimal. Total capacity in Saskatchewan and New Brunswick will rise to 9.9 million t K_2O by 1985, while an optimistic forecast for production and sales is between 7.5 and 8.0 million t. Canadian potash mines will still operate at about 75 per cent nameplate capacity.

The FAO/UNIDO/World Bank Working Group on Fertilizers estimated that world demand for potash over the next five years will grow by 3.5 per cent annually. Starting with a demand base of 26.0 million t in 1982, demand would rise to 31.5 million t by 1987.

Between 1982 and 1987 expansion and new mines start-ups will continue in Canada, U.S.S.R., Israel, Jordan and Brazil raising the nominal world potash capacity from 32.8 million t to about 38.9 million t K_2O, an annual growth rate of 3.4 per cent. Therefore, for this five-year period the average world capacity utilization will remain low at about 80 per cent rather than the preferred 85 to 90 per cent level. After 1987 however, prospects should improve rapidly for all primary potash producers as the world will probably re-enter a long period of balanced supply and demand.

Salt

G.S. BARRY

Canada is self-sufficient in salt. Nova Scotia, Quebec and Ontario produced most of the rock salt mined in Canada, while salt in brines which accounted for 25 per cent of the total output was produced in Alberta, Ontario and Saskatchewan.

Production of salt from all sources in 1982 was 7.90 million t, an 8.6 per cent increase from last year (7.32 million t). Shipments at 7.93 million t however were lower than production, which resulted in a buildup of salt inventories to 995 582 t as of the end of 1982.

The 1982 average value of salt in all forms is estimated at $20.10/t compared to $18.16/t in 1981. Milder winter conditions were responsible for a reduction in rock salt usage for de-icing purposes for the last three years but this reduction was not as severe in Canada as it was in the United States. There was a 5 per cent reduction in salt consumption by the chemical industry in Canada but salt produced from brines in the United States recorded a substantial decline owing to the reduction in chlorine production. The demand for polyvinyl chloride decreased because of the slowdown in the construction industry.

Exports to the United States during 1982 were 1 714 183 t, an increase of 15.8 per cent compared to 1981. Imports however were also 21.7 per cent higher. Normally, Canadian exports exceed imports by about a quarter of a million t and this difference is expected to further increase in Canada's favour. Imports were 65 per cent from the United States, 24 per cent from Mexico and the remaining 11 per cent mainly from Chile and the Bahamas.

PRODUCTION AND DEVELOPMENTS IN CANADA

Atlantic region. Salt deposits occur in isolated sub-basins of a large sedimentary basin that underlies the northern mainland of Nova Scotia and extends westward under the bordering areas of New Brunswick, northeastward under Cape Breton Island, Prince Edward Island, the Madeleine Islands and southwestern Newfoundland. The salt beds occur within the Mississippian Windsor Group and are generally folded and faulted. The deposits appear to be steeply dipping tabular bodies, domes and brecciated structures of rock salt.

Salt production in the Atlantic provinces in 1982 was from an underground mine at Pugwash, Nova Scotia and a brining operation near Amherst, Nova Scotia. At Pugwash, The Canadian Salt Company Limited mines annually between 800 000 and 1 000 000 t of rock salt more than 90 per cent destined for Canadian markets. Up to 100 000 tpy of salt is dissolved for vacuum pan evaporation and sold for high quality applications including table salt.

In New Brunswick, Potash Company of America (PCA) has a major potash mine under construction at Plumweseep, near Sussex, 60 km east of Saint John. The mine will be in production in late 1983. In addition to potash the company intends to extract common salt at a rate of 400 000 to 500 000 tpy and sell most of the output in eastern United States. The salt will be mined in a separate section of the mine which contains beds of high purity. Cavities created by the extraction of the commercial salt will be backfilled with waste salt from the flotation of the potash. Salt extraction was carried out in 1980 and 1981, was interrupted in 1982 and will resume again in early 1983.

Quebec. Seleine Mines Inc., a subsidiary of Société québécoise d'exploration minière (SOQUEM) a provincial public company continued in its efforts to put into production a 1.25 million tpy underground salt mine on Madeleine Islands in the Gulf of St. Lawrence. Production start-up was scheduled for April 1982 but a delay of approximately 14 months was incurred as a result of several construction problems. The

TABLE 1. CANADA, SALT PRODUCTION AND TRADE, 1981 AND 1982

	1981		1982P	
	(tonnes)	($)	(tonnes)	($)
Production				
By type				
Mined rock salt	4 440 367	..	5 197 000	..
Fine vacuum salt	775 721	..	750 000	..
Salt content of brines used or shipped	2 107 243	..	2 008 000	..
Total	7 323 331	..	7 955 000	..
Shipments				
By type				
Mined rock salt	4 371 314	74,260,277	5 158 000	..
Fine vacuum salt	764 037	49,147,516	760 000	..
Salt content of brines used or shipped	2 107 243	8,156,732	2 008 000	..
Total	7 242 594	131,564,525	7 926 000	159,153,000
By province				
Ontario	4 967 619	79,098,134	2 479 000	97,701,000
Nova Scotia	1 029 241	26,809,307	1 142 000	30,979,000
Saskatchewan	387 787	12,019,447	402 000	14,363,000
Alberta	857 947	13,637,637	903 000	16,109,000
Total	7 242 594	131,564,525	7 926 000	159,152,000
Imports				
Salt and brine				
United States	1 002 876	13,878,000	993 442	14,058,000
Mexico	228 370	2,208,000	361 078	3,864,000
Spain	22 583	494,000	48 893	1,293,000
Bahamas	-	-	15 319	199,000
Chile	-	-	106 872	2,354,000
Portugal	894	56,000	1 124	89,000
Other countries	269	34,000	153	30,000
Total	1 254 992	16,670,000	1 526 881	21,887,000
Salt and brine by province of landing				
Newfoundland	22 110	474,000	44 561	753,000
Nova Scotia	1 363	73,000	20 819	832,000
New Brunswick	33	3,000	34	1,000
Quebec	334 948	4,577,000	414 125	6,139,000
Ontario	509 666	6,605,000	543 995	7,123,000
Manitoba	73	7,000	784	74,000
Saskatchewan	470	24,000	1 163	93,000
Alberta	302	14,000	4 868	326,000
British Columbia	386 027	4,893,000	496 532	6,546,000
Total	1 254 992	16,670,000	1 526 881	21,887,000
Exports				
Salt and brine				
United States	1 480 065	19,172,000	1 714 183	21,661,000
Cuba	13 680	831,000	-	-
Guyana	3 836	564,000	-	-
Zaire	5 333	220,000	-	-
Leeward-Windward Islands	2 235	158,000	1 964	164,000
Other countries	2 561	135,000	1 955	176,000
Total	1 507 710	21,080,000	1 718 102	22,001,000

Sources: Statistics Canada; Energy, Mines and Resources Canada.
P Preliminary; .. Not available; - Nil.

TABLE 2. CANADA, SALT SHIPMENTS, 1971, 1978-82

	Producers' Shipments					
	Mined Rock	Fine Vacuum	In Brine and recovered in Chemical Operations	Total	Imports	Exports
			(tonnes)			($)
1971	3 670 373	567 491	1 036 189	5 274 053	836 436	7,029,000
1978	4 625 528	719 472	1 542 932	6 887 932	1 330 474	12,888,000
1979	4 934 574	735 460	1 645 914	7 315 948	1 276 179	17,902,000
1980	4 507 416	781 428	2 134 010	7 422 854	1 151 203	18,228,000
1981	4 371 314	764 037	2 107 243	7 242 594	1 254 992	21,080,000
1982P	5 158 000	760 000	2 008 000	7 926 000	1 526 881	22,001,000

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

most severe setback was incurred by failure of the frozen wall during No. 2 shaft sinking which caused flooding. Delays were also experienced in underground development. At the end of the year work was still in progress on the 20 000 t underground salt storage system and the crusher. The company expects that the mine will achieve designed capacity operational level during the second part of 1984. Total capital costs for the mine and port facilities will be substantially in excess of $65 million originally budgeted. Navigation Sonamar Inc. has a long-term contract for salt transport. Shipping will be on a 270 day-per-year basis from April 1 to December 31.

Seleine has a long-term contract with the Government of Quebec to supply road salt and a future contract to supply 300 000 tpy to Diamond Crystal Salt Company of NY. Since production in 1982 was not at a level orginally anticipated, Seleine marketed salt that it bought from other producers. Reserves are sufficient to permit the expansion of this mine to 2 million tpy should market conditions warrant it in the future.

Ontario. Thick salt beds underlie much of southwestern Ontario, extending from Amherstburg northeastward to London and Kincardine, bordering on what is known geologically as the Michigan Basin. As many as six salt beds, occurring in the Upper Silurian Salina Formation at depths from 275 to 825 m, have been identified and traced from drilling records. Maximum bed thickness is 90 m, with aggregate thickness reaching as much as 215 m. The beds are relatively flat-lying and undisturbed, resulting in low-cost mining.

During 1981, those beds were worked through two rock salt mines, one at Goderich and one at Ojibway, and through brining operations at Goderich, Sarnia, Windsor and Amherstburg.

Domtar Inc. is expanding its production at the Goderich mine in Ontario from 2.0 million to 3.1 million tpy. Freezing ground for the sinking of a new shaft began in late 1980; shaft sinking began in the spring of 1981 and was completed in October 1982. The entire project is slated for completion in March 1983, by which time total capital expenditures should reach about $36 million.

Prairie Provinces. Salt beds underlie a broad belt of the Prairie Provinces extending from the extreme southwestern corner of Manitoba northwestward across Saskatchewan and into the north-central part of Alberta. Most of the salt deposits occur within the Prairie Evaporite Formation, which constitutes the upper part of the Middle Devonian-Elk Point Group, with thinner beds of salt occurring in Upper Devonian rocks. Depths range from 180 m at Fort McMurray, Alberta, to 900 m in eastern Alberta, central Saskatchewan and southwestern Manitoba, and to 1 830 m around Edmonton, Alberta, and in southern Saskatchewan. Cumulative thicknesses reach a maximum of 400 m in east-central Alberta. The beds lie relatively flat and undisturbed. The same rock sequence contains a number of potash beds currently under exploitation in Saskatchewan.

TABLE 3. CANADA, SUMMARY OF SALT PRODUCING AND BRINING OPERATIONS

Company	Location	Initial Production	Production* 1982P (1981) (000 tonnes)	Employment 1982P (1981)	Remarks
Nova Scotia & New Brunswick					
The Canadian Salt Company Limited	Pugwash	1959	964.3 (825.6)	) 216) (229))	Rock salt mining to a depth of 253 m.
	Pugwash	1962	89.6 (93.2)	))	Dissolving rock salt fines for vacuum pan evaporation.
Denison-Potacan Potash Company	Sussex	1982	56.1 (-)	- (-)	Salt from the development of a potash mine. Marketed temporarily by The Canadian Salt Company.
Potash Company of America	Sussex	1980	- (114.8)	- -	Development salt from a potash mine under construction for production in 1983. Salt shipments will be resumed in February 1983.
Domtar Inc.	Amherst	1947	72.4 (80.8)	71 (71)	Brining for vacuum pan evaporation.
Ontario					
Allied Chemical Canada, Ltd.	Amherstburg	1919	513.1 (585.0)	8** (8)	Brining to produce soda ash.
The Canadian Salt Company Limited	Ojibway	1955	2 134.3 (2 041.5)	256 (250)	Rock salt mining at a depth of 300 m.
	Windsor	1892	121.6 (144.8)	152 (139)	Brining, vacuum pan evaporation and fusion.
Dow Chemical Canada Inc.	Sarnia	1950	667.6 (747.2)r	5** (10)	Brining to produce caustic soda and chlorine.
Domtar Inc.	Goderich	1959	1 906.0 (1 360.0)	284 (240)	Rock salt mining at a depth of 536 m.
	Goderich	1880	118.2 (103.2)	64 (62)	Brining for vacuum pan evaporation.
Quebec					
Seleine Mines Inc.	Madeleine Islands	1982	87.8 (-)	150 (-)	Production began in late 1982.
Prairie Provinces					
International Minerals & Chemical Corporation (Canada) Limited	Esterhazy, Sask.	1962	71.5 (60.0)	3 (3)	Byproduct salt from potash mine for use in snow and ice control.
The Canadian Salt Company Limited	Belle Plaine, Sask.	1969	77.4 (68.5)	24 (27)	Producing fine salt from byproduct brine from potash mine.
Prince Albert Pulp Company Ltd.	Saskatoon, Sask.	1968	34.0 (36.0)	5** (5)	Brining to produce caustic soda and chlorine.
Domtar Inc.	Unity, Sask.	1949	165.5 (170.0)	87 (85)	Brining, vacuum pan evaporation and fusion.
The Canadian Salt Company Limited	Lindbergh, Alta.	1968	133.5 (129.3)	65 (82)	Brining, vacuum pan evaporation and fusion.
Dow Chemical Canada Inc.	Fort Sask., Alta.	1968	792.5 (809.0)	8** (8)	Brining to produce caustic soda, chlorine, and ethylene storage.
			8 005.4 (7 368.9)	1 398 (1 229)	

* Shipments; ** Employment part of a chemical complex.
P Preliminary; r Revised; - Nil.

Brine for vacuum-pan evaporation is produced from these formations at two locations - Lindbergh, Alberta and Unity, Saskatchewan - while brine for the production of caustic soda and chlorine is obtained at Saskatoon, Saskatchewan and Fort Saskatchewan, Alberta. In addition, byproduct brine from a potash solution mine at Belle Plaine, Saskatchewan, is used in the production of fine vacuum-pan salt by The Canadian Salt Company Limited. International Minerals & Chemical Corporation (Canada) Limited (IMCC) supplies a small quantity of waste salt from the Esterhazy potash mine for snow and ice control on highways.

British Columbia. Solar-evaporated salt from Mexico and Chile supplies the British Columbia caustic soda and chlorine manufacturing industry. ERCO Industries Limited has a plant in North Vancouver; FMC of Canada Limited has one at Squamish and Hooker Chemical Canada Ltd., at North Vancouver.

CANADIAN CONSUMPTION AND TRADE

Salt is marketed in at least 100 different forms, packages and containers, and its direct and indirect uses number in the thousands. The largest single market for salt in Canada is for snow and ice control on highways and city streets. By comparison with other uses, this market is new, having expanded in Canada from less than 100 000 t in 1954 to an estimated 2.5 million t in 1982. However, this market is expected to increase marginally over the next decade.

The next-largest consumer of salt is the industrial chemical industry, particularly for the manufacture of caustic soda (sodium hydroxide) and chlorine. Salt for four caustic soda and chlorine plants is obtained from on-site brining and natural brines; others use mined rock salt or imported solar-evaporated salt. Other industrial chemicals that require significant quantities of salt in the manufacturing process include sodium carbonate (soda ash), sodium chlorate, sodium bicarbonate, sodium chlorite and sodium hypochlorite. Strong growth in this market is expected to continue, based on domestic demand as well as on export opportunities.

The pattern of Canada's salt trade has not changed considerably for quite a few years except that Chile became a new supplier to Canada. Because of its low unit value and availability in most key market areas, salt is seldom hauled over long distances, except in the case of seaborne and intercoastal shipments where greater mileage entails little additional cost. Sales of highway salt on the eastern seaboard of the United States, beginning in 1982 by Seleine Mines Inc. and in 1983 by the Potash Company of America from their respective mines in Quebec and New Brunswick, will increase Canadian exports and replace salt traditionally imported from Mexico and the Caribbean countries.

TABLE 4. WORLD SALT PRODUCTION, 1979-82

	1979	1980	1981P	1982e
			(000 tonnes)	
United States	41 567	36 630	35 295	35 108
People's Republic of China[e]	14 770	17 280	18 325	18 144
U.S.S.R.[e]	14 297	14 515	14 515	14 515
West Germany	15 089	12 973	12 261	12 701
India	7 036	7 262	7 261	7 257
France	8 058	7 103	6 636	6 622
Canada	6 881	7 029	7 285	7 167
United Kingdom	7 819	7 156	6 808	6 804
Mexico	6 169	6 575	7 003	6 985
Italy	5 669	5 267	4 899	5 171
Australia	5 172	5 315	5 298	5 262
Poland	4 429	4 534	3 388	3 266
Other countries	36 629	36 905	37 137	36 106
Total	173 585	168 544	166 111	165 108

Sources: U.S. Bureau of Mines, Preprints 1981 and U.S. Bureau of Mines Mineral Commodity Summaries, 1982; Energy, Mines and Resources Canada.
P Preliminary; [e] Estimated.

TABLE 5. CANADA, AVAILABLE DATA ON SALT CONSUMPTION, 1979-1982

	1979r	1980r	1981p	1982e
	(tonnes)			
Snow and ice control[1]	2 984 541	2 472 849	3 001 260	3 088 315
Industrial chemicals[2]	2 203 611	2 899 660	3 165 164	2 982 600
Fishing industry	51 000	65 000	68 000	71 000
Food processing				
Fruit and vegetable processing	21 422	20 619	19 168	22 200
Bakeries	13 838	15 017	14 079	15 000
Fish products	28 354	24 296	33 983	31 700
Dairy products	9 128	13 056	10 740	11 900
Biscuits	2 012	1 892	2 022	2 400
Miscellaneous food preparation	42 742	46 587	24 874	41 200
Grain mills[3]	58 901	77 412	67 036	73 700
Slaughtering and meat processors	47 919	45 611	44 725	49 900
Pulp and paper mills[4]	53 000	28 980	25 344	29 300
Leather tanneries	10 217	7 346	9 964	10 300
Miscellaneous textiles	2 185	2 924	2 664	3 200
Breweries	140	294	352	300
Total	5 529 010	5 721 543	6 489 375	6 433 015

Sources: Statistics Canada; Salt Institute; Pulp and Paper Canada, April 1980.
[1] Fiscal year ending June 30. [2] Includes rock salt, fine vacuum salt and salt contained in brine. [3] Includes feed and farm stock salt in block and base forms. [4] Not included in 1979 Statistics Canada Survey. Figures are estimates as published in "Pulp and Paper Canada".
[e] Estimated by Energy, Mines and Resources Canada; [p] Preliminary; [r] Revised.

OUTLOOK

Demand for industrial salt is expected to continue moderately strong for the longer term but the period 1982-83 is most likely to reflect the overall recessionary pattern of the North American economy. A very slow growth of not more than 1 per cent per year is forecast for the main usage of salt - road de-icing. The overall growth in salt consumption in North America for the 1982-1986 inclusive period may be in the order of 1.5 to 2.5 per cent per year.

In its salt industry survey of 1980 the United States Bureau of Mines (USBM) forecasts an increase of world salt production capacity from 187 million t in 1979 to 236 million t in 1985 which indicates no shortage for this period, since long term growth in demand is forecast by most experts to be in the range of 2.5 per cent to 4 per cent per year. (236 million t corresponds to a 4 per cent growth.)

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
92501-1	Common salt (including rock salt)	free	free	5¢/100 lb.	free
92501-2	Salt for use of the sea or gulf fisheries	free	free	free	free
92501-3	Table salt made by the admixture of other ingredients when containing not less than 90 per cent of pure salt	4.6	4.6	15	3
92501-4	Salt liquors and sea water	free	free	free	free

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
			(%)			
92501-3	4.6	4.5	4.4	4.3	4.1	4.0

UNITED STATES, Customs Tariffs (MFN)

		1982	1983	1984	1985	1986	1987
				(%)			
420.92	Salt in brine	4.5	4.4	4.2	4.0	3.9	3.7
420.94	Salt in bulk	1.9	1.5	1.1	0.8	0.4	free
420.96	Salt, other	Remains free					

Sources: The Customs Tariff and Commodities Index, 1982, Revenue Canada; Tariff Schedules of the United States Annotated (1982), USITC Publication 1200; U.S. Federal Register Vol. 44, No. 241.

Selenium and Tellurium

D.A. CRANSTONE

Selenium

Selenium is a nonmetallic element whose chemistry is similar to that of sulphur. It has some of the properties of a metal and is sometimes referred to as a metal. Selenium occurs in minerals associated with copper, lead and iron sulphides. Commercial production is from electrolytic copper refinery slimes and from flue dusts from copper and lead smelters. Thus, selenium production is related to refined copper production and to the relative recovery rates of selenium. A significant amount of selenium is also recovered from secondary sources.

CANADA

Selenium is recovered in Canada as a byproduct from the refining of blister copper and from the retreatment of recycled materials. Annual production is irregular, varying according to operating rates and recoveries at copper refineries and market conditions for selenium. For example, production of selenium from domestic primary material reached a recent low of 122 000 kilograms in 1978, and then increased substantially during the following three years (Table 2). The 279 626 kg recovered in 1980 was the highest level of production from blister copper in Canada since 1971. Production dropped to 198 000 kg in 1982 because of strikes and other closures of the two Canadian copper refineries. In addition, substantial amounts of xerographic scrap and other selenium scrap are imported from the United States and other countries to be re-refined in Canada and re-exported. The total amount of selenium refined in Canada in 1982 from both primary and secondary sources was 273 325 kg.

Noranda Mines Limited's CCR Division copper refinery at Montreal East, Quebec, operates Canada's largest selenium recovery plant. The refinery handles copper from the company's Horne and Gaspé smelters in Quebec and from the Flin Flon smelter of Hudson Bay Mining and Smelting Co., Limited in Manitoba. The amount of selenium recovered from these sources declined from 333 400 kg in 1975 to 235 900 kg in 1981. With the Hudson Bay and Gaspé mines and smelters having been closed for part of 1982, even less selenium came from these sources in 1982. The selenium recovery unit produces commercial-grade (99.5 per cent) and high-purity (99.99 per cent) selenium and a variety of selenium compounds. Annual capacity is up to 326 600 kg of selenium in elemental form and in salts, depending on copper production and its selenium content. In addition, production capacity of secondary selenium is 163 300 kg per annum. CCR treats selenium-bearing scrap on a toll basis. A strike at the CCR copper refinery began on May 2 and lasted for 17 weeks, although some refinery operations were continued on a reduced scale by supervisory personnel. During the year, new facilities were installed to enlarge the range of high-purity selenium alloys produced.

The 67 200 kg per year selenium recovery plant of Inco Limited at Copper Cliff, Ontario treats tankhouse slimes from the company's Copper Cliff copper refinery and its Port Colborne, Ontario nickel refinery, and produces minus 200 mesh selenium powder (99.5 per cent Se). The Inco copper refinery was closed by a strike during June 1982, then remained closed for most of the second half of the year when Inco's Sudbury operations were closed because of low nickel demand. Output from this plant is likely to remain well below capacity for many years because of depressed production of nickel and copper.

TABLE 1. CANADA, SELENIUM PRODUCTION, EXPORTS AND CONSUMPTION, 1981 AND 1982

	1981		1982P	
	(kilograms)	($000)	(kilograms)	($000)
Production				
All forms[1]				
Quebec	172 363	5,848	133 000	2,520
Ontario	28 576	970	28 000	526
Manitoba	45 358	1,539	35 000	662
Saskatchewan	9 072	308	2 000	44
Total	255 369	8,665	198 000	3,752
Refined[2]	350 010	..	273 325	..
Exports				
United States	163 202	5,444	128 000	4,055
United Kingdom	64 546	1,129	47 000	452
Japan	8 165	376	2 000	87
Netherlands	19 731	351	10 000	128
Spain	16 057	212	14 000	142
Puerto Rico	1 950	105	2 000	105
Other countries	24 949	442	11 000	125
Total	298 600	8,059	214 000	5,094
Consumption[3]	9 414	..	..	..

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

[1] Recoverable selenium content of blister copper treated at domestic refineries, plus refined selenium from domestic primary materials. [2] Refinery output from all sources, including imported materials and secondary sources. [3] Consumption (selenium content), as reported by consumers.
P Preliminary; .. Not available.

Canada consumes only about 3 per cent of its refined selenium, primarily in the glass industry. Most selenium production is exported but volume of exports varies widely from year to year, often differing significantly from refined production. The United States is Canada's major market, followed by the United Kingdom. These two countries together purchased 82 per cent of Canada's exports in 1982.

WORLD

Producing countries include the United States, Canada, Japan, the U.S.S.R., Belgium, Sweden, Mexico, Yugoslavia, Finland, Peru, Australia, and Zambia. Non-communist world production of refined selenium, which increased sharply in 1977, peaked at 1 562 193 kg in 1979 and declined to an estimated 1 180 509 kg by 1982 Table 3). In 1982, Canada was the non-communist world's second largest producer of refined selenium following Japan. The United States ranked third.

Production of selenium in the United States in 1982 was 226 796 kg, a decline from the 251 744 kg produced in 1981 because of decreased U.S. copper production. Most U.S. production is derived from copper refinery slimes plus a small amount of scrap selenium. The United States imported 50 per cent of its requirements in 1982, about the same as in 1981.

Consumption of selenium in the non-communist world in 1982 was reported at 1.22 million kg, the same as in 1981.

TABLE 2. CANADA, SELENIUM PRODUCTION, EXPORTS AND CONSUMPTION, 1970, 1975, 1978-82

	Production			
	All forms[1]	Refined[2]	Exports[3]	Consumption[4]
	(kilograms)			
1970	300 884	387 572	311 209	7 135
1975	182 385	342 392	218 000	9 933
1978	122 405	392 777	242 200	14 364
1979	217 759	511 703	289 200	15 772
1980	279 626	377 204	306 800	10 795
1981	255 369	350 010	298 600	9 414
1982P	198 000	273 325	214 000	..

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

[1] Recoverable selenium content of blister copper treated at domestic refineries, plus refined selenium from domestic primary materials. [2] Refinery output from all sources, including imported materials and secondary sources. [3] Exports of selenium, metal powder, shot, etc. [4] Consumption (selenium content), as reported by consumers.
P Preliminary; .. Not available.

TABLE 3. NON-COMMUNIST WORLD REFINERY PRODUCTION OF SELENIUM, 1980-82

	1980	1981	1982e
	(kilograms)		
Japan	453 590	430 006	453 592
Canada	377 204	350 010	273 325
United States	141 070	251 744	226 796
Mexico	81 650	9 072	9 072
Sweden	68 040	68 039	68 039
Belgium and Luxembourg[e]	58 970	58 967	58 967
Other countries	128 820	102 058	90 718
Total	1 309 344	1 269 896	1 180 509

Sources: U.S. Bureau of Mines Mineral Commodity Summaries, 1982, 1983; Energy, Mines and Resources Canada.
e Estimated.

TABLE 4. CANADA, INDUSTRIAL USE OF SELENIUM, 1980-82

	1980	1981	1982P
	(kilograms of contained selenium)		
By end-use			
Glass	7 642	6 115	..
Other[1]	3 153	3 299	..
Total	10 795	9 414	..

P Preliminary; .. Not available.
[1] Steel, pharmaceuticals.

Apparent consumption of selenium in the United States in 1982 was 498 960 kg compared with 459 040 kg in 1981. Consumption in 1982 was about 15 per cent less than the total U.S. production plus imports for consumption. The main industries in the United States that currently consume selenium, according to the United States Bureau of Mines, are: electronic and photocopier components, 35 per cent; glass manufacturing, 30 per cent; chemical sand pigments, 25 per cent; and other uses, 10 per cent.

U.S. producer stocks declined slightly to 276 700 kg in 1982 from 292 600 kg in 1981. Stocks are not expected to decline significantly in the near-term.

PRICES

Producer prices for selenium have not been published since 1981 but it is understood that the price was $US 4.50 a pound during 1982. The U.S. dealer price for commercial grade (99.5 per cent) in U.S. currency was $3.55-4.00 a pound early in the year, declined to a low of $3.25-3.55 a pound on August 5 and was $3.25-3.60 a pound at the end of October.

USES

Selenium is used in the manufacture of glass, steel, electronic components, explosives, batteries, animal and poultry feeds, fungicides and pigments, and in xerography. The 1979 edition of this review contains a more detailed description of selenium uses.

Elemental selenium is marketed in two grades: commercial, with a minimum content of 99.5 per cent Se; and high purity, with a minimum content of 99.99 per cent Se. Other forms include ferroselenium, nickel-selenium, selenium dioxide, barium selenite, sodium selenate, sodium selenite and zinc selenite.

As new uses are found for this versatile element, demand may eventually exceed supply. The recent successful introduction of the selenium-alloyed, low antimonial-lead, maintenance-free battery illustrates a recently developed end-use for selenium. Other developments include an improved solar photovoltaic cell (a copper indium selenide-cadmium sulphide cell) and a lead sulphide selenide diode for fibre optic communications systems.

Researchers are exploring the possibility of substituting crude selenium-bearing concentrates for refined selenium in some uses. Coal fly ash, for example, has the potential to be used directly as a source of dietary selenium for livestock or as a soil preparation to increase the selenium content of crops.

OUTLOOK

Since selenium is primarily a byproduct of copper refining, production should increase again as copper production recovers to more normal levels. As indicated by falling prices, demand for selenium is weak, a situation that may continue at least until world economic conditions improve and perhaps even longer. However, the development of new uses could eventually strain the available supply. While higher prices would encourage improved recoveries, new copper production is increasingly derived from low-selenium ores. Selenium tends to volatilize and be emitted as SeO_2 gas during copper smelting, and up to half of the selenium content in copper ores is lost in this way. Recovery of much of this lost selenium is technically feasible, but significantly higher selenium prices would be necessary to make such recovery economic.

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
92804-4	Selenium	5	10	15	5

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
			(%)			
92804-4	10.0	10.0	10.0	10.0	9.9	9.2

UNITED STATES (MFN)		1982	1983	1984	1985	1986	1987
				(%)			
420.50	Selenium dioxide			Remains free			
420.52	Selenium salts			Remains free			
420.54	Other selenium compounds	4.5	4.4	4.2	4.0	3.9	3.7
632.40	Selenium metal, unwrought, other than alloys, waste and scrap			Remains free			
632.88	Selenium metal alloys, unwrought	7.7	7.3	6.8	6.4	5.9	5.5
633.00	Selenium metals, wrought	7.7	7.3	6.8	6.4	5.9	5.5

EUROPEAN ECONOMIC COMMUNITY (MFN)		1982	Base Rate	Concession Rate
28.04 C.11	Selenium	free	free	free

Sources: The Customs Tariff and Commodities Index, January 1982, Revenue Canada; Tariff Schedules of the United States Annotated (1982), USITC Publication 1200; U.S. Federal Register Vol. 44, No. 241; Official Journal of the European Communities, Vol. 24, No. L335, 1981.

Tellurium

Tellurium, like selenium, is recovered in Canada from the tankhouse slimes from the two electrolytic copper refineries and the Port Colborne nickel refinery. It is refined by the same two companies, Noranda Mines Limited's CCR Division at Montreal East, Quebec, and Inco Limited at Copper Cliff (Sudbury), Ontario. Although more "metallic" than selenium, tellurium resembles selenium and sulphur in chemical properties and, like selenium, is a semiconductor. Tellurium output is related to selenium output because tellurium is a coproduct of selenium recovery.

CANADA

Production of tellurium (all forms) in 1982 (19 000 kg) was down considerably from the 1981 level (Table 5). The large difference between production (all forms) and refined production in some years is attributable to market conditions; producers refine according to sales and stockpile any surplus in less processed forms. The lower production in 1982 was due to closure of the CCR and Inco copper refineries for part of the year.

CCR has an annual capacity of up to 27 200 kg of tellurium in powder, stick, lump and dioxide forms. The Copper Cliff refinery has an annual capacity of up to 8 200 kg of tellurium in the form of dioxide.

In 1982, Cominco Ltd. built a $3 million plant to expand its production of cadmium mercury telluride in the form of single crystals. When sliced into thin wafers and polished, this compound is used in a wide range of electronic devices that detect infrared radiation to provide optical images or data.

WORLD

Tellurium production of the non-communist world since 1977 has been generally higher than production levels during the preceding few years even taking into account the decline in production that has occurred since 1979. In 1982, the non-communist world, excluding the United States, produced 97 331 kg of refined tellurium compared with 103 170 kg in 1981 (Table 6). Production figures on a worldwide basis are not well documented, especially since United States tellurium production was last published in 1975. At that time, the United States accounted for 42 per cent of the production from reporting countries. The United States Bureau of Mines has predicted that 1983 U.S. domestic mine production will be 68 000 kg of byproduct tellurium. Major mine-producers of tellurium are the United States, Chile, the U.S.S.R. and Canada. In 1982, Japan, Peru and Canada had the highest refinery production of the reporting countries. Two companies refine tellurium in the United States: AMAX Copper, Inc., at Carteret, N.J.; and ASARCO Incorporated, at Amarillo, Texas. AMAX ceased production of tellurium at the end of 1982 because of copper mine cutbacks.

Apparent consumption in the United States in 1982 was 77 000 kg. A much smaller amount was consumed in 1980 and subsequent years as a result of the closure of a chemical plant in Texas, in 1979. This plant used a large quantity of tellurium as a catalyst for producing ethylene glycol (anti-freeze) but experienced problems with its patented tellurium process. U.S. consumption in 1981 was 85 000 kg.

PRICES

Most of the commercial-grade tellurium sold by the primary producers is in the form of slab, stick, lump, tablet and powder. It is also sold as copper-tellurium and iron-tellurium alloys. Normal commercial grades contain a minimum of 99 per cent or 99.5 per cent tellurium. Tellurium dioxide is sold in the form of minus 40 to minus 200-mesh powder containing a minimum of 75 per cent tellurium.

As a result of falling prices, producers suspended publication of tellurium prices on January 5, 1981, but it is understood that the producer price was about $US 14 a pound during 1982.

USES

Tellurium supply is related to copper production but the nature of demand justifies only a low rate of recovery. Tellurium and many of its compounds are highly toxic and great care is required in their handling. Major uses are as additions to ferrous and non-ferrous alloys to improve machineability or otherwise improve their metallurgical properties; however, bismuth is increasingly used as a substitute. Tellurium also performs an important role in the manufacture of rubber products, thermoelectric devices, catalysts, electronics, insecticides and germicides, delay blasting caps, glass, ceramics and pigments. The 1979 edition of this review contains a more detailed description of tellurium uses.

OUTLOOK

Supply of tellurium is largely limited to that available from copper output and, as in the case of selenium, new copper production is increasingly derived from tellurium-poor ores. In the short to medium term, demand is expected to grow slowly and supply should be adequate to meet requirements. However, as the total available supply of tellurium is even more limited than that of selenium, significant new uses of tellurium, such as in solar collectors, or as cadmium telluride in photovoltaic cells on which research is being carried out by the U.S. Department of Energy could result in the higher prices that would justify a higher percentage recovery from tellurium-bearing copper ores.

The decline in the world economic situation, substitution of other materials, and the closing of a chemical plant in the United States has led to a temporary oversupply of tellurium.

TABLE 5. CANADA, PRODUCTION AND CONSUMPTION OF TELLURIUM, 1970, 1975, 1978-82

	Production		Consumption
	All forms[1]	Refined[2]	Refined[3]
	(kilograms)		
1970	26 459	29 317	399
1975	19 854	42 253	..
1978	31 421	45 299	..
1979	42 433	47 204	..
1980	15 011	8 974	..
1981	31 145	21 297	..
1982P	19 000	15 684	..

[1] Includes recoverable tellurium content of blister copper treated, plus refined tellurium from domestic primary materials. [2] Refinery production from all sources, including imported material and secondary sources. [3] Consumption (tellurium content), as reported by consumers.
P Preliminary; .. Not available, withheld to avoid disclosing company data.

TABLE 6. NON-COMMUNIST WORLD REFINERY PRODUCTION OF TELLURIUM, 1980-82

	1980	1981	1982e
	(kilograms)		
Japan	79 830	59 874	58 967
Hong Kong[2]	-	-	..
Peru	21 770	21 772	22 226
Canada	8 974	21 297	15 684
Fijie	11 350	-	..
India	200	227	454
Totale[1]	122 124	103 170	97 331

Sources: U.S. Bureau of Mines, Mineral Commodity Summaries, 1982 and 1983; Energy, Mines and Resources Canada.

[1] Available data. United States withholds its figures to avoid disclosing company data, but accounted for 42 per cent of world output in 1975. [2] Revised to zero from figures previously published.
e Estimated; .. Not available; - Nil.

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
92804-5	Tellurium metal	5	10	15	5

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
			(%)			
92804-5	10.0	10.0	10.0	10.0	9.9	9.2

UNITED STATES (MFN)		1982	1983	1984	1985	1986	1987
					(%)		
427.12	Tellurium salts	4.4	4.4	4.4	4.4	4.4	4.4
421.90	Tellurium compounds	4.5	4.4	4.2	4.0	3.9	3.7
632.48	Tellurium metals, unwrought other than alloys, and waste and scrap	2.5	2.0	1.5	1.0	0.5	free
632.88	Tellurium metal alloys, unwrought	7.7	7.3	6.8	6.4	5.9	5.5
633.00	Tellurium metal, wrought	7.7	7.3	6.8	6.4	5.9	5.5

EUROPEAN ECONOMIC COMMUNITY	1982	Base Rate	Concession Rate
28.04 C.111 Tellurium metal	2.3	2.4%	2.1%

Sources: The Customs Tariff and Commodities Index, January 1982, Revenue Canada; Tariff Schedules of the United States Annotated (1982), USITC Publication 1200; U.S. Federal Register Vol. 44, No. 241; Official Journal of the European Communities, Vol. 24, No. L335, 1981, GATT Documents, 1979.

Silica

B.W. BOYD

Silica production in Canada peaked in 1979 and has been in decline since then. The greatest impact was in Ontario where the closing of Inco Limited's smelter at Copper Cliff at mid-year 1982 eliminated their requirement for 'own make' smelter flux. Indusmin Limited, the largest producer of silica in Ontario, also suffered a severe reduction in sales so that shipments in 1982 were less than 50 per cent of the 1979 level. For Canada as a whole, shipments fell by 24 per cent over the three years.

Imports and exports of silica sand were lower in 1982 than in 1981 as total consumption in North America was reduced.

CANADIAN SCENE

Newfoundland. Dunville Mining Company Limited, a subsidiary of ERCO Industries Limited, continued to produce silica from a quarry at Villa Marie with no significant changes in their 1982 operations.

Nova Scotia. Nova Scotia Sand and Gravel Limited processed silica sand suitable for sand-blasting, glass, fibreglass and filter sands, from their plant in Shubenacadie. Most of the product was marketed in the four Atlantic provinces. Crushing facilities for beneficiation of sand for flint glass were completed in 1982. Sales in 1982 were down by a large margin and at least one former customer went bankrupt due to the recession.

New Brunswick. Chaleur Silica Ltd. continued to quarry sandstone at Bass River. In September of 1981, an extension on the washing plant was completed and sales improved in 1982 with shipments to new customers. A drilling program initiated in 1982 proved up new reserves of high quality silica sand.

Quebec. Indusmin Limited continued to produce from their St. Donat and St. Canut operations. According to Indusmin's Annual Report for 1982, sales and revenues were lower than in 1981 because of reduced requirements from the glass industry and a strike at the plant of a major customer.

Baskatong Quartz Inc. operated 2 high-purity silica deposits in 1982, one near Le Petit Lac Malbaie in Charlevoix County and the other at St. Ludger in Frontenac County. The material is supplied to the SKW Canada Inc. ferrosilicon plant at Bécancour.

Armand Sicotte & Sons Limited produced coarse grade silica from their quarry near Ste-Clotilde. The company is considering penetration of glass and sand-blasting markets in northeastern United States.

The Union Carbide Canada Limited quartzitic sandstone quarry at Melocheville, Beauharnois County, was not operated during 1982. The metallurgical plants at Beauharnois and Chicoutimi were supplied from inventory and other producers.

Sable de Silice Crémazie Inc. took over operations of Montreal Silica Mines Ltd. and Usinage de Silice Champlain Limitée in March 1982. Unconsolidated Pleistocene sands near Ormstown provide feed for its washing and screening plant.

Ontario. Indusmin Limited continued to quarry a high-grade silica deposit on Badgeley Island in Georgian Bay and to operate their grinding and processing plant at Midland. Sales of excess fines increased in 1982 as new markets for this material were found. The company's exploration efforts in the Badgeley Island area located further reserves of high quality quartzite.

The Comet Quartz Limited property near Madawaska in the Algonquin Park area did not produce in 1982. The company considers it a high-purity quartz deposit with potential for the cultured quartz market and for the solar grade silicon industry.

B-Mac Silicon Aggregates Ltd. produced sand for foundries and for sand-blasting from their quarry at Bracebridge.

TABLE 1. CANADA, SILICA PRODUCTION AND TRADE, 1981 AND 1982

	1981		1982P	
	(tonnes)	($)	(tonnes)	($)
Production, quartz and silica sand				
By province				
Quebec	694 000	12,950,000	706 000	13,781,000
Ontario	901 000	10,969,000	482 000	8,292,000
Alberta	..	3,173,000	..	3,088,000
Manitoba	198 000	2,284,000	164 000	2,688,000
Nova Scotia	..	2,334,000	..	1,401,000
New Brunswick	..	1,000,000	..	1,400,000
Saskatchewan	142 000	1,169,000	97 000	1,049,000
Newfoundland	..	768,000	..	1,632,000
British Columbia	..	46,000	..	36,000
Total	2 238 000	34,693,000	1 797 000	33,367,000
By use				
Glass and fiberglass	489 000	12,542,000	..	..
Flux	837 000	4,054,000	..	..
Ferrosilicon	339 000	3,193,000	..	..
Other uses[1]	573 000	14,904,000	..	..
Total	2 238 000	34,693,000	1 797 000	33,367,000
Imports				
Silica sand				
United States	1 142 801	18,467,000	788 468	15,475,000
United Kingdom	79	3,000	-	-
Other countries	-	-	300	120,000
Total	1 142 880	18,470,000	788 768	15,595,000
Silex and crystallized quartz				
United States	251	319,000	229	265,000
Japan	-	-	1	1,000
West Germany	-	-	10	15,000
Brazil	-	-	1	1,000
Total	251	319,000	241	282,000
Firebrick and similar shapes, silica				
Japan	9 646	4,489,000	19	10,000
United States	3 679	2,189,000	2 584	2,021,000
France	106	133,000	219	254,000
West Germany	175	130,000	52	49,000
Other countries	156	146,000	110	72,000
Total	13 762	7,087,000	2 984	2,406,000
Exports				
Quartzite				
United States	119 347	1,107,000	65 314	566,000
Other countries	-	-	19	2,000
Total	119 347	1,107,000	65 333	568,000

Source: Statistics Canada; Energy, Mines and Resources Canada.
[1] Includes foundry use, sand blasting, silica brick, concrete products, chemical manufacture, building products and silicon carbide.
P Preliminary; - Nil; .. Not available.

TABLE 2. CANADA, SILICA PRODUCTION AND TRADE, 1970, 1975, 1978-82

	Production	Imports			Exports	Consumption
Year	Quartz and Silica Sand	Silica Sand	Silex or Crystallized Quartz	Firebrick and Similar Shapes	Quartzite	Quartz and Silica Sand
			(tonnes)			
1970	2 937 498	1 176 199	186	2 020	58 917	3 979 305
1975	2 491 715	1 044 160	1 550	18 818	39 977	3 510 818
1978	2 245 136	1 242 444	1 955	6 948	67 775	2 987 736
1979	2 368 497	1 651 890	1 259	4 896	60 823	3 611 815r
1980	2 252 000	1 200 237	281	4 775	63 166	4 512 637
1981	2 238 000	1 142 880	251	13 762	119 347	3 983 751
1982P	1 797 000	788 768	241	2 984	65 333	..

Sources: Statistics Canada; Energy, Mines and Resources Canada.
P Preliminary; .. Not available; r Revised.

Manitoba. Steel Brothers Canada Ltd. continued to operate one of the purest deposits of silicon dioxide in North America, at Black Island in Lake Winnipeg. Production volume decreased again in 1982 reflecting the drop in consumption by the glass industry. Markets are mainly in western Canada but shallow inroads are being made in the United States market. No major changes were made in plant facilities in 1982 and the company remained fully operational throughout the year.

Alberta. Sil Silica, now a division of Strathcona Resource Industries Ltd., quarried Pleistocene dune sands at Bruderheim, 65 km northeast of Edmonton. The company remained operational in 1982 but production was affected by lower demand in the housing and oil industries.

British Columbia. Outside of Golden, Mountain Minerals Co. Ltd. processed friable Mt. Wilson quartzite to produce a glass grade silica sand. Coarser material was sold for silicon carbide use. Near Nicholson, south of Golden, a massive quartzite of the same unit was quarried by B. Miller Inc. and exported to Washington state. Contech Enterprises Ltd. worked a quartz vein near Chase, east of Kamloops, also for the export market.

On a smaller scale, International Marble & Stone Company Ltd. in Sirdar and Pacific Silica Products of Osoyoos produced crushed and sized silica products.

TABLE 3. CANADA, ESTIMATED CONSUMPTION OF SILICA, BY INDUSTRIES, 1980 AND 1981

	1980	1981
	(tonnes)	
Foundry sand	1 366 152r	1 085 481
Glass manufacture (including glass fibre)	968 019	951 442
Smelter flux[1]	1 192 868r	837 203
Refractory brick mixes, cements	512 416	359 163
Artificial abrasives	130 461	125 706
Metallurgical	67 812	143 447
Chemicals	38 603	39 430
Gypsum products	8 850	2 314
Concrete products	63 254	211 608
Fertilizer, stock poultry feed	4 172	3 982
Other[2]	160 030	223 975
Total	4 512 637r	3 983 751

[1] Producers' shipments of quartz and silica for flux purposes. [2] Includes asbestos products, ceramic products, frits and enamels, paper and paper products, roofing and other minor uses.
r Revised.

At various base-metal smelters across Canada, companies made use of cheaper local deposits of lower-grade silica in preference to higher cost higher-purity silica that must be hauled from a distance.

TRADE

The amount of quartzite exported to the United States in 1982 returned to the level of 1980 and previous years leaving the higher exports in 1981 as a brief anomaly. Imports of all grades of silica were down significantly as expected with the general slump in demand.

OUTLOOK

There are indications that the Canadian silica industry is awaiting the end of current recessionary conditions to undergo a period of significant growth. These would include: investigations of promising silica deposits in Manitoba, stimulation of interest in several deposits in eastern Ontario, development plans for the silica sands of Îles de la Madeleine by Magdalen Silica Inc. and continuing examination of properties north of Baie Saint-Paul in Quebec by the Société québécoise d'exploration minière (SOQUEM).

Since roughly 40 per cent of the silica produced is consumed as smelter flux, a major portion of the silica market is dependent on recovery of the nonferrous smelting industry. Amounts of silica consumed in the manufacture of glass and glass fibre, as well as in foundry sand, can be expected to increase as the markets for these products improve.

In the long term, growth should be possible as research and technological advances are made in the fields of fibre optics, solar grade silicon and quartz culture.

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
29500-1	Ganister and sand	free	free	free	free
29700-1	Silex or crystallized quartz, ground or unground	free	free	free	free

UNITED STATES

513.14	Sand, other	free
514.91	Quartzite, whether or not manufactured	free
523.11	Silica, not specially provided for	free

		1982	1983	1984	1985	1986	1987
		¢ per long ton					
513.11	Sand containing 95% or more silica, and not more than 0.6% of oxide of iron	16	12	9	6	3	free

Sources: The Customs Tariff and Commodities Index, January 1982, Revenue Canada; Tariff Schedules of the United States Annotated 1982, USITC Publication 1200; U.S. Federal Register Vol. 44, No. 241.

Silicon, Ferrosilicon and Silicon Carbide

D.G. LAW-WEST

SILICON, FERROSILICON, SILICON CARBIDE AND FUSED ALUMINA

Silicon is the second most abundant element in the earth's crust and world resources of this metal are almost inexhaustible. Silica deposits (SiO_2) are the main commercial source of silicon. The production of silicon metal, ferrosilicon and silicon carbide from silica ores requires large amounts of electricity and, therefore, production plants are usually situated in areas with an abundant supply of electrical power. In Canada, these silicon products are manufactured in plants in Quebec and southern Ontario.

CANADA

The Canadian ferrosilicon and silicon metal industry is concentrated in Quebec where large supplies of hydroelectric power and raw materials are available. There were three producers of primary ferrosilicon in 1982, two of which produced silicon metal. Byproduct ferrosilicon was also produced in the manufacture of fused aluminum oxide abrasives.

Ferrosilicon is offered for sale in several grades, expressed in terms of per cent contained silicon. The more common grades of 50 and 75 per cent are produced for consumption by the steel industry. Byproduct ferrosilicon usually grades below 20 per cent; the most common use for this material is in the flotation circuit of mineral processing operations.

SKW Canada Inc. was the only domestic producer to operate at capacity throughout the year. Production from its plant at Bécancour, Quebec during 1982 amounted to 25 000 t of 75 per cent grade ferrosilicon and 25 000 t of silicon metal. SKW exports most of its output, mainly to the United States, Japan and West Germany.

Union Carbide Canada Limited closed its ferrosilicon and silicon metal operation at Beauharnois, Quebec on May 2, 1982, mainly because of weak demand from the steel industry. The closure affected some 185 employees who were laid off for an indefinite time. The plant contains four furnaces, of which only one had been operating at the time of closure. Union Carbide continued to operate its ferrosilicon plant at Chicoutimi, Quebec where 26 000 t of 75 per cent grade and some 50 per cent grade were produced. Except for a transformer failure early in the year, the plant operated at capacity during 1982.

Chromasco Limited cut back production at its Beauharnois ferrosilicon operation by about 50 per cent during the year and, as a result, the company reduced its labour force from 350 to 200 employees. In 1982, the company produced approximately 24 000 t of 50, 75 and 85 per cent grade ferrosilicon.

The availability of electrical energy also enables Canada to produce and export bulk quantities of synthetic abrasives such as silicon carbide (SiC) and fused alumina (Al_2O_3). Producers of these abrasives are located in Quebec and Ontario. The Quebec-based companies, with products shown in brackets, are: Carborundum Canada Inc., Shawinigan (SiC); Norton Company (SiC) and Electro Refractories & Abrasives Canada Ltd., both in Cap-de-la Madeleine (SiC); and Unicorn Abrasives of Canada Limited, Arvida (Al_2O_3). The Ontario-based companies are: Carborundum Canada Inc. (Al_2O_3), Norton Company (Al_2O_3 and SiC) and Usigena (Canada) Limited (Al_2O_3 and SiC), all of Niagara Falls; and The Exolon Company of Canada, Ltd., Thorold (Al_2O_3 and SiC). All Canadian production of synthetic abrasives is exported, principally to the United States where the bulk material is crushed, screened and classified. A small part of the processed material is reimported for the production of bonded abrasives such as abrasive wheels and coated abrasives such as sandpaper.

USES

Silicon metal is used mainly as an alloying agent for aluminum. It increases fluidity

TABLE 1. CANADA, FERROSILICON, SILICON CARBIDE AND OTHER FERROALLOYS[1], EXPORTS AND IMPORTS, 1981 AND 1982

	1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)
Exports				
Ferrosilicon				
Japan	24 717	18,595	22 340	15,268
United States	23 687	14,571	14 457	10,473
South Korea	1 102	1,149	2 543	2,321
West Germany	286	335	434	551
Australia	388	437	197	218
United Kingdom	774	433	601	173
Turkey	440	286	-	-
Thailand	276	210	-	-
Other countries	740	706	255	206
Total	52 410	36,722	40 827	29,210
Silicon carbide, crude and grains				
United States	65 810	33,772	57 848	30,846
Japan	1 334	823	1	23
Other Countries	-	-	35	23
Total	67 144	34,595	57 884	30,892
Ferroalloys, nes				
United States	3 098	8,570	2 603	4,050
United Kingdom	1 703	220	2 154	321
South Korea	27	33	21	286
Taiwan	31	425	22	277
Mexico	28	49	52	86
Japan	144	32	122	27
Algeria	122	169	-	-
Other countries	163	39	84	78
Total	5 316	9,537	5 058	5,125
Imports				
Ferrosilicon				
United States	14 419	12,072	9 390	10,462
France	451	642	175	244
Brazil	397	459	214	237
Norway	3 209	2,292	38	41
Venezuela	150	138	9	9
Other Countries	3	2	34	36
Total	18 629	15,605	9 860	11,029
Silicomanganese, including silico spiegel				
Norway	2 476	1,601	1 537	866
South Africa	4 563	2,167	960	482
United States	4 396	3,740	380	372
Brazil	1 200	567	-	-
Other Countries	34	21	-	-
Total	12 669	8,096	2 877	1,720
Ferroalloys, nes				
United States	4 037	7,891	2 926	5,033
Brazil	1 172	11,839	433	3,814
France	1 853	4,057	1 082	2,132
Chile	226	3,397	37	459
Greece	9 840	14,911	-	-
People's Republic of China	100	1,336	-	-
Other countries	576	2,650	328	720
Total	17 804	46,081	4 806	12,158

Source: Statistics Canada.
[1] Other important ferroalloys are discussed in the manganese, nickel and titanium reviews for 1982.
P Preliminary; - Nil; nes Not elsewhere specified.

TABLE 2. CANADA, CONSUMPTION, EXPORTS, IMPORTS AND PRODUCTION OF FERROSILICON, 1970, 1975, 1978-82

	Consumption[1]	Exports		Imports		Production[2]
	(tonnes)	(tonnes)	($ 000)	(tonnes)	($ 000)	(tonnes)
1970	50 556	45 345	8,284	9 477	2,386	86 424
1975	54 904	29 029	8,075	26 353	15,665	57 580
1978	63 931	60 146	27,053	10 487	7,890	113 590
1979	61 928	40 732	21,962	19 855	14,041	82 805
1980	63 321	52 164	33,866	18 508	13,869	96 977
1981	62 090	52 410	36,722	18 629	15,605	95 871
1982P	..	40 827	29,210	9 860	11,029	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Consumption as reported by consumers. [2] Consumption plus net exports equals derived production.
P Preliminary; .. not available.

and corrosion resistance as well as thermal and electrical conductivity. In addition, silicon metal reduces the specific density and thermal expansion of aluminum alloys. These alloys are used principally to make aluminum castings, and contain on average about 6 per cent silicon. More than one-half of the cast aluminum tonnage is used in the transportation industry. Another important use of silicon metal is in the fabrication of silicones, which are used in oil production and for the manufacture of more than 200 products, including synthetic rubber resins and electric motor insulation. Silicon metal is also used to make silicon bronze, aluminum alloys for coating steel sheets, semiconductor electronic devices and silicon nitride (Si_3N_4).

The iron and steel industry is the largest user of ferrosilicon and other silicon alloys such as silicocalcium, silicochrome and silicomanganese. Ferrosilicon functions primarily as a deoxidizer in molten steel. In addition, it is used as a graphite promoter during the production of carbon steels, as an additive to improve the electrical properties of electric steels and as a reducing agent in the manufacture of non-ferrous alloys. Carbon steel contains on average 0.755 kilograms (kg) of silicon per t of steel, and consumes about one-third of Canadian ferrosilicon production. Stainless steels and electric steels, which contain an average of 10 and 20 kg of silicon respectively per t of steel, and other types of steel consume the remaining two-thirds. Ferrosilicon is also used in the silicothermic process for the production of other metals, but only small tonnages are required for this purpose.

OUTLOOK

The outlook for Canadian ferrosilicon and silicon metal production during 1983 is not expected to change from 1982. Two of the three operating plants are expected to

TABLE 3. CANADA, MANUFACTURERS' SHIPMENTS OF CRUDE SILICON CARBIDE 1970, 1975, 1977-81

	(tonnes)	($ 000)
1970	104 113	17,653
1975	89 346	24,597
1977	104 011	36,965
1978	106 763	38,763
1979	101 265	44,108
1980	86 353	46,897
1981	89 977	50,758

Source: Statistics Canada.

TABLE 4. CANADA, EXPORTS OF SILICON CARBIDE, CRUDE AND GRAINS 1970, 1975, 1978-82

	(tonnes)	($ 000)
1970	96 159	15,976
1975	78 615	17,441
1978	107 351	33,818
1979	84 436	31,258
1980	72 414	33,244
1981	67 144	34,595
1982P	57 884	30,892

Source: Statistics Canada.
P Preliminary.

TABLE 5. CANADA, MANUFACTURERS' SHIPMENTS OF CRUDE FUSED ALUMINA 1970, 1975, 1977-81

	(tonnes)	($ 000)
1970	131 364	18,088
1975	110 736	26,162
1977	139 859	41,977
1978	154 303	49,916
1979	152 118	51,206
1980	146 655	56,957
1981	149 840	57,949

Source: Statistics Canada.

TABLE 6. CANADA, EXPORTS OF FUSED ALUMINA, CRUDE AND GRAINS, 1970, 1975, 1978-82

	(tonnes)	($ 000)
1970	152 572	23,234
1975	127 658	26,650
1978	167 344	48,830
1979	183 124	55,138
1980	166 328	55,867
1981	157 993	67,954
1982P	114 553	55,492

Source: Statistics Canada.
P Preliminary.

remain at capacity rates of production except for normal maintenance outages. This will result in stock accumulation while the market remains weak. While the industry at year-end was optimistic on an improved market situation by late 1983, there was still no evidence for a strong recovery in the world steel industry, the primary market for ferrosilicon and silicon products.

Potential areas for expanding silicon metal consumption include the electronics industry where high purity silicon metal is used to produce silicones; the alloy industry, where silicon has scope to substitute for other metals; and the solar energy field, where silicon alloys are widely used in heat exchanger systems.

PRICES

As published by **METALS WEEK** in December 1981 and 1982

		1981	1982
		(¢US)	
Ferrosilicon, U.S. producer, per pound of silicon content; lump bulk lots, fob shipping point			
High-purity 75% Si		53.25	47.00
Regular 50% Si		49.25	45.00
Silicon metal, per pound contained silicon, fob shipping point, lump, bulk and carload lots,			
(% max. Fe)	(% max. Ca)		
0.35	0.07	72.40	66.80
0.50	0.07	70.20	64.50
1.00	0.07	67.50	62.00

Prices published by **AMERICAN METAL MARKET** in December 1981 and 1982

	1981	1982
	(¢US)	
SMZ alloy: 60-65% Si, 5-7% Mn, 5-6% Zr, ½ in. x 12 M, per pound of alloy	53.25	53.25
Calcium-silicon and calsibar alloy, fob producer, 15-ton lots, per pound	82.00	66.00

PRICES (cont'd)

	1981	1982
	($US)	
Electric furnace silvery pig iron,		
fob Keobuck, Iowa		
16% Si, per ton	210.00	220.00
20% Si, per ton	237.00	249.00

Prices published by **INDUSTRIAL MINERALS** in December 1981 and 1982

(tonnes, cif main European port)	1981	1982
	(£)	
Fused alumina, 8-220 mesh, cif		
Brown, min. 94% Al_2O_3	380-400	350-420
White, min. 99.5% Al_2O_3	450-500	410-500
Silicon carbide, 8-220 mesh, cif		
Black, about 99% SiC - Grade 1	650-690	650-700
- Grade 2	620-640	580-680
Green, over 99.5% SiC	830-870	850-950

fob Free on board; cif Cost, insurance and freight.

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(cents)		
37502-1	Silicomanganese - silico spiegel and other alloys of manganese and iron containing more than 1%, by weight, of silicon per pound or fraction thereof, on the manganese contained therein	free	0.74	1.75	free
37503-1	Ferrosilicon, being an alloy of iron and silicon containing 8% or more, by weight of silicon and less than 60%, per pound or fraction thereof, on the silicon contained therein	free	free	1.75	free
37504-1	Ferrosilicon, being an alloy of iron and silicon containing 60% or more, by weight, of silicon and less than 90%, per pound or fraction thereof, on the silicon contained therein	free	0.74	2.75	free
37505-1	Ferrosilicon, being an alloy of iron and silicon containing 90% or more, by weight, of silicon per pound or fraction thereof, on the silicon contained therein	free	2.4	5.5	free
92804-1	Silicon metal	10%	12.8%	25%	8.5%
92815-4	Silicon sulphide	10%	12.8%	25%	8.5%

CANADA (cont'd)

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
			(cents)			
37502-1	0.74	0.73	0.73	0.72	0.71	0.7
37504-1	0.74	0.73	0.73	0.72	0.71	0.7
37505-1	2.4	2.3	2.3	2.2	2.1	2.0
			(%)			
92804-1	12.8	12.1	11.4	10.7	9.9	9.2
92815-4	12.8	12.1	11.4	10.7	9.9	9.2

UNITED STATES (MFN)

519.21	Crude silicon carbide	free
519.37	Silicon carbide in grains, ground, pulverized or refined	0.3¢
606.35	Ferrosilicon, containing 8-60% silicon	free
606.42	Ferrosilicon chromium	10%

		1982	1983	1984	1985	1986	1987
		(% unless otherwise specified)					
606.36	Ferrosilicon, containing 60-80% silicon and over 3% calcium	per lb. on Si content 1.1	1.1	1.1	1.1	1.1	1.1
606.37	Other ferrosilicon containing 60-80% silicon	1.6	1.6	1.6	1.6	1.5	1.5
606.39	Ferrosilicon containing 80-90% silicon	1.9	1.9	1.9	1.9	1.9	1.9
606.40	Ferrosilicon containing over 90% silicon	9.3	8.6	7.9	7.2	6.5	5.8
606.44	Ferrosilicon manganese	per lb. on Mn content 5.2	5.0	4.7	4.4	4.2	3.9

EUROPEAN ECONOMIC COMMUNITY (MFN)

		1982	Base Rate	Concession Rate
			(%)	
28.13	Silicon dioxide	5.7	6.4	4.6
73.02	Ferrosilicon	9.4	10.0	6.2
	Ferrosilico-manganese	5.5	5.5	5.5
	Ferrosilico-chrome	6.7	7.0	4.9

JAPAN (MFN)

28.04	Silicon - single crystal	9.0	15.0	7.2
	- other	5.3	7.5	4.9
28.56	Silicon carbide	5.3	7.5	4.9
68.06	Abrasive paper	8.6	15.0	6.5
73.02	Ferrosilicon	3.8	5.0	3.7

Sources: The Customs Tariff and Commodities Index, January 1982, Revenue Canada; Tariff Schedules of the United States Annotated (1982), USITC Publication 1200; U.S. Federal Register Vol. 44, No. 241; Customs Tariff Schedules of Japan, 1982; Official Journal of the European Communities, L335, Vol. 24.

Silver

S.A. HAMILTON

The weakness in the world economy was responsible for a depressed price for silver in 1982, especially at mid-year, when prices declined to 1978 levels. Lower interest rates and expectations of a further decline, plus renewed speculative activity resulted in some price improvement toward the end of the year. Although weak silver prices forced closure of some silver producing mines and curtailed output at others, estimated world silver output in 1982 was about the same as the 11 354 t produced in 1981. A number of mines scheduled for production in the next few years have been placed on hold until the price increases and shows some signs of stability. In Canada the main casualties of low silver prices were United Keno Hill Mines Limited in the Yukon, one of Canada's major silver producers over the last half century, which closed indefinitely and the property of Cadillac Explorations Limited in the Laird River region in the Northwest Territories where production was postponed.

CANADIAN DEVELOPMENTS

Canada's primary production of silver was 1 204 000 kg in 1982 compared with 1 129 394 kg in 1981 (Table 1). Despite the depressed state of base-metals markets and low silver prices which forced some silver and base-metal mines to close, others to suspend production for short to indefinite periods and still others to curtail tonnage treated, silver production in 1982 increased by about 6.6 per cent over the previous year. Higher silver production from the larger base-metal mines which generally had normal operations during the year was the main reason for increased output.

The dollar value of silver produced in Canada declined from $458.1 million in 1981 to $378.8 million in 1982 because of a 24 per cent decline in the yearly average silver price.

Consumption of silver in Canada in 1982 for all uses including coinage is estimated at 289 000 kg compared with 292 130 kg in 1981. About 9 070 kg was used by the Royal Canadian Mint in the production of a numismatic silver dollar coin to commemorate the 100th anniversary of the founding of the city of Regina, the capital of Saskatchewan. The coins assay 50 per cent silver and contain 11.66 g of silver each.

Canada's export of silver in ores and concentrates and as refined metal totalled 1 736 757 kg in 1982, 18.9 per cent above 1981 (Table 1). Canada's main market continued to be the United States which took over 74 per cent of total exports in 1982, the remainder going mostly to Japan and Belgium-Luxembourg. Over 99 per cent of Canada's refined metal exports in 1982 were made to the United States.

British Columbia was the leading silver-producing province in 1981, primarily because of Equity Silver Mines Limited production, followed by Ontario and New Brunswick. These three provinces accounted for about 87 per cent of Canada's total silver output.

The principal source of silver was as a byproduct of base-metal ores, which accounted for over 76 per cent of the total output. The remainder was derived from mines whose primary product was silver and from lode and placer gold ores. The principal producers of silver in Canada are listed in Table 3.

The largest producers of silver in Canada in 1982, in declining order of output, were Equity Silver Mines Limited in north-central British Columbia, Brunswick Mining and Smelting Corporation Limited in New Brunswick, Kidd Creek Mines Ltd. at Timmins, Ontario and Cominco Ltd. (Sullivan mine) in British Columbia. The Cobalt district in Ontario, once the major silver producing district, is now relatively minor.

METAL PRODUCTION IN CANADA

Production of refined silver in 1982 at six Canadian primary silver refineries is shown in Table 4.

TABLE 1. CANADA, SILVER PRODUCTION, TRADE AND CONSUMPTION, 1981 AND 1982

	1981		1982P	
	(kilograms)	($000)	(kilograms)	($000)
Production[1]				
By province and territories				
British Columbia	401 887	163,024	458 000	144,111
Ontario	324 535	131,646	345 000	108,448
New Brunswick	192 817	78,215	243 000	76,310
Yukon	79 721	32,339	70 000	22,141
Quebec	57 960	23,511	54 000	16,967
Manitoba	25 732	10,438	25 000	7,973
Saskatchewan	5 567	2,258	4 000	1,405
Northwest Territories	33 193	13,465	4 000	1,181
Newfoundland	7 146	2,899	1 000	225
Alberta	5	2	--	--
Nova Scotia	831	337	-	-
Total	1 129 394	458,134	1 204 000	378,761
By source[2]				
Base-metal ores	914 898	371,125	918 000	288,790
Gold ores	10 582	4,292	19 000	5,977
Silver ores	199 412	80,891	267 000	83,994
Placer gold ores	4 502	1,826	..	..
Total	1 129 394	458,134	1 204 000	378,761
Refined silver[3]	875 121	..	790 358	..
Exports				
Silver in ores and concentrates				
Japan	218 631	67,556	217 235	48,672
United States	129 361	38,242	163 102	38,531
Belgium-Luxembourg	137 319	33,662	97 476	17,453
Mexico	-	-	45 833	16,299
Portugal	-	-	28 166	7,364
West Germany	17 704	4,001	21 157	2,797
Sweden	9 087	3,478	7 502	2,326
Other countries	34 347	8,895	22 065	3,237
Total	546 449	155,834	602 536	136,679
Refined metal				
United States	908 245	389,428	1 125 563	367,968
United Kingdom	3 136	1,290	5 434	1,686
Trinidad-Tobago	400	182	538	186
Other countries	3 019	1,029	2 686	538
Total	914 800	391,929	1 134 221	370,378
Imports				
Silver in ores and concentrates				
United States	58 927	20,976	40 989	10,642
Chile	6 330	1,477	25 736	8,019
South Africa	35 240	8,585	31 399	5,933
South Korea	3 533	1,158	22 767	5,535
Other countries	21 317	7,364	22 751	5,349
Total	125 347	39,560	143 642	35,478
Refined metal				
United States	284 470	112,596	256 280	76,606
United Kingdom	2 643	484	207 854	64,287
Chile	4 000	1,679	15 998	4,673
Mexico	15 070	5,878	3 110	885
Others	21 145	4,120	944	273
Total	327 328	124,757	484 186	146,724

TABLE 1. (cont'd.)

	1981		1982P	
	(kilograms)	($000)	(kilograms)	($000)
Consumption, by use				
Sterling	32 247	..	..	..
Silver alloys	41 105	..	..	..
Wire rod	3 527	..	..	..
Others[4]	215 251	..	..	..
Total	292 130	..	..	..

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. [2] Estimated by Energy, Mines and Resources Canada; the base-metal category includes production of some mines normally regarded as silver producers, but which also recover some base-metal. [3] From all sources, domestic and imported materials of both primary and secondary origin. [4] Includes sheet, coinage fabricated investment bars and miscellaneous uses.
P Preliminary; - Nil; .. Not available: -- Amount too small to be expressed.

TABLE 2. CANADA, SILVER PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975, AND 1978-82

	Production		Exports			Imports,	Consumption[3]
	All Forms[1]	Refined[2] Silver	In Ores and Concentrates	Refined Silver	Total	Refined Silver	Refined Silver
				(kilograms)			
1970	1 376 354	955 668	678 676	752 689	1 431 365	134 347	187 679
1975	1 234 642	931 540	471 410	713 566	1 184 976	420 078	642 089
1978	1 266 927	1 026 998	482 793	1 070 284	1 553 077	36 001	329 320
1979	1 146 908	949 778	415 726	911 146	1 326 872	38 308	251 985
1980	1 070 000	985 051	396 690	881 761	1 278 451	339 180	265 938
1981	1 129 394	875 121	546 449	914 800	1 461 249	327 328	292 130
1982P	1 204 000	790 358	602 536	1 134 221	1 736 757	484 186	..

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. [2] From all sources, domestic and imported materials of both primary and secondary origin. [3] In some years includes only partial consumption for coinage.
P Preliminary; .. Not available.

Canadian Copper Refiners Limited at Montreal East, Quebec, was Canada's largest producer of refined silver, mainly from the treatment of copper anodes and blister copper and the further refining of lower-grade silver bullion. The silver refinery of Cominco Ltd. at Trail, British Columbia, was the second largest producer, recovering by-product silver in the processing of its own ores, as well as custom lead, zinc and silver ores and concentrates. Other producers of refined silver were Inco Metals Company at Copper Cliff, Ontario (from nickel-copper concentrates), and the Royal Canadian Mint at Ottawa, Ontario (from gold bullion). At Cobalt, Ontario, Canadian Smelting & Refining (1974) Limited recovered silver from silver-cobalt ores and concentrates produced in that area. At Belledune, New Brunswick, the Smelting Division of Brunswick Mining and Smelting Corporation Limited recovered byproduct silver from lead concentrates treated in a blast furnace.

At its electronic materials plant at Trail, Cominco also produces a high-purity silver metal with metallic impurities totalling one part per million or less. This specialty metal product is manufactured mainly for applications such as solder preforms, brazing preforms and lead wire in the electronics industry.

MINE DEVELOPMENTS IN CANADA

Atlantic provinces

Silver production in the Atlantic provinces in 1982 was approximately 27.6 per cent higher than in 1981. Increased silver production from the base-metal mine of Brunswick Mining and Smelting Corporation Limited in New Brunswick, one of the major Canadian silver producers, was the main reason for higher silver output in the area.

In Newfoundland, Consolidated Rambler Mines Limited, a copper producer, depleted its reserves and closed its mine at the end of April. ASARCO Incorporated closed the mill at its Buchans mine and is carrying out an underground exploration program on a new zone to determine if economic reserves can be developed.

Quebec

Silver production in Quebec, derived mainly from base-metal ores, showed a small decrease in 1982 from the previous year. Lost silver production from mine closures, both permanent and temporary, and production cutbacks were partly offset by output from Les Mines Selbaie which recorded its first full year of production.

Lemoine Mines Limited, a subsidiary of Northgate Exploration Limited, a substantial silver producer, and Madeleine Mines Ltd. depleted their ore reserves and closed in 1982.

Ontario

Ontario is one of the major silver producing provinces in Canada. Output increased in 1982 largely because of increased production from Kidd Creek Mines Ltd. and Noranda Mines Limited group of mines in the Sturgeon Lake area. The temporary suspension of operations at the nickel mines in the Sudbury area because of a worldwide surplus of nickel affected output somewhat. Kidd Creek Mines, in the Timmins area, is one of the major silver producers in Canada, and operations in 1982 were normal except for a short period at the end of the year.

In the past the Cobalt district was a major silver producer but today two companies account for a relatively small silver output. Reserves at the Silverfields property of Teck Corporation are limited but the company is actively exploring the optioned adjoining property of Consolidated Summit Mines Limited, for additional mill feed. Under Ontario government approval the company is exporting its silver concentrate for treatment.

In March, Agnico-Eagle Mines Limited purchased the precious metal smelter and refinery of Canadian Smelting & Refining (1974) Limited (CSR) at Cobalt from Sulpetro Minerals Limited for $2.1 million. The company operates a number of silver mines in the Cobalt area and shipped its concentrate to the CSR plant until July 1981, when shipments were stopped because an agreement could not be reached on a new contract. Following its purchase of the plant Agnico-Eagle resumed treating its concentrates at the refinery. The company reported in May 1982 that it was stockpiling its silver output in expectation of higher silver prices.

Manitoba-Saskatchewan

In Manitoba and Saskatchewan silver is derived from base-metal mines operated by Hudson Bay Mining and Smelting Co., Limited near Flin Flon and Snow Lake. Some silver is also recovered from the Fox and Ruttan copper-zinc mines operated by Sherritt Gordon Mines Limited at Lynn Lake and Ruttan.

British Columbia

British Columbia continued to be the largest silver producing province in Canada and production in 1982 increased significantly over the previous year. Equity Silver Mines Limited in the north central district, which is controlled by Placer Development Limited, is the largest silver producer in Canada. The Sullivan lead-zinc mine of Cominco Ltd. at Kimberley is also one of Canada's major silver producers. The copper mines are small contributors to silver production. The gold-silver mine of Du Pont of Canada Exploration Limited near Chappelle Creek in the north central district was a substantial

TABLE 3. PRINCIPAL SILVER (MINE) PRODUCERS - CANADA, 1982 AND (1981)

Company and Location	Mill Capacity (tonnes of ore/day)	Grade of Ore Milled: Silver (grams/tonne)	Copper (%)	Lead (%)	Zinc (%)	Ore Milled (tonnes)	Silver produced (kilograms)	Remarks
Newfoundland								
ASARCO Incorporated, Buchans	1 100 (1 100)	.. (92.91)	.. (0.80)	.. (5.31)	.. (8.95)	.. (689 472)	.. (5 288)	Closed in 1982.
Consolidated Rambler Mines Limited, Baie Verte	1 100 (1 100)	.. (17.83)	3.84 (3.82)	- (-)	- (-)	54 234 (143 247)	571 (1 554)	Depleted ore reserves and closed end of April 1982.
New Brunswick								
Brunswick Mining and Smelting Corporation Limited, Nos. 12 and 6 mines Bathurst	10 000 (10 000)	100.01 (97.9)	0.30 (0.35)	3.55 (3.50)	8.90 (8.74)	3 633 499 (3 423 000)	258 503 (195 710)	
Heath Steele Mines Limited, Newcastle	3 600 (3 600)	57.60 (51.43)	0.99 (0.91)	1.45 (1.45)	3.97 (3.94)	1 399 078 (1 251 936)	47 120 (29 766)	
Quebec								
Campbell Resources Inc., Henderson, Cedar Bay, and Gwillim mines Chibougamau	3 650 (3 650)	6.82 (6.24)	0.99 (0.96)	- (-)	- (-)	341 768 (393 725)	1 437 (897)	
Corporation Falconbridge Copper, Lake Dufault Division, Corbet mine, Noranda	1 400 (1 400)	13.37 (19.51)	2.90 (2.78)	- (-)	0.70 (1.19)	324 129 (452 960)	3 026 (5 972)	Mine closed June 30 pending an improvement in metal prices.
Corporation Falconbridge Copper, Opemiska Division, Perry, Springer and Cooke mines, Chapais	2 900 (2 900)	10.63 (12.72)	1.59 (1.64)	- (-)	- (-)	954 463 (850 046)	8 201 (7 527)	
Gaspé Copper Mines, Limited, Needle Mountain and Copper Mountain mines, Murdochville	30 400 (30 400)	3.75 (3.62)	0.51 (0.46)	- (-)	- (-)	5 878 696 (10 120 723)	9 458 (17 928)	Mine closed June 30; re-opened Aug. 15 at reduced rate; closed in December pending metal price improvement.

TABLE 3. (cont'd.)

Company and Location	Mill Capacity	Silver	Copper	Lead	Zinc	Ore Milled	Silver produced	Remarks
		Grade of Ore Milled						
	(tonnes of ore/day)	(grams/ tonne)	(%)	(%)	(%)	(tonnes)	(kilograms)	
Quebec (cont'd)								
Les Mines Gallen Limitée (Noranda Mines Limited) Noranda	.. (..)	31.89 (33.94)	0.10 (0.12)	- (-)	4.43 (3.14)	161 916 (34 548)	1 892 (424)	Closed in mid-year until market improves. Ore milled at Horne Mill.
Les Mines Selbaie, (Selco Inc.) Joutel	1 500 (1 500)	34.29 (26.8)	3.36 (3.24)	- (-)	(0.86) (0.77)	470 351 (94 917)	14 520 (2 275)	
Madeleine Mines Ltd., Murdochville	2 500 (2 500)	.. (..)	0.88 (0.92)	- (-)	- (-)	414 144 (577 433)	1 904 (2 782)	Mine closed June 30 when ore reserves depleted.
Noranda Mines Limited, Mattagami Division, Matagami	3 500 (3 500)	20.91 (19.58)	0.99 (0.75)	0.05 (-)	6.10 (4.85)	1 178 041 (1 203 854)	10 711 (6 034)	Orchan mine closed Oct. 30; ore reserves depleted.
Northgate Patino Mines Inc., Copper Rand Mill Chibougamau	2 700 (2 700)	8.85 (9.12)	1.60 (1.64)	- (-)	- (-)	663 262 (670 765)	3 902 (4 202)	
Northgate Patino Mines Inc., Lemoine Mine, Chibougamau	300 (300)	42.51 (69.58)	2.34 (3.70)	- (-)	5.93 (8.47)	111 117 (85 004)	3 948 (4 575)	Closed in latter part of 1982.
Ontario								
Agnico-Eagle Mines Limited, Cobalt district	350 (350)	519.09 (310.92)	.. (..)	- (-)	- (-)	34 310 (43 786)	17 752 (12 759)	Purchased Canadian Smelting & Refining (1974) Limited silver refinery from Sulpetro Minerals Limited.
Falconbridge Limited Ontario Mines, Sudbury district	11 200 (11 200)	6.86 (3.43)	1.02 (..)	- (..)	- (..)	1 559 178 (2 759 702)	5 480 (4 678)	Plant shut down from June 27 to end of year.

Inco Limited, Sudbury and Shebandowan, Ont., and Thompson, Man.	73 950 (73 950)	5.14 (..)	0.96 (1.09)	- (-)	- (-)	6 804 000 (12 156 480)	32 659[1] (46 996)[1]	Mine closed at end of May by strike. Strike settled in June but mine to remain closed until April 1983.
Kidd Creek Mines Ltd., Timmins	12 250 (12 250)	75.8 (64.8)	2.0 (1.90)	0.95 (0.70)	5.48 (5.27)	4 418 596 (4 076 323)	261 204 (186 817)	
Mattabi Mines Limited, Sturgeon Lake	2 700 (2 700)	105.94 (86.40)	0.64 (0.56)	0.74 (0.57)	7.42 (6.50)	752 931 (896 197)	63 945 (60 153)	Closed for 10 weeks during summer because of weak markets. Includes ore from "F" Group Mine and Lyon Lake Division.
Noranda Mines Limited, Geco Division Manitouwadge	4 550 (4 550)	45.60 (46.63)	1.59 (1.83)	0.13 (0.10)	3.51 (3.16)	1 350 734 (1 329 955)	46 953 (43 109)	
Teck Corporation, Silverfields Division, Cobalt district	250 (250)	274.29 (229.68)	0.6 (..)	- (-)	- (-)	71 837 (77 930)	18 520 (16 956)	Limited reserves - to close early 1983.
Umex Inc., Thierry mine, Pickle Lake	3 650 (3 650)	7.89 (..)	0.85 (0.85)	- (-)	- (-)	217 166 (903 358)	898 (7 065)	Closed in April on care and maintenance basis.
Manitoba-Saskatchewan								
Hudson Bay Mining and Smelting Co., Limited, Flin Flon mill	10 700 (10 700)	20.67 (16.66)	1.90 (2.01)	- (-)	2.71 (2.34)	1 034 449 (1 754 225)	14 567 (17 748)	Closed for eight weeks in mid-year.
Hudson Bay Mining and Smelting Co., Limited, Snow Lake mill, Snow Lake	3 450 (3 450)	14.16 (..)	2.48 (0.85)	0.19 (-)	2.84 (-)	687 574 (903 358)	7 791 (3 737)	
Sherritt Gordon Mines Limited, Fox mine, Lynn Lake	2 600 (2 600)	14.06 (7.57)	1.76 (1.42)	- (-)	1.77 (1.73)	427 695 (733 925)	3 442 (4 852)	Closed for 15 weeks be ginning June 21.
Sherritt Gordon Mines Limited, Ruttan mine, Ruttan	9 050 (9 050)	8.17 (7.31)	2.16 (1.30)	- (-)	0.14 (1.25)	784 363 (1 702 814)	5 099 (10 808)	Closed for 15 weeks beginning June 21.

TABLE 3. (cont'd)

Company and Location	Mill Capacity (tonnes of ore/day)	Grade of Ore Milled: Silver (grams/tonne)	Copper (%)	Lead (%)	Zinc (%)	Ore Milled (tonnes)	Silver produced (kilograms)	Remarks
British Columbia								
Afton Operating Corporation Dominion pit, Kamloops	6 350 (6 350)	3.60 (4.90)	0.58 (0.93)	- (-)	- (-)	1 025 025 (2 553 060)	2 166 (7 656)	Mine closed near end of June on temporary basis pending market improvement.
Brenda Mines Ltd. Peachland	27 000 (27 000)	1.20 (..)	0.14 (0.137)	- (-)	- (-)	9 484 562 (10 199 300)	6 319 (5 877)	Closed for short period in summer.
Cominco Ltd., Bethlehem Copper Division, Highland Valley	18 150 (18 150)	2.40 (..)	0.38 (0.39)	- (-)	- (-)	3 112 829 (6 496 000)	2 951 (3 662)	Closed July 1 because mine not profitable.
Cominco Ltd., Sullivan mine, Kimberley	9 075 (9 075)	65.49 (62.06)	- (-)	4.98 (4.4)	3.23 (3.2)	2 219 198 (2 210 000)	126 123 (98 939)	Closed for one month at mid-year.
Dankoe Mines Ltd., Keremeos	150 (150)	108.99 (190.29)	0.18 (-)	0.13 (..)	0.14 (..)	10 000 (32 755)	988 (3 498)	Mill custom-treated gold ore in 1982.
Dickenson Mines Limited, Silvana Division, Slocan district	100 (100)	403.89 (429.19)	- (-)	3.54 (4.17)	2.83 (3.47)	26 189 (27 672)	9 724 (11 037)	
Du Pont of Canada Exploration Limited, Baker Mine, north central British Columbia	90 (90)	418.29 (381.26)	- (-)	- (-)	- (-)	31 029 (16 689)	11 255 (4 884)	
Equity Silver Mines Limited, Houston	4 500 (4 500)	121.71 (143.6)	0.39 (0.39)	- (-)	- (-)	2 073 000 (1 910 000)	216 800 (228 000)	
Gibraltar Mines Limited, McLeese Lake	36 300 (36 300)	.. (..)	0.30 (0.38)	- (-)	- (-)	13 379 000 (13 258 000)	3 615 (5 624)	Mining suspended in July, milling low grade stock-piled ore.
Lornex Mining Corporation Ltd., Highland Valley	76 000 (68 000)	.. (..)	0.364 (0.415)	- (-)	- (-)	27 843 200 (20 739 400)	22 987 (18 351)	First full year of operation of expanded mine output.

Newmont Mines Limited, Similkameen Division, Princeton	19 150 (19 150)	1.37 (..)	0.38 (0.40)	- (-)	- (-)	6 742 833 (6 868 411)	5 383 (4 527)	Production from Copper Mountain open pit.
Noranda Mines Limited, Granisle mine, Babine Lake	14 300 (14 300)	1.71 (..)	0.42 (0.37)	- (-)	- (-)	1 880 953 (3 832 920)	1 856 (3 235)	Operations closed July 1.
Northair Mines Ltd., Alta Lake	250 (250)	35.86 (28.63)	0.19 (0.15)	1.32 (1.15)	2.32 (2.09)	33 104 (62 548)	1 034 (1 520)	Operations suspended because of low metal price.
Teck Corporation, Beaverdell mine, Beaverdell	100 (100)	386.64 (294.81)	- (-)	0.29 (..)	0.62 (..)	36 380 (36 683)	12 571 (9 509)	
Utah Mines Ltd., Island Copper mine, Coal Harbour, Vancouver Island	34 450 (34 450)	1.37 (..)	0.43 (0.44)	- (-)	- (-)	15 291 656 (14 156 618)	14 391 (13 114)	
Wesfrob Mines Limited, Tasu Harbour, Queen Charlotte Islands	4 650 (4 650)	2.98 (..)	0.38 (0.32)	- (-)	- (-)	1 108 115 (1 008 806)	2 972 (2 347)	
Westmin Resources Limited, Buttle Lake, Vancouver Island	900 (900)	127.86 (127.18)	1.06 (1.13)	1.11 (1.22)	7.28 (7.35)	287 584 (246 154)	29 828 (24 354)	Developing new H-W orebody for production.
Yukon Territory								
Cyprus Anvil Mining Corporation, Faro	9 050 (9 050)	33.81 (42.00)	- (-)	2.80 (2.90)	4.70 (4.80)	1 643 983 (2 472 120)	35 203 (51 881)	Suspended operations in early June because of market conditions.
Hudson Bay Mining and Smelting Co., Limited Whitehorse Copper Division, Whitehorse	2 250 (2 250)	.. (10.08)	1.39 (1.42)	- (-)	- (-)	898 000 (726 103)	.. (6 049)	Ore reserves depleted and mine closed at end of 1982.
United Keno Hill Mines Limited, Elsa	450 (450)	843.43 (754.16)	- (-)	3.70 (3.59)	0.65 (0.64)	50 341 (60 713)	36 958 (36 020)	Suspended operations in mid-July pending an increase in silver price.

TABLE 3. (cont'd)

Company and Location	Mill Capacity (tonnes of ore/day)	Grade of Ore Milled: Silver (grams/ tonne)	Copper (%)	Lead (%)	Zinc (%)	Ore Milled (tonnes)	Silver contained in concentrates produced (kilograms)	Remarks
Northwest Territories								
Echo Bay Mines Ltd., Port Radium Great Bear Lake	100 (100)	.. (923.10)	.. (0.91)	- (-)	- (-)	.. (38 102)	.. (34 867)	Milled stockpile ore and mill closed at end of March.
Nanisivik Mines Ltd., Strathcona Sound, Baffin Island	1 350 (1 350)	58.15 (62.40)	- (-)	1.50 (1.46)	11.30 (11.31)	633 621 (566 093)	31 795 (32 978)	
Terra Mines Ltd., (formerly Terra Mining and Exploration Limited), Camsell River area Great Bear Lake	180 (180)	760.46 (1159.00)	0.39 (0.66)	0.32 (-)	0.25 (-)	36 627 (1 436)	26 919 (1 758)	Milling resumed in 1982.

Sources: 1981 company reports and technical press; 1982 EMR questionnaire.
[1] Silver delivered to market.
- Nil; .. Not available.
Note: For 1982, 'silver produced' means silver contained in all concentrates.

TABLE 4. CANADA, SILVER REFINERY PRODUCTION AND CAPACITY

	Production[1] Refined Silver (kilograms)	Annual[2] Rated Capacity
Brunswick Mining and Smelting Corporation Limited, Smelting Division, Belledune, New Brunswick	98 700[3]	125 000
Canadian Copper Refiners Limited, Montreal East, Quebec	442 471	777 600
Canadian Smelting & Refining (1974) Limited Cobalt, Ontario	17 928	186 600[4]
Cominco Ltd., Trail British Columbia	301 100	373 200
Inco Metals Company Copper Cliff, Ontario	32 659[5]	..
Royal Canadian Mint Ottawa, Ontario	10 927.5[6]	12 450

Sources: Company Reports; Royal Canadian Mint.
[1] Production of refined silver includes silver produced or derived from domestic and imported ores and concentrates as well as secondary materials. The largest portion of such refined silver was however, derived, from domestic ores and concentrates. [2] As of December 31, 1982. [3] Bullion produced by Brunswick Mining and Smelting Corporation Limited was shipped to Canadian Copper Refiners Limited (CCR) for further refining and is included in bullion produced by CCR. [4] Up to this amount, depending on nature of material processed. [5] Silver delivered to market. [6] Silver derived from refining gold bullion.

producer of silver, recording its first full year of operation in 1982. A few small mines in the southern part of the province are operated primarily for their silver content.

Yukon Territory

The mining industry in the Yukon suffered a severe blow when the two major silver producers closed their operations at mid-year pending an improvement in the price of base-metals and silver. Cyprus Anvil Mining Corporation closed its operations on June 4 for a short period but continuing adverse economic conditions forced the company to extend the closure period indefinitely.

United Keno Hill Mines Limited closed its mining operations indefinitely in July 1982 in response to high operating costs and a substantial decline in the silver price. About 200 employees were affected. The mine has been placed on a standby basis pending a higher and more stable silver price. The Mayo district will feel the impact of the United Keno closure as the mine is the main economic base of the area.

Reserves at the only remaining base-metal mine operating in the Yukon, the copper mine of Whitehorse Copper, were depleted and the mine closed in late 1982.

Northwest Territories

Silver production in the Northwest Territories declined in 1982. The main producer, Echo Bay Mines Ltd., at Port Radium, Great Bear Lake, milled stockpiled ore and closed in March. The employees were transferred to the company's newly developed Lupin gold mine at Contwoyto Lake.

Terra Mines Ltd. (formerly Terra Mining and Exploration Limited) continued an underground exploration program at its properties at Great Bear Lake with funds provided by Procan Exploration Company of Calgary, a Canadian partnership owned by the Hunt Brothers of Texas. Terra reopened its mill in March 1982, treating ore from its Silver Bear Mine. In August 1982, a formal agreement was signed by Terra and Procan which cancelled a 1980 royalty purchase agreement. Under the terms of the cancellation agreement, Terra transferred to Procan the majority of mining claims and leases owned by Terra north of Camsell River in the Great Bear Lake district. In exchange Procan made a final payment of \$3.6 million under the 1980 agreement bringing to \$29.1 million the total received by Terra. In addition, Procan gave up its 50 per cent interest in Terra's mines and all plants and equipment, including the mill and other Terra properties south of the Camsell River.

Cadillac Explorations Limited postponed the opening of its 1 350 tpd plant at its lead-zinc-silver-copper mine at Prairie Creek, 340 km north of Fort Nelson, British

Columbia, pending an improvement in world metal prices. The company has made application to upgrade the present 165 km winter road to all-weather standards in order that concentrates and supplies can be hauled year-round instead of for a short period during the winter. This would lower inventory costs when the mine is in production. Plant construction is 90 per cent complete. Reserves are estimated at 1.36 million t averaging 188 g/t silver, 11 per cent lead, 12 per cent zinc and 0.4 per cent copper.

INTERNATIONAL DEVELOPMENTS

Estimated world production of silver in 1982 was 11 321 t, slightly below 1981 output (Table 5).

Based on preliminary data, Canada was the fourth largest mine producer in 1982, being surpassed by U.S.S.R., Peru, and Mexico. United States production was slightly below that of Canada. These five countries account for about 62.5 per cent of the world's total primary silver production.

In 1982, non-communist world consumption of silver for both industrial and coinage uses, as estimated by Handy & Harman, was 11 477 t compared with 10 983 t in 1981. The gap between primary production and consumption in 1982 was 3 235 t compared with 2 535 t in 1981. The shortfall was made up largely from old scrap, Indian stocks and demonetized silver coins.

The Silver Institute in its publication Modern Silver Coinage 1981, reported that silver used in official silver coins in 1981 was 183 661 kg compared with 429 466 kg in 1980. The main reason for the sharp decline in silver usage in 1981 was that Mexico and the U.S.S.R. did not report the fabrication of any silver coins. The leading consumers of silver in coinage in 1981 and the amounts used were: Austria 68 347 kg, Greece 13 256 kg, Isle of Man 9 812 kg, and Italy 9 185 kg. These four countries accounted for nearly 55 per cent of the total silver used in coinage.

The U.S.S.R. is believed to be the world's largest silver producer. Most of the silver is recovered as a byproduct from lead-zinc-copper mines. Output of base-metal ores is increasing at a low rate and production of silver from the U.S.S.R. is not expected to rise significantly in the next few years. Output in 1981 was estimated at 1 579 953 kg.

TABLE 5. WORLD MINE PRODUCTION[1] OF SILVER, 1981 AND 1982

	1981[p]	1982[e]
	(kilograms)	
U.S.S.R.[e2]	1 579 953	1 539 600
Mexico	1 654 977	1 550 197
Peru	1 387 176	1 654 705
Canada	1 129 394	1 204 000
United States	1 265 432	1 093 067
Australia	743 257	908 092
Poland[e]	640 019	684 107
Chile	361 060	382 197
Japan	280 320	305 812
Republic of South Africa	236 957	216 001
Bolivia	205 296	170 188
Sweden	174 996	164 850
Yugoslavia[2]	137 983	103 963
Spain	192 414	192 850
Morocco	99 609	108 850
Zaire	80 104	70 000
South Korea	97 885	109 588
Argentina	78 018	68 402
Philippines	62 959	63 503
People's Republic of China[e]	65 045	64 592
Greece	60 509	52 875
Italy	55 338	55 973
France	53 070	29 211
Other countries[e]	712 735	529 043
Total	11 354 506	11 321 666

Sources: Energy, Mines and Resources Canada; Nonferrous Metal Data 1982, American Bureau of Metal Statistics Inc.; Mineral Commodity Summaries 1983, U.S. Bureau of Mines; J. Aron & Company Inc.
[1] Recoverable content of ores and concentrates produced unless otherwise noted.
[2] Smelter and refinery production.
[p] Preliminary; [e] Estimated.

In 1982, Mexico retained its position as the non-communist world's largest silver producing country followed by Peru, Canada and the United States. Other major silver producing countries are Australia, Poland, Chile and Japan.

Production of silver in Mexico declined in 1982 compared with 1981 production of 1 654 977 kg. In September, Mexico introduced strict restrictions on the export of gold and silver. The new restrictions require that an export licence for silver be obtained from the Central Bank.

TABLE 6. UNITED STATES CONSUMPTION OF SILVER BY END-USE[1], 1981 AND 1982

	1981[f]		1982[P]	
	(kilograms)	(%)	(kilograms)	(%)
Electroplated ware	121 428	3.3	107 120	2.8
Sterling ware	137 073	3.8	206 963	5.5
Jewellery	166 963	4.6	219 715	5.8
Photographic materials	1 587 055	43.8	1 610 040	42.5
Dental and medical supplies	53 156	1.5	53 374	1.4
Mirrors	18 071	0.5	30 108	0.8
Brazing alloys and solders	240 057	6.6	245 220	6.5
Electrical and electronic products:				
Batteries	118 287	3.3	139 592	3.7
Contacts and conductors	821 474	22.6	899 886	23.8
Bearings	7 714	0.2	7 092	0.2
Catalysts	119 126	3.3	75 146	2.0
Coins, medallions and commemorative objects	81 553	2.2	48 117	1.3
Miscellaneous[2]	155 362	4.3	142 018	3.7
Total net industrial consumption	3 627 319	100.0	3 784 391	100.0
Coinage	5 567		57 417	
Total consumption	3 632 886		3 841 808	

Sources: United States Bureau of Mines, Mineral Industry Surveys, "Gold and Silver in December 1982".
[1] End-use as reported by converters of refined silver. [2] Includes silver-bearing copper, silver-bearing lead anodes, ceramic paints, etc.
[f] Final figures include companies reporting annually; P Preliminary.

A major development in the silver industry in Mexico in 1982 was the opening in June of the 10 000 tpd open-pit silver-lead-zinc mine of Minera Real de Angeles, S.A. de C.V. in the State of Zacatecas. Minera Real is a Mexican company in which Placer Development Limited of Vancouver, British Columbia has a 34 per cent interest and has managerial responsibility for the operation. Other partners in the venture are the Mexican government, through Comision de Fomento Minero, and Minera Frisco S.A. de C.V., a major Mexican mining company, each with a 33 per cent interest. Cost of bringing the mine into production was $US 170 million. Annual silver output will be about 220 000 kg (7 million ounces), making it the largest silver producer in Mexico and one of the world's larger producers. Reserves are estimated to be 59 million t averaging 74 g/t silver; 1 per cent lead and 0.92 per cent zinc.

Avino Mines & Resources Limited of Vancouver has a 49 per cent interest in Minera Mexicana de Avino S.A. which operates an open-pit silver mine in the State of Durango. In September the mill was operating at a rate of about 800 tpd. New equipment is being installed which should increase tonnage treated to about 1 350 tpd in 1983. Plant expansions have been financed out of cash flow. Consideration is being given to construction of a cyanide plant to treat over 900 000 t of tailings containing 103 g/t silver. Open-pit ore reserves have been estimated at 4.5 million t averaging 171 g/t silver with some copper.

Lacana Mining Corporation of Toronto has two major silver operations in Mexico. In Guanajuato, Lacana has a 30 per cent interest in Torres Mining Complex which operates four mines that ship some 2 000 tpd to its centrally located concentrator. In addition, Torres is developing four other properties in the district. Silver production in 1981 was 135 387 kg. In Coahuila state, the company has a 40 per cent interest in La Encantada Mining Group that operates three mines that ship ore to a 1 200 tpd centrally located concentrator. Production in 1981 was 46 200 kg.

TABLE 7. NON-COMMUNIST WORLD CONSUMPTION OF SILVER, 1981 AND 1982

	1981	1982P
	(kilograms)[1]	
Industrial uses		
United States	3 626 665	3 803 955
Japan	1 859 988	1 869 319
West Germany	870 897	1 045 077
Italy	768 256	715 380
India	590 966	699 828
United Kingdom	575 414	622 070
France	640 732	578 525
Belgium	503 876	469 663
Canada	264 380	279 931
Mexico	99 531	118 193
Other countries	902 002	908 221
Total industrial uses	10 702 707	11 110 162
Coinage		
Austria	93 310	124 414
United States	-	46 655
Canada	6 221	9 331
Other countries	180 400	186 621
Total coinage	279 931	367 021
Total consumption	10 982 638	11 477 183

Source: Handy & Harman, The Silver Market, 1982.
[1] One kilogram equals 32.1507 troy ounces.
P Preliminary; - Nil.

Many of the silver producing Mexican mines have major expansions under way or planned. Industrial Minera Mexico S.A., a major Mexican mining complex, plans to increase annual silver production from 373 000 kg to 684 000 kg.

Silver and other metals account for about 50 per cent of Peru's foreign exchange earnings, silver being a major contributor. The depressed silver price, about $5.00 at midyear, adversely affected export earnings and the profitability of the silver mines, and led to postponement of projects to develop new mines or expand existing mines. The Peruvian cabinet in late July declared the small and medium mining industry in a state of emergency, issuing several decrees which introduced measures to improve the economic situation of the mines. These included an exemption from the present 9 per cent export tax, payroll, goods, and service taxes and an increase to $120 million in the Banco Mineros Mining Compensation Fund which provides working capital assistance to these mines. All wage contracts were extended for a period of 6 months but during this period no workers could be laid off.

In the United States, declining silver prices and depressed economic conditions forced the closing of a number of silver mines and the suspension or curtailment of a number of exploration programs. Byproduct silver production from copper mines was lowered by short to indefinite closures at many of these mines.

ASARCO Incorporated is a major producer of silver from wholly and partly owned mines. The Troy mine in Montana, controlled by ASARCO, recorded its first full year of production. Output is expected to be about 130 000 kg, making it the largest silver producing mine in the United States. Ore reserves are estimated at 50 million t averaging 58 g/t Ag and 0.74 per cent Cu. In 1981, ASARCO's overall silver production was 321 700 kg.

In 1982, Hecla Mining Company permanently closed its 50 per cent owned Star-Mining Unit mine and its 64 per cent owned Consolidated Silver mine in Idaho, and its Leadville mine in Colorado, temporarily pending an improvement in the silver price. Normal operations were maintained throughout the year at its Lucky Friday mine in Idaho.

Sunshine Mining Company opened its 450 tpd 16-to-1 silver mine near Silver Peach, Nevada in February. Cost of the project was about $23 million and annual production is expected to be about 37 000 kg. In mid-year Sunshine closed its Sunshine mine in Idaho, the largest silver producer in the United States, until the price of silver increases.

In late 1982, Gulf Resources & Chemical Corporation announced that its subsidiary, The Bunker Hill Co., sold its Idaho assets to three Idaho businessmen.

Ranchers Exploration and Development Corporation brought its 450 tpd Escalante silver mine in southwestern Utah on-stream in late 1981 at a cost of about $20 million. Annual silver production should be about 46 700 kg. The company has initiated a program whereby dividend payments are made in silver.

In August 1982 M.I.M. Holdings Limited, Queensland, Australia, the world's largest silver producing mine, announced that its $A 26.5 million expansion program was completed, increasing silver, lead and zinc output by about 20 per cent. For the past five years silver production has varied from 373 500 kg to 460 000 kg.

The Que River base and precious metals mine in Tasmania, in which Aberfoyle Limited holds a 90 per cent interest, recorded its first full year of production. Reserves are estimated at 2.4 million t, averaging 206 g/t Ag, 7.7 per cent Pb and 13.3 per cent Zn. Que River has a contract to have 200 000 tpy of its ore treated at a nearby concentrator. Cominco Ltd. has a 47 per cent interest in Aberfoyle.

The Electrolytic Zinc Company of Australasia Ltd. expects to bring its Elura lead-zinc-silver mine, near Cobar, New South Wales, into production in early 1983 at an annual rate of 1.1 million t. Reserves are estimated at 27 million t averaging 139 g/t Ag, 5.67 per cent Pb and 8.3 per cent Zn. The mine will be a substantial contributor to Australia's silver output.

In Honduras, Rosario Resources Corporation, a subsidiary of AMAX Inc., completed expansion of the concentrator at its El Mochito silver-lead-zinc mine from 1 130 tpd to 1 260 tpd. Silver production in 1982 should be significantly higher than the 51 800 kg produced in 1981. Reserves are estimated at 7 million t averaging 150 g/t Ag and 13.4 per cent combined Pb-Zn. To assist the mining industry the Honduras government revised its tax laws. Royalty payments are to be reduced from the previous levels ranging between 10 and 20 per cent to 5 per cent and provision for a system of credits was introduced which will reduce cash requirements for royalties during periods of unprofitable operations. In addition, the total of royalties, income tax and export taxes will not exceed 55 per cent of taxable income.

In Chile, Compania Minera San Jose, Inc., a subsidiary of St. Joe Minerals Corporation of New York, recorded its first full year of production at its 80 per cent controlled El Indio, 1 250 tpd gold-silver-copper mine, located about 500 km northeast of Santiago. Production in 1982 should be about 32 240 kg of silver and over 11 000 kg of gold. A high-grade gold section is being mined to provide cash flow to finance development. Reserves are estimated to be 3.1 million t averaging 144.0 g/t Ag, 12.0 g/t Au and 3.52 per cent Cu.

SILVER STOCKS AND COMMODITY EXCHANGES

In the United States a report on the disposal of the 137.5 million ounces of silver in the strategic stockpile, prepared by an Intergovernmental Agency, was scheduled for release on July 1, 1983, but an announcement was made in mid 1982 that sales would be postponed indefinitely. A money bill authorizing funds to pay the cost of government operations, which became law on December 21, 1982, carried an amendment restricting the sale of silver from the strategic stockpile. The bill provides that the government may not sell silver from the stockpile in any 12-month period in excess of 10 per cent of annual domestic silver production from existing mines. This would limit annual silver sales to under 4 million ounces.

On July 22, 1980, President Reagan signed into law a bill authorizing the minting of silver and gold coins to commemorate the 1984 Summer Olympics at Los Angeles. The silver coins will be legal tender and will be issued in two separate designs, one in 1983 and one in 1984. Sales in the United States will be handled by the Treasury Department and sales in foreign countries by private-sector marketers. By law, the coins will be priced so that there will be no cost to the government. The maximum number of silver coins will be 50 million of $1.00 value containing 90 per cent silver and 10 per cent copper and weighing 26.73 grams. The silver will come from existing government stocks. The national defense stockpile will not be involved.

The General Services Administration (GSA) held an auction on July 21, 1982 at which 364,226 ounces of silver reclaimed from the Veterans Administration were sold at an average price of $7.11 an ounce, slightly lower than the Handy & Harman of New York quote for that day.

The United States Bureau of Mines had Economic Consulting Services, Inc. of Washington, D.C. conduct a study to determine unreported above-ground silver stocks and the market mechanism through which this silver might enter the market. The study estimated that United States residents held more than 1.5 billion ounces of silver in the form of coins and bullion. Individuals hold an additional 850 million ounces in sterling ware. Some of this silver would become available in a rising silver market. Secondary industry would have no problems moving this silver from private hands to industrial users because of recent plant expansions.

World silver stocks in the non-communist world as estimated by Handy & Harman of New York was 66 365.5 t at the end of 1982 compared with 65 388.8 t at the end of 1981.

On the New York Commodity Exchange (Comex), one of the principal futures markets for contracts in silver in the United States, the trading volume in silver in 1982 amounted to 2 839 468 contracts of 5,000 troy ounces each compared with 1,240,720 contracts in 1981. The volume of silver traded on the Chicago Board of Trade in 1982 was 77,677 contracts of 5,000 troy ounces each and 775,136 contracts of 1,000 troy ounces each compared with 214,236 contracts of 5,000 troy ounces each and 184,776 contracts of 1,000 troy ounces each in 1981. Trading volume on the Mid American Commodity Exchange at Chicago was 125,405 contracts of 1,000 troy ounces each compared with 143,051 contracts in 1981. Silver traded on the London Metal Exchange was 1 070.5 million troy ounces in 1982 compared with 454.00 million troy ounces in 1981.

Comex silver stocks at the end of 1982 were 91.24 million troy ounces compared with 77.60 million troy ounces at the end of 1981. Chicago Board of Trade silver in storage at the end of 1982 and registered for delivery against future contracts was 15.80 million troy ounces in 1981. London Metal Exchange silver stocks at the end of 1982 were 35.90 million troy ounces compared with 32.23 million troy ounces at the end of 1981. United States industrial stocks on hand December 31, 1982 were reported to be about 20.66 million troy ounces compared with 20.69 million troy ounces in 1981.

PRICES

The silver price trend was downward for the first half of 1982 because of continuing high interest rates, persistent world recession, uncertainty as to whether the United States would resume silver sales after July 1 and general lack of speculative interest. The Falkland Islands dispute exerted only a minor upward trend on the price. The monthly average silver price for January 1982 was $US 8.03 per ounce, falling to the low monthly average for 1982 of $5.56 in June. The price of silver increased steadily for the rest of the year and the average monthly price for December was $10.59 per ounce, the high for the year. The improvement in the price was the result of a number of factors: an announcement that silver sales from the U.S. strategic stockpile were postponed indefinitely; lower interest rates and expectations of further declines; an announcement by Peru that it was to withhold silver from the market; and substantial purchases of silver by the U.S.S.R. In September exports by the United Kingdom to the U.S.S.R. were 81 180 kg and some dealers estimate total 1982 sales to the U.S.S.R. of over 311 030 kg.

The average silver price (Handy & Harman of New York) for 1982 was $US 7.95 per ounce compared with $10.52 in 1981 and $20.63 in 1980. The high silver price for 1982 was $US 11.21 an ounce on December 29 and the low price was $4.89 on June 24. The year's opening and closing prices were $8.02 and $10.90 per ounce. The London

TABLE 8. ANNUAL AVERAGE SILVER PRICES: CANADA, UNITED STATES AND UNITED KINGDOM, 1972-82

	Canada	United States Handy & Harman, New York	United Kingdom London Spot
	($Cdn)	($US)	(pence)[2]
	(per troy ounce)		
1972	1.671	1.685	67.403
1973	2.567	2.558[1]	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

Sources: Canadian prices as quoted in the Northern Miner (arithmetical average of daily quotations). United States and United Kingdom prices as quoted in Metals Week.

[1] The 60-day general price freeze in effect in the United States from June 13 through August 12, 1973 forced intermittent suspension of Handy & Harman's daily quotation during July and August for a total of 22 days. [2] 1972-82 prices are expressed in new British pence, following British conversion to decimal currency, February 11, 1971, at the rate of 100 pence per pound sterling. Previous rate was 240 pence per pound.

spot silver price closely followed the U.S. pattern. The average spot price for the year 1982 was 455.34 pence per ounce ($US 7.92 per ounce).

In 1982 the Canadian silver price followed its U.S. counterpart, the main difference being the currency exchange differential. The average Canadian silver price for 1982 was $313.40 per kg ($9.75 per ounce) compared with $405.55 per kg ($12.61 per oz) in 1981.

OUTLOOK

Canada's output of primary silver in 1983 is expected to be slightly lower than that in 1982, especially if there is no significant improvement in the world economy and the silver price. In the short to medium term, Canada's silver production should remain near its present level. There are no major mine developments on the horizon in which the silver content of the ore is significant.

Worldwide silver production in 1983 should not vary greatly from that in 1982. The present worldwide recession will limit or postpone plans to expand plant capacity and will postpone bringing new properties, other than higher grade deposits, into production. In the short term, no drastic change in world output is envisaged. With improved economic conditions silver production should increase, especially in Mexico, Peru and the United States.

Over the years there has been a shortfall between primary production and consumption which has been made up largely from secondary supplies. In 1980 to 1982 silver was in a surplus position largely because of the large amount of scrap offered to the market in early 1980 following the sharp upsurge in price. The surplus is declining mainly because a reduced amount of scrap is being offered to the market owing to lower silver prices. Much of the surplus silver is being absorbed by investors and speculators who now play a dominate role in influencing the price pattern. Silver from scrap material and other above ground stockpile sources will continue to be available, the amount varying with the price. Consumption is expected to be comparatively stable and remain near its present level in the short term. Electronic technology currently being developed in the photographic industry is not expected to cut into the amount of silver used in photography.

Speculative activity in the silver market makes it difficult to make price projections but the wild fluctuations in late 1979 and early 1980 are not expected to recur. Above ground silver stocks, including the surplus U.S. strategic stockpile, are large and under normal market conditions should ensure a comparatively stable price pattern but price movements could remain erratic in the short term. The general consensus is that the silver price in 1983 could be in the range of $US 9.00 to $12.00 per ounce. Unsettling world events did not unduly affect the price in 1982 but prices were more responsive to interest rates, a lowering of interest rates leading to a higher silver price.

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation (%)	General	General Preferential
32900-1	Ores of metals, nop	free	free	free	free
35800-1	Anodes of silver	free	free	10	free
35900-1	Silver in ingots, blocks, bars, drops, sheets or plates, unmanufactured; silver sweepings	free	free	free	free
35905-1	Scrap silver and metal alloy scrap containing silver	free	free	25	free
36100-1	Silver leaf	12.5	16.7	30	11
36200-1	Articles consisting wholly or in part of sterling or other silverware, nop; manufactures of silver, nop	15.7	18.2	45	12

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984 (%)	1985	1986	1987
36100-1	16.7	15.7	14.6	13.5	12.4	11.3
36200-1	18.2	16.8	15.3	13.9	12.4	11.0

UNITED STATES (MFN)

601.39	Precious metal ores, silver content	free
605.20	Silver bullion, silver dore and silver precipitates	free
605.70	Precious metal sweepings and waste and scrap, silver content	free
644.56	Silver leaf	2.5¢ per 100 leaves

		1982	1983	1984 (%)	1985	1986	1987
420.60	Silver compounds	4.5	4.4	4.2	4.0	3.9	3.7
605.46	Platinum-plated silver, unwrought or semi-manufactured	12.8	11.8	10.7	9.6	8.6	7.5
605.47	Gold-plated silver, unwrought or semi-manufactured	19.4	17.5	15.6	13.8	11.9	10.0
605.48	Other unwrought or semi-manufactured silver	8.8	8.3	7.7	7.1	6.6	6.0
605.65	Rolled silver, unworked or semi-manufactured	8.8	8.3	7.7	7.1	6.6	6.0

EUROPEAN ECONOMIC COMMUNITY (MFN)		1982	Base Rate	Concession Rate
			(%)	
28.49	Colloidal silver, amalgams, salts and other compounds of silver			
A.	Colloidal silver	7.0	8.0	5.3
B.	Amalgams of silver	7.0	8.0	5.3
C.	Salts and other compounds, inorganic or organic of silver	8.3	9.6	6.0
71.05	Silver, including silver gilt and platinum-plated silver, unwrought or semi-manufactured			
A.	Unwrought	free	free	free
B.	Bars, rods, wire and sections, plates, sheets, strips	1.9	2.0	1.8
C.	Tubes, pipes and hollow bars	3.3	3.5	2.9
D.	Foil of a thickness, excluding any backing, not exceeding 0.15 mm	5.9	6.5	5.0
E.	Powder, purls, spangles, cuttings and other forms	4.6	5.0	3.8
71.06	Rolled silver, unworked, or semi-manufactured			
A.	Unworked	4.6	5.0	3.8
B.	Semi-manufactured	5.8	6.5	4.6
71.08	Rolled gold on silver, unworked or semi-manufactured	3.3	3.5	2.9
71.10	Rolled platinum or other platinum group metals on silver, unworked or semi-manufactured	3.3	3.5	2.9
71.11	Silversmiths sweepings, residues and other waste and scrap	free	free	free
71.12	Articles of jewellery and parts thereof, of silver or rolled silver			
A.	Of silver	4.1	4.5	3.5
B.	Of rolled silver	7.8	9.0	5.8
71.13	Articles of silversmiths wares and parts thereof, of silver, other than above			
A.	Of silver	5.8	7.5	3.0
B.	Of rolled silver	4.6	5.0	3.8
71.14	Other articles of silver or rolled silver			
A.	Of silver	6.0	7.5	5.1
B.	Of rolled silver	5.4	6.0	4.4

Sources: The Customs Tariff and Commodities Index, January 1982, Revenue Canada, Tariff Schedules of the United States Annotated 1982, USITC Publication 1200; U.S. Federal Register Vol. 44, No. 241; Official Journal of the European Communities, L335, Vol. 24.
nop Not otherwise provided for.

Sodium Sulphate

G.S. BARRY

Sodium sulphate is produced from natural brines and deposits in alkaline lakes in areas with dry climates and restricted drainage, from subsurface deposits and brines, or as a byproduct of chemical processes. Canada's sodium sulphate industry is based on extraction from natural brines and deposits in several alkaline lakes in Saskatchewan and Alberta. Nine plants producing natural sodium sulphate operated in Canada in 1982. Byproduct sodium sulphate is recovered at one rayon plant and at three paper mills in Ontario. Production of byproduct sodium sulphate commenced in December 1982 at a new silver mine in British Columbia.

In the United States, natural and byproduct sodium sulphate production is almost evenly split. In Europe, sodium sulphate is produced almost entirely as a byproduct of chemical processes.

PRODUCTION AND DEVELOPMENTS IN CANADA

Markets remained strong for the fourth successive year. Shipments of natural sodium sulphate from Canadian producers increased by 2.6 per cent to 549 000 t in 1982 but were still much below the record level of 638 000 t achieved in 1974. The unit value of shipments increased from $73.65 in 1981 to $86.69 per t in 1982. On a net basis Canada exports about half of its production.

Besides natural sodium sulphate, about 90 000 tpy are produced as a byproduct of industrial and chemical processes in central Canada. Between 35 and 40 per cent of the total sodium sulphate produced in Canada is the higher grade and higher priced "detergent grade". Placer Development Limited brought on-stream the Equity Silver Mines Limited property in British Columbia in December 1982. About 5 000 t of sodium sulphate will be produced annually as a byproduct of leaching of copper-silver concentrates. Another byproduct will be sodium antimonate.

Deposits. The sodium sulphate deposits in Saskatchewan and Alberta have formed in shallow, undrained lakes and ponds where in-flow is greater than out-flow. Percolating ground waters carry dissolved salts into the basins from the surrounding soils. High rates of summer evaporation concentrate the brine to near saturation, and cooler fall temperatures cause crystallization and precipitation of sodium sulphate as mirabilite ($Na_2SO_4.10H_2O$). The cycle has been repeated year after year and thick deposits of hydrous sodium sulphate, accompanied by other salts and mud, have accumulated.

Deposits in Saskatchewan have been identified that contain, in total, approximately 90 million t of anhydrous sodium sulphate. Of this amount, a total of about 51 million t is in 21 individual deposits, each containing more than 500 000 t of sodium sulphate. Exploitation currently takes place on the following lakes (with reserves, in millions of t, in brackets): Whitehorse Lake (6.5), Horseshoe Lake (3.7), Frederic Lake (2.4), Chaplin Lake (3.0), Ingebrigt Lake (9.0), Alsack Lake (2.6), East Coteau Lake (3.5), and Snakehole Lake (1.7), all in Saskatchewan. Production in Alberta is from Horseshoe Lake (2.0). For Saskatchewan, the reserves calculations were made in 1978 and for Alberta in 1982. Since that time reserves changed only marginally.

Recovery and processing. Because sodium sulphate is recovered by evaporation of concentrated brines or by dredging of the permanent beds of crystals, weather is as important for recovery of sodium sulphate as it is for its deposition. A large supply of fresh water is also essential. One method of sodium sulphate recovery is to pump lake brines that have been concentrated by hot summer weather into evaporating ponds or reservoirs. Continued evaporation produces a saturated or near-saturated solution of mirabilite. Differential crystallization occurs in the fall when the solution cools. Hydrous sodium sulphate crystallizes and precipitates,

TABLE 1. CANADA, SODIUM SULPHATE PRODUCTION AND TRADE, 1981 AND 1982

	1981		1982P	
	(tonnes)	($)	(tonnes)	($)
Production				
Shipments				
Saskatchewan	..	36,374,000	..	43,984,000
Alberta	..	3,030,000	..	3,608,000
Total	535 000	39,404,000	549 000	47,592,000
Imports				
Total salt cake and Glauber's salt				
United Kingdom	22 235	427,000	16 381	1 107,000
United States	2 725	329,000	912	234,000
Total	24 960	756,000	17 293	1,341,000
Exports				
Crude sodium sulphate				
United States	274 631	23,428,000	355 910	34,279,000
Egyptian Arab Republic	4 091	940,000	-	-
Other countries	5 559	978,000	12 020	1,222,000
Total	284 281	25,346,000	367 930	35,501,000

Sources: Energy, Mines and Resources Canada; Statistics Canada.
P Preliminary; .. Not available; - Nil.

TABLE 2. CANADA, NATURAL SODIUM SULPHATE PLANTS, 1982

	Plant Location	Source Lake	Annual Capacity (tonnes)
Alberta			
Alberta Sulphate Limited	Metiskow	Horseshoe	75 000
Saskatchewan			
Hudson Bay Mining and Smelting Co., Limited	Grant	Snakehole	63 000
Hudson Bay Mining and Smelting Co., Limited	Hardene	Alsask	42 500
Midwest Chemicals Limited	Palo	Whiteshore	109 000
Ormiston Mining and Smelting Co. Ltd.	Ormiston	Horseshoe	90 700
Saskatchewan Minerals	Chaplin	Chaplin	90 000
Saskatchewan Minerals	Bishopric	Frederick	45 000
Saskatchewan Minerals	Fox Valley	Ingebrigt	135 000
Saskatchewan Minerals*	Gladmar	East Coteau	45 400
Total			695 600

Source: Company reports.
* Since Oct. 1980; formerly Sybouts Sodium Sulphate Co., Ltd.

TABLE 3. CANADA, SODIUM SULPHATE PRODUCTION, TRADE AND CONSUMPTION 1970, 1975, 1976-82

	Production[1]	Imports[2]	Exports	Consumption[3]
	(tonnes)			
1970	445 017	26 449	108 761	291 439
1975	472 196	22 638	178 182	256 385
1976	460 193	29 266	146 396	265 608
1977	394 795	34 639	117 027	254 872
1978	376 563	25 178	129 029	236 766
1979	443 279	23 156	193 268	255 059
1980	496 000	20 211	245 831	232 045
1981	535 000	24 960	284 281	206 957
1982P	549 000	17 293	367 930	..

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

[1] Producers' shipments of crude sodium sulphate only; does not include 90 000 to 100 000 t of byproduct sodium sulphate produced annually. [2] Includes Glauber's salt and crude salt cake. [3] Underestimated; for example, industry estimate for 1982 is just over 310 000 t (natural and byproduct).
P Preliminary; .. Not available.

whereas sodium chloride, magnesium sulphate and other impurities remain in solution. Before freezing weather sets in, the impure solution remaining in the reservoir is drained or pumped back into the source lake. After the crystal bed has become frozen, harvesting is carried out using conventional earth-moving equipment. The harvested crystal is stockpiled adjacent to the plant.

Some operators use floating dredges to mine the permanent crystal bed. The slurry of crystal and brine is transported to a screening house at the plant by pipeline. If sufficiently concentrated, the brine from the screens is collected in an evaporation pond.

One company uses a combination of dredging and solution mining, and pumps a concentrated brine to an air-cooled crystallizer at the plant, where sodium sulphate is separated from other insoluble salts.

Processing of a natural salt consists of dehydration (Glauber's salt contains 55.9 per cent water of crystallization) and drying. Commercial processes used in Saskatchewan include Holland evaporators, gas-fired rotary kilns, submerged combustion and multiple effect evaporators. Salt cake, the product used principally in the pulp and paper industry, contains a minimum of 97 per cent Na_2SO_4. Detergent-grade material analyzes up to 99.7 per cent Na_2SO_4. Uniform grain size and free-flow characteristics are important in material handling and use.

Of the nine plants in the prairies, three are capable of producing detergent-grade sodium sulphate. Each of the three plants has the capacity to produce 80 per cent or more of its output as a high-grade product. The "natural" sodium sulphate industry employs about 300 persons.

TABLE 4. CANADA, AVAILABLE DATA ON SODIUM SULPHATE CONSUMPTION, 1980 AND 1981

	1980	1981
	(tonnes)	
Pulp and paper	175 127	148 971
Soaps	38 814	40 855
Glass and glass wool	10 045	12 001
Other products[1]	8 059	5 130
Total	232 045	206 957

Source: Energy, Mines and Resources Canada.

[1] Colours, pigments, feed supplements and other minor uses.

TABLE 5. CANADA, RAILWAY TRAIN LOADINGS OF SODIUM SULPHATE, 1981 AND 1982

	1981r	1982P
	(tonnes)	
Eastern Canada[1]	35 218	37 483
Western Canada	499 686	515 476
Canada	534 904	552 959

Source: Statistics Canada.

[1] Eastern Canada refers to provinces east of the Ontario-Manitoba border.
P Preliminary; r revised.

Byproduct recovery. Courtaulds (Canada) Inc. produces approximately 21 000 t of detergent-grade sodium sulphate as a by-product of viscose rayon production at its Cornwall, Ontario plant. Ontario Paper Company Limited at Thorold, Ontario produced 51 100 t of salt cake in 1982, (68 000 t in 1981) as a byproduct of paper manufacturing. It is mostly used in the glass industry and 60 per cent is exported. The capacity of the Thorold plant is 77 000 tpy. The Great Lakes Paper Company, Limited at Thunder Bay, produces salt cake for internal consumption (about 10 000 t in 1982). Production capacity is double the consumption, but the extra amount cannot be commercialized because of the lack of drying facilities.

PRICES

Canadian prices of sodium sulphate were $70 and $90 per t respectively for salt cake and detergent grade at the beginning of the year. The prices increased to $75 and $95 per t in April and remained at this level until the end of 1982. In January 1983, the price of detergent grade (also used in glass) was increased to $101 per t, but that of salt cake remained the same. Prices for newly produced B.C. salt cake were based on the quoted price for natural salt cake from the Prairies. Prices for detergent grade by-product sodium sulphate in Ontario were in the order of $155 to $170 per t (for bulk) fob plants.

USES

In the chemical pulping of wood the digestion reagent consists of about two-thirds canotic soda and one-third sodium sulphide obtained by using sodium sulphate as makeup. About 33 per cent of sulphur input is retained in the organic chemicals recycled in the process. Lately, technical improvements in the process significantly decreased the consumption of sodium sulphate per t of pulp produced, to about 20 kg/t.

Sodium sulphate is used as a builder; or more correctly as a diluent in detergents (supplies "bulk"); it is claimed to improve detergency through its effect on the colloidal properties of the cleaning system. The curtailment in the usage of phosphates on grounds of pollution control in all probability is not going to affect the use of sodium sulphate. The content of sodium sulphate in detergents varies from about 10 to 65 per cent. Roskill Information Services Ltd., suggests that as a very rough estimate sodium sulphate used in detergents of all types would represent some 10 per cent of world consumption.

Some sodium sulphate is used by the glass industry as a source of Na_2O to speed melting. Other end uses of sodium sulphate are in the dyeing industry in the manufacture of viscose sponges, the tanning industry and textiles.

An important new use is linked to pollution abatement measures. Sodium sulphate is added to coal as a conditioner, since it improves the efficiency of high-temperature electrostatic precipitators by preventing clogging by fly-ash. Only about 5 kg of sodium sulphate (worth about 48 cents) is used for a tonne of coal. Experiments are being conducted in using sodium sulphate as a heat storage medium in solar energy conservation (heating) projects.

OUTLOOK

Outlook for Canadian production and sales of sodium sulphate in 1983 remains good in spite of the economic recession. This is due principally to a strong export market, with Canadian product replacing other sources of supply. However, increased industrial activity will result quickly in additional secondary supplies and the overall sales of Canadian natural sodium sulphate in 1983 will not show an increase if the recovery is strong.

The longer term growth in sodium sulphate demand in North America will come mainly from the detergent industry sector (2 per cent to 3 per cent per year) and possibly the power industry, where sodium sulphate is increasingly used as a conditioner in coalburning thermal plants. In the United States this new market has the potential to expand substantially perhaps up to 300 000 tpy in the late 1980s, or early 1990s.

Experiments were conducted in 1981 by Potash Corporation of Saskatchewan (PCS) in the use of sodium sulphate for the manufacture of potassium sulphate. The process is technically feasible and if economic conditions warrant it, the industry intends to put an experimental 30 000 tpy plant on stream in the foreseeable future.

U.S. commodity experts, however, still forecast none or little growth in sodium sulphate consumption in the decade of the 1980s since consumption in other traditional sectors, for example sodium sulphate usages in the pulp and paper industry, is declining.

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
21000-1	Natural sodium sulphate	10.0	14.1	25.0	9.0

MFN reductions under GATT (effective January 1 of year given)

	1982	1983	1984	1985	1986	1987
21000-1	14.1	13.8	13.4	13.1	12.8	12.5

UNITED STATES Custom Tariffs (MFN)

Item No.		1982	1983	1984	1985	1986	1987
421.42	Crude sodium sulphate	Remains free					
421.44	Anhydrous						
	(per long ton)	37¢	36¢	36¢	35¢	34¢	33¢
421.46	Crystallized	2.9%	2.8%	2.7%	2.7%	2.6%	2.5%

Sources: The Customs Tariff and Commodities Index, January 1982, Revenue Canada. Tariff Schedules of the United States Annotated 1982, USITC Publication 1200; U.S. Federal Register Vol. 44, No. 241.

Stone

M. PRUD'HOMME

SUMMARY

Canadian dimension stone has attracted attention in the building industry during the past year, especially granite. Extensive exploration, improved technology, growing capacity and intensive marketing have led toward increased sales and higher unit value. Competitiveness versus traditional substitutes such as concrete and ceramics remains, but variety, aesthetic considerations and prices have kept the dimension stone industry on an expanding trend. During 1982, new quarry operations started production in British Columbia, Ontario and Quebec. Prospects are foreseen in Newfoundland and in Ontario.

Naturally-occurring rock material, quarried or mined for industrial use with no change in its chemical state and with its physical character altered only by shaping or by sizing, is commercially termed "stone".

Dimension stone is shaped for use as a building block, slab or panel. It may be rough-cut, sawn or polished, and its application may depend on its strength, hardness, durability and ornamental qualities. Crushed stone is used mainly as an aggregate in concrete and asphalt, in highway and railway construction and as heavy riprap for facing wharves and breakwaters.

Granite, limestone, marble and sandstone are the principal rock types from which building and ornamental stone is fashioned. Over 90 per cent is used in construction-oriented projects, while less than 10 per cent is used as monument stone. Imports of rough blocks, particularly of granite, for sawing and polishing, as well as of finished stones for distribution to retailers, have cut into markets formerly supplied from domestic sources.

In the building sector of the construction industry, granite, limestone and marble are used as facing stone in the form of cut and polished panels, in conjunction with steel and concrete, for institutional and commercial buildings. In residential buildings the use of limestone or sandstone ashlar, or coursing stone, is becoming increasingly popular. The emphasis has changed from stone used for structural purposes to stone used for its aesthetic qualities. The architect and contractor can design and build for lasting beauty using Canadian building stone.

High costs associated with quarrying, finishing, transporting and placing dimension stone in the building construction sector have made market penetration by concrete products possible.

CANADIAN SCENE

Production of stone of all types in Canada in 1982 decreased about 28.9 per cent to 61.9 million t, while the unit value of production increased by 11.3 per cent. Stone is produced in direct response to the demands of the construction industry, which utilizes 93 per cent of output principally as crushed stone. Less than 1 per cent of stone production is used as building stone in the form of panels or blocks now that concrete products have become widely accepted in such applications. Since 1979, there has been a growing interest in Canadian stone for building use. Shipments of granite from Quebec, especially black anorthosite, red granite and brownish monzonite, for modular panelling have shown marked increase. The chemical uses are limited to the cement, lime, glass and metal smelting industries and account for about 3 per cent of stone production, mainly limestone. The remaining 3 per cent is consumed in pulverized form as filler and extender materials, and for agricultural purposes.

Crushed stone statistics are also included in the review on Mineral Aggregates along with data on Sand and Gravel and the Lightweight Aggregates. Most provinces have accumulated data relative to occurrences of stone of all types and in many cases have published such studies. The federal government, through the

TABLE 1. CANADA, TOTAL SHIPMENTS OF STONE, 1980-82

	1980		1981		1982P	
	(000 t)	($ 000)	(000 t)	($ 000)	(000 t)	($ 000)
By province						
Newfoundland	948	2,688	519	2,074	490	2,058
Nova Scotia	1 809	7,308	825	4,244	800	4,320
New Brunswick	3 054	11,029	2 688	10,665	2 500	10,425
Quebec	54 657	161,766	44 961	154,594	23 301	94,823
Ontario	31 529	106,300	30 707	116,931	30 200	120,752
Manitoba	2 088	9,705	1 845	9,853	1 800	10,098
Alberta	193	1,034	271	2,017	325	2,542
British Columbia	9 088	41,326	5 044	20,668	2 513	9,930
Canada	103 366	341,156	86 860	321,046	61 929	254,948
By use						
Building stone						
Rough	289	4,242	376	6,047	..	..
Monumental and ornamental stone	28	2,547	27	3,207	..	..
Other (flagstone, curbstone, paving blocks, etc.)	49	1,950	33	1,134	..	..
Chemical and metallurgical						
Cement plants, foreign	1 293	2,147	1 584	3,000	..	..
Lining, open-hearth furnaces	32	110	20	71	..	..
Flux in iron and steel furnaces	1 068	3,377	757	2,779	..	..
Flux in nonferrous smelters	212	1,710	151	1,339	..	..
Glass factories	237	2,661	188	2,370	..	..
Lime kilns, foreign	306	1,102	303	1,239	..	..
Pulp and paper mills	330	2,942	353	2,992	..	..
Sugar refineries	101	394	79	378	..	..
Other chemical uses	110	1,112	148	2,277	..	..
Pulverized stone						
Whiting (substitute)	32	1,513	35	1,812	..	..
Asphalt filler	53	403	41	176	..	..
Dusting, coal mines	6	159	8	167	..	..
Agricultural purposes and fertilizer plants	1 109	8,695	1 032	9,190	..	..
Other uses	576	2,830	596	973	..	..
Crushed stone for						
Manufacture of artificial stone	34	253	36	240	..	..
Roofing granules	306	15,849	266	15,931	..	..
Poultry grit	53	943	25	745	..	..
Stucco dash	25	1,410	21	1,291	..	..
Terrazzo chips	5	159	2	50	..	..
Rock wool	2	32	1	23	..	..
Rubble and riprap	15 284	25,899	11 275	25,761	..	..
Concrete aggregate	7 472	24,236	6 737	24,330	..	..
Asphalt aggregate	5 482	17,552	4 549	16,761	..	..
Road metal	30 750	102,064	21 749	70,820	..	..
Railroad ballast	3 233	14,470	5 528	29,944	..	..
Other uses	34 889	100,395	30 940	95,999	..	..
Total	103 366	341,156	86 860	321,046	..	..

P Preliminary; .. Not available.

Geological Survey of Canada, has also gathered and published a great number of geological papers pertaining to stone occurrences. Works by W.A. Parks[1] and by M.F. Goudge[2] have become classics in the fields of building stones and limestones, respectively.

Atlantic provinces. Limestone. The many occurrences of limestone in the Atlantic provinces have been systematically catalogued during the past few years[3,4,5]. Deposits of commercial importance are being worked in three of the four provinces.

In Newfoundland limestone is available from small, impure exposures in the eastern portion of the island, from small, high-calcium deposits in the central region, and from large, high-purity, high-calcium occurrences in the west. Other than periodic operation to secure aggregate for highway work, the main exploitation is by North Star Cement Limited at Corner Brook[6]. Large quantities of high-calcium limestone have been outlined in the Port au Port district.

In Nova Scotia limestones occur in the central and eastern parts of the province in thin, tilted lenses typical of deposits in Atlantic Canada and in contrast to deposits of much greater thickness and areal extent in central Canada.

In New Brunswick limestone is quarried at three locations - Brookville, Elm Tree and Havelock - for use as a crushed stone, as an aggregate, for agricultural application, for cement and lime manufacture, and for use as a flux.

Granite. Occurrences of granites in the Atlantic region have been described by Carr[7]. In Nova Scotia, a grey granite is produced from operations near Nictaux and from one quarry at Shelburne for use mainly in the monument industry. A black granite from Shelburne and a diorite from Erinville are used for monuments and for dimension stone.

Granites are quarried intermittently from a number of deposits within New Brunswick to obtain stone of required colour and texture for specific application. A red, fine- to medium-grained granite is quarried 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 upon demand, as is a salmon-coloured, medium-grained granite near Antinouri Lake, and a black, ferromagnesian rock in the Bocabec River area. Red granite is available in the St. George district. Manufacturers of monument stone continue to import dark, crude granite from South Africa.

In Newfoundland, there is a recognized potential for the development of labradorite deposits in the Nain River area of Labrador.

Sandstone. A medium-grained buff sandstone is quarried at Wallace, Nova Scotia, for use as heavy riprap and for dimension stone applications.

In New Brunswick, a red, fine- to medium-grained sandstone has been quarried in Sackville for use in construction of buildings on the Mount Allison University campus. Deposits are exploited from time to time throughout Kent and Westmorland counties for local projects and for highway work.

Quebec. Limestone. Limestone occurs in the St. Lawrence and Ottawa River valleys and in the Eastern Townships. Other major deposits in the province are located in the Gaspé region. The limestones range in age from Precambrian to Carboniferous and vary widely in purity, colour, texture and chemical composition[2]. Limestone blocks and other shapes are produced for the construction trade in the Montreal region and at various locations throughout the province as the need arises. Marble has been produced in the Eastern Townships and the Lac St-Jean areas.

Granite. Quebec, the major Canadian granite producer, accounts for up to 95 per cent of total granite shipments for use as building stone. Since 1979, sales have increased due to improved marketing and advanced processing technology. More than 25 companies quarry granite in Quebec, mainly in the Rivière-à-Pierre, the Lac St-Jean and the Appalachians regions. New quarries are expected to be operational in 1983 near Rouyn, St-Didace and Rivière-à-Pierre localities. In June 1982, Granicor Inc. inaugurated a process plant using advanced technology for cutting and polishing dimension stone. The company has obtained a major building contract in the United States worth several million dollars, to supply brownish monzonite modular block panels, extracted near the Chamouchouane River in the Lac St-Jean area. In September 1982, capacity expansion plans were being considered. During the same

TABLE 2. CANADA, PRODUCTION OF LIMESTONE, 1980 AND 1981

	1980		1981	
	(000 t)	($000)	(000 t)	($000)
By province				
Newfoundland	675	1,778	338	1,223
Nova Scotia	216	1,942	213	2,088
New Brunswick	914	5,491	546	4,565
Quebec	22 987	76,533	23 155	83,221
Ontario	29 402	84,300	27 889	86,620
Manitoba	970	3,124	863	2,817
Alberta	193	991	271	2,001
British Columbia	2 834	10,926	2 503	10,611
Canada	58 191	185,085	55 778	193,146
By use				
Building stone				
Rough	245	1,500	293	1,428
Monumental and ornamental	1	77	1	72
Other (flagstone, curbstone, paving blocks, etc.)	12	434	8	202
Chemical and metallurgical				
Cement plants, foreign	1 293	2,147	1 584	2,999
Lining, open-hearth furnaces	32	90	20	71
Flux, iron and steel furnaces	1 068	3,377	757	2,779
Flux, nonferrous smelters	212	1,707	151	1,337
Glass factories	237	2,661	188	2,370
Lime kilns, foreign	306	1,102	303	1,239
Pulp and paper mills	321	2,840	345	2,886
Sugar refineries	101	394	79	378
Other chemical uses	110	1,112	148	2,277
Pulverized stone				
Whiting substitute	32	1,513	35	1,812
Asphalt filler	53	403	34	158
Dusting, coal mines	6	159	8	167
Agricultural purposes and fertilizer plants	1 055	8,206	1 020	9,029
Other uses	573	2,749	550	466
Crushed stone for				
Artificial stone	18	50	30	123
Roofing granules	42	314	30	312
Poultry grit	52	921	24	726
Stucco dash	25	1,406	20	1,288
Rock wool	2	32	1	23
Rubble and riprap	1 048	2,190	471	1,447
Concrete aggregate	6 187	19,920	6 038	21,008
Asphalt aggregate	3 742	11,542	3 561	12,795
Road metal	19 971	59,037	18 108	58,906
Railroad ballast	992	2,322	999	3,192
Other uses	20 455	56,880	20 972	63,656
Total	58 191	185,085	55 778	193,146

TABLE 3. CANADA, PRODUCTION OF MARBLE, 1980 AND 1981

	1980		1981	
	(000 t)	($000)	(000 t)	($000)
By province				
Quebec	314	1,709	310	1,881
Ontario	2	98	4	135
Canada	316	1,807	314	2,016
By use				
Building stone				
Rough	-	-	2	111
Chemical process stone				
Flux in nonferrous smelters	--	3	--	1
Pulp and paper mills	9	102	8	105
Pulverized stone				
Agricultural purposes and fertilizer plants	53	489	11	162
Other uses	3	81	46	507
Crushed stone for				
Artificial stone	16	203	7	117
Stucco dash	--	5	--	3
Terrazzo chips	5	159	2	51
Concrete aggregate	47	265	31	184
Road metal	77	233	51	172
Roofing granules	--	5	2	50
Poultry grit	-	-	--	1
Other uses	105	262	153	552
Total	316	1,807	314	2,016

- Nil; -- Amount too small to be expressed.

TABLE 4. CANADA, PRODUCTION OF GRANITE, 1980 AND 1981

	1980		1981	
	(000 t)	($000)	(000 t)	($000)
By province				
Newfoundland	162	447	71	369
Nova Scotia	--	18	1	21
New Brunswick	1 928	5,186	1 967	5,773
Quebec	28 426	76,772	19 784	62,314
Ontario	2 094	21,509	2 666	29,850
Manitoba	1 118	6,582	982	7,035
British Columbia	6 255	30,400	2 541	10,056
Canada	39 983	140,914	28 012	115,418
By use				
Building stone				
Rough	26	2,035	59	3,584
Monumental and ornamental	27	2,470	26	3,131
Other (flagstone, curbstone, paving blocks, etc.)	28	1,140	13	573
Pulverized stone				
Asphalt filler	-	-	7	18
Crushed stone for				
Roofing granules	264	15,530	234	15,569
Poultry grit	1	21	--	18
Rubble and riprap	12 721	22,580	10 734	24,151
Concrete aggregate	939	2,772	479	2,183
Asphalt aggregate	1 488	5,048	844	3,329
Road metal	9 410	38,491	2 729	8,918
Railroad ballast	2 013	11,125	4 482	26,412
Other uses	13 066	39,702	8 405	27,532
Total	39 983	140,914	28 012	115,418

- Nil; -- Amount too small to be expressed.

year, A. Lacroix et fils Granit received a grant to expand facilities, thus creating 15 jobs. Searches for new deposits are concentrated in the Lac St-Jean and Abitibi areas. In 1983, the North Shore of the St. Lawrence River will be investigated by provincial government geologists.[8]

Sandstone. There are far fewer sandstone-producing operations in Quebec than there are producers of limestones and granites. Of six operations producing from sandstone resources only one is listed as marketing flagstone and construction blocks, in Hemmingford, Huntingdon County.

Ontario. Limestone. Although limestones in Ontario range from Precambrian through Devonian, the major production comes from Ordovician, Silurian and Devonian deposits[9,10]. Of particular importance are the limestones and dolomite from the following geological sequences: the Black River and Trenton formations, extending from the lower end of Georgian Bay across southern Ontario to Kingston; the Guelph-Lockport Formation, extending from Niagara Falls to the Bruce Peninsula and forming the Niagara Escarpment; and the Middle Devonian limestone extending from Fort Erie through London and Woodstock to Lake Huron. Production of building stone, fluxstone and crushed aggregate from the limestones of these areas normally accounts for about 90 per cent of total stone production in Ontario.

Marble is widely distributed over southeastern Ontario and, according to the Ontario Ministry of Natural Resources reports, underlies as much as 250 square kilometres (km^2)[11].

Steep Rock Calcite, a division of Steep Rock Iron Mines Limited, produces medium- to high-grade calcium carbonate at Tatlock and Perth. In 1982, the provincial government granted up to $1.35 million to assist the company's $6 million expansion plan which will double fine and medium production capacity.

The filler markets have become extremely attractive recently, not only to new ventures but also to companies hitherto interested in production of only coarser aggregate materials. Many lime operations now produce a filler-grade limestone product.

Granite. Granites occur in northern, northwestern and southeastern Ontario[12,13]. Few deposits have been exploited for the production of building stone because the major-consuming centres are in southern and southwestern Ontario where ample, good-quality limestones and sandstones are readily available. The areas most active in granite building stone production have been the Vermilion Bay area near Kenora, the River Valley area near North Bay, and the Lyndhurst-Gananoque area in southeastern Ontario. Rough building blocks were quarried from a gneissic rock near Parry Sound, while at Havelock a massive red-granite rock was quarried. In 1982, Fairmont Granite Limited of Beebe, Quebec, has reopened a fine pink granite quarry in Belmont Township for the production of building stone for modular block panels. A grant of up to $101,000 was made available through the Ontario Small Rural Mineral Development Program. In 1982, a study to assess building stone and other industrial minerals in the northwestern region was arranged between the Ontario and the federal governments under the Northern Ontario Rural Development Agreement.

Sandstone. Sandstone quarried near Toronto, Ottawa and Kingston has been used widely in Ontario as building stone[14]. Medina sandstones vary from grey, through buff and brown to red, and some are mottled. They are fine- to medium-grained. The Potsdam stone is medium-grained; the colour ranges from grey-white through salmon-red to purple, and it can also be 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 the following ages are represented: Precambrian, Ordovician, Silurian, Devonian and Cretaceous. Limestones of commercial importance occur in the three middle periods and range from magnesian limestone through dolomite to high-calcium limestones[2,15].

Although building stone does not account for a large percentage of total limestone produced, the best known Manitoba limestone is Tyndall Stone, a mottled dolomitic limestone often referred to as "tapestry" stone. It is widely accepted as an attractive building stone, and is quarried at Garson, Manitoba, about 50 km northeast of Winnipeg. 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

TABLE 5. CANADA, PRODUCTION OF SANDSTONE, 1980 AND 1981

	1980		1981	
	(000 t)	($000)	(000 t)	($000)
By province				
Newfoundland	110	462	109	482
Nova Scotia	1 591	5,348	612	2,136
New Brunswick	213	352	174	326
Quebec	1 145	5,111	1 276	6,132
Ontario	4	224	4	234
Alberta	1	43	--	16
Canada	3 064	11,540	2 176	9,326
By use				
Building stone				
Rough	18	707	22	924
Monumental and ornamental	-	-	--	4
Other (flagstone, curbstone, paving blocks, etc.)	10	375	12	359
Crushed stone for				
Rubble and riprap	2	2	70	164
Concrete aggregate	300	1,279	190	955
Asphalt aggregate	252	961	145	637
Road metal	1 131	3,978	503	1,932
Railroad ballast	227	1,023	46	341
Other uses	1 124	3,215	1 188	4,010
Total	3 064	11,540	2 176	9,326

- Nil; -- Amount too small to be expressed.

centres for use in the metallurgical, chemical, agricultural and construction industries.

The eastern ranges of the Rocky Mountains contain limestone spanning the geologic ages from Cambrian to Triassic, with major deposits in the Devonian and Carboniferous periods in which a wide variety of types occur[16]. 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]. 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 produced stone for construction and for filler use[17]. Periodically, interest is revived in the possible use of travertine from a British Columbia source.

Granite. In Manitoba, at Lac du Bonnet northeast of Winnipeg, a durable, red granite is quarried for building and monument use. Grey granite located east of Winnipeg near the Ontario border is a potential source of building stone.

In British Columbia a light-grey, to blue-grey even-grained granodiorite of medium texture is available from Nelson Island. An andesite has been quarried at Haddington Island, off the northeast coast of Vancouver Island, for use as a building stone. In 1982, Babette Lake Quartzite Products Ltd. started to produce blocks of massive pink quartzite to make cut and polished facing stone.

Sandstone. Sandstone for building and ornamental uses, quarried near Banff, Alberta is hard, fine-grained, medium-grey and is referred to as "Rundal Stone".

USES

Limestones are widely distributed in Canada and generally are available in sufficient quantity and with such chemical or physical specifications that long transportation hauls

TABLE 6. CANADA, PRODUCTION OF SHALE, 1980 AND 1981

	1980		1981	
	(000 t)	($000)	(000 t)	($000)
By province				
Quebec	1 785	1,641	436	1,048
Ontario	27	169	144	92
Canada	1 812	1,810	580	1,140
By use				
Crushed stone for				
Rubble and riprap	1 512	1,127	-	-
Road metal	161	326	358	893
Other uses	139	357	222	247
Total	1 812	1,810	580	1,140

- Nil.

TABLE 7. CANADA, PRODUCTION OF STONE BY TYPES, 1975, 1979-81

	1975		1979		1980		1981	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
Granite	11 470	34,913	43 104	135,804	39 983	140,914	28 012	115,418
Limestone	72 284	152,521	61 953	178,931	58 191	185,085	55 778	193,146
Marble	356	1,843	385	2,177	316	1,807	314	2,016
Sandstone	3 753	10,881	3 692	12,863	3 064	11,540	2 176	9,326
Shale	1 551	2,566	585	933	1 812	1,810	580	1,140
Total	89 414	202,724	109 719	330,708	103 366	341,156	86 860	321,046

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

are unnecessary. Limestone products are low-priced commodities and only rarely, when a market exists for a high-quality, specialized product such as white portland cement or a high-purity extender, are they beneficiated or moved long distances. Provided the specifications are met, the nearest source is usually considered, regardless of provincial or national boundaries.

Some major uses in the chemical field are: neutralization of acid waste liquors; extraction of aluminium 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.

Limestone is used in the metallurgical industries as a fluxing material where it combines with impurities in ore to form a fluid slag that can be separated from molten metal. Calcium limestones are used in open-hearth steel manufacture, whereas both calcium limestones and dolomitic limestones are used as a flux in the production of pig iron in blast furnaces.

Limestone is used extensively as a filler or an extender and, where quality permits, as whiting. In such applications both physical and chemical properties are important. Specifications vary widely but, in general, a uniform, white material passing 325 mesh would meet the physical requirements. Whiting is used in ceramic bodies, plastics, floor coverings, insecticides, paper, wood putty, rubber, paints and as a filler in many other commodities. In paint manufacture the material may be used as a pigment extender.

TABLE 8. CANADA, STONE EXPORTS AND IMPORTS, 1980-82

	1980		1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Exports						
Building stone, rough	5 019	723	11 182	1,222	2 941	576
Stone crude, nes	67 051	1,250	116 782	1,693	16 170	559
Natural stone, basic products	..	7,928	..	10,359	..	19,603
Total		9,901		13,274		20,738
Imports						
Building stone, rough	9 329	985	11 086	1,012	11 862	890
Stone crude, nes	20 163	1,054	7 233	952	4 180	470
Granite, rough	21 890	1,946	34 278	4,802	22 033	4,095
Marble, rough	6 656	2,290	7 485	3,053	7 059	3,282
Shaped or dressed granite	..	2,509	..	3,880	..	14,831
Shaped or dressed marble	..	1,858	..	2,119	..	1,709
Natural stone basic products	..	2,980	..	3,590	..	3,576
Total		13,622		19,408		28,853

Source: Statistics Canada.
P Preliminary; nes not elsewhere specified; .. Not available.

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.

Dolomite is the source of magnesium metal produced 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 Industries Limited.

As a dimension stone, granite is processed for interior and exterior floor- and wall-covering, modular block panelling and for monument stone. Uniformity of colour and texture, and durability are the main features sought. Quarrying must take into account geological and structural features as well as topography and accessibility.

OUTLOOK

Dimension stone has been the subject of periodic surges of interest in past years. Currently the industry, especially in Quebec, is in a period of significant growth. Completion of intensive modernization has permitted producers to offer high-quality finished products at competitive prices. Markets for building stone are still under pressure from competitive substitutes such as steel, concrete, glass and ceramics. However, for aesthetic reasons and particular physical characteristics, the demand for granite dimension stone is likely to expand as new markets are developed and producers increase capacity. Efforts have been made on behalf of the industry to illustrate to contractors and architects the availability of a wide range of Canadian building stones and their adaptability in modern building design.

There is justifiable concern for the future development, operation, and rehabilitation of pits and quarries in all locations, especially in and near areas of urban development. Rehabilitation of stone quarries for subsequent land use is generally more difficult and costly than rehabilitation of gravel pits. Although an open-pit mining operation close to residential areas is seldom desirable, nonrenewable mineral resources must be fully and wisely utilized. When urban sprawl has been unexpectedly rapid, conflicts for land use can materialize and potential sources of raw mineral materials for the construction industry can be overrun. Master plans for land use are required to coordinate all phases of development so that mineral exploitation is part of the urban growth pattern.

TARIFFS

CANADA Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
29635-1	Limestone, not further processed than crushed or screened	free	free	25	free
30500-1	Flagstone, sandstone and all building stone, not hammered, sawn or chiselled	free	free	20	free
30505-1	Marble, rough, not hammered or chiselled	free	free	20	free
30510-1	Granite, rough, not hammered or chiselled	free	free	20	free
30515-1	Marble, sawn or sand rubbed, not polished	free	4.6	35	free
30520-1	Granite, sawn	free	6.8	35	free
30525-1	Paving blocks of stone	free	6.8	35	free
30530-1	Flagstone and building stone, other than marble or granite, sawn on not more than two sides	free	6.8	35	free
30605-1	Building stone, other than marble or granite, sawn on more than two sides but not sawn on more than four sides	5	6.8	10	4.5
30610-1	Building stone, other than marble or granite, planed, turned, cut or further manufactured than sawn on four sides	7.5	10.8	15	7
30615-1	Marble, not further manufactured than sawn, when imported by manufacturers of tombstones to be used exclusively in the manufacture of such articles, in their own factories	free	free	20	free
30700-1	Marble, nop	14.3	14.3	40	9.5
30705-1	Manufactures of marble, nop	14.3	14.3	40	9.5
30710-1	Granite, nop	14.8	14.8	40	9.5
30715-1	Manufactures of granite, nop	14.8	14.8	40	9.5
30800-1	Manufactures of stone, nop	15.6	15.6	35	10
30900-1	Roofing slate, per square of 100 square feet	free	free	75¢	free
30905-1	Granules, whether or not coloured or coated, for use in manufacture of roofing, including shingles and siding	free	free	25	free

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
				(%)		
30515-1	4.6	4.5	4.4	4.3	4.1	4.0
30520-1	6.8	6.5	6.3	6.0	5.8	5.5
30525-1	6.8	6.5	6.3	6.0	5.8	5.5
30530-1	6.8	6.5	6.3	6.0	5.8	5.5
30605-1	6.8	6.5	6.3	6.0	5.8	5.5
30610-1	10.8	10.3	9.7	9.1	8.6	8.0
30700-1	14.3	13.3	12.2	11.1	10.1	9.0
30705-1	14.3	13.3	12.2	11.1	10.1	9.0
30710-1	14.8	13.9	12.9	12.0	11.1	10.2
30715-1	14.8	13.9	12.9	12.0	11.1	10.2
30800-1	15.6	15.0	14.4	13.8	13.1	12.5

UNITED STATES (MFN)

		1982	1983	1984	1985	1986	1987
				(%)			
	Granite, suitable for use as monumental, paving or building stone:						
513.71	Not pitched, not lined, not pointed, not hewn, not sawed, not dressed, not polished, and not otherwise manufactured			Free			
513.74	Pitched, lined, pointed, hewn, sawed, dressed, polished, or otherwise manufactured	5.3	5.1	4.9	4.7	4.4	4.2
	Limestone, suitable for use as monumental, paving or building stone:						
514.21	Not hewn, not sawed, not dressed, not polished, and not otherwise manufactured, per cubic foot	0.6¢	0.5¢	0.4¢	0.2¢	0.1¢	free
514.24	Hewn, sawed, dressed, polished, or otherwise manufactured	8.8	8.3	7.7	7.1	6.6	6.0
514.51	Marble, breccia, in block, rough or squared only, per cubic foot	12.9¢	12.7¢	12.6¢	12.4¢	12.2¢	12.0¢
514.57	Marble, breccia, oronyx, sawed or dressed, over 2 inches thick, per cubic foot	23.1¢	22.5¢	21.9¢	21.2¢	20.6¢	20.0¢
	Stone suitable for use as monumental, paving, or building stone:						
515.51	Not hewn, not sawed, not dressed, not polished, and not otherwise manufactured, per cubic foot	0.6¢	0.5¢	0.4¢	0.2¢	0.1¢	free
515.54	Hewn, sawed, dressed, polished, or otherwise manufactured, per cubic foot	8.8¢	8.3¢	7.7¢	7.1¢	6.6¢	6.0¢

Sources: The Customs Tariff and Commodities Index, January 1982, Revenue Canada; Tariff Schedules of the United States Annotated 1982, USITC Publication 1200; U.S. Federal Register, Vol. 44, No. 241.

Sulphur

B.W. BOYD

Sulphur, principally in the form of sulphuric acid, is used at some stage in the production of virtually everything we eat, wear or use. As such, its consumption level traditionally has served as an indicator of the state of the economy of an individual nation or of the world. About 60 per cent of all sulphur is consumed in the production of phosphate and ammonium sulphate fertilizers.

Canadian sulphur is obtained from three sources: elemental sulphur, derived from sour natural gas, petroleum, and tar sands; sulphur in the form of sulphuric acid recovered from smelter gases; and pyrite concentrates, used in sulphuric acid manufacture.

Sulphur recovered from sour natural gas is presently the most important source in Canada, particularly in Alberta where it occurs as hydrogen sulphide in varying quantities in many reservoirs. Since hydrogen sulphide is corrosive and toxic, it must be removed from gas prior to distribution.

In 1982, sulphur demand in the western world declined by about 15 per cent in line with lower fertilizer usage during the recession. Consequently, world trade in elemental sulphur fell by about 1 million t or 7 per cent and by year-end prices in the major markets had weakened from the stable level maintained in 1981 and much of 1982.

For Canada, the world market is very important, with offshore exports accounting for 70 per cent of all sales. Furthermore, Canada has a dominant position in the world market accounting for 45 per cent of international trade. Canadian exports were maintained at the 1981 level for the first half of 1982 but later suffered the decline that had already hit most other exporting countries. Consequently, net exports offshore for 1982 were 13 per cent lower than the peak 5 796 000 t achieved the previous year.

The largest drop was in sales to western Europe which were only 480 000 t in 1982 compared with 839 000 t the year before. Morocco, Tunisia and Brazil also reduced imports from Canada due to lower requirements for their fertilizer production. Exports to India were partially replaced by sales from Saudi Arabia which started shipping sulphur in March 1982. An anomaly in the world market was the increase in imports by the U.S.S.R. which more than doubled its imports from Canada, taking 328 000 t.

The largest customer for Canadian elemental sulphur, the United States, cut back imports from Canada by 25 per cent. Within the United States, annual consumption of sulphur in all forms fell from 12.8 to 10.4 million t and production fell from 12.1 to 10.1 million t. In June, for the first time, recovered sulphur production exceeded Frasch production. During the following months the difference increased so that in December recovered sulphur, at 473 000 t exceeded Frasch production by 152 000 t. Imports of sulphur at 1.9 million t, mainly in liquid form, were 600 000 t lower than in 1981. Canada and Mexico supplied 64 and 36 per cent respectively. A net 568 000 t of sulphur was added to United States stocks to bring the stockpile to 4.2 million t.

Canadian consumption of sulphur in all forms fell 14 per cent in 1982 to a level of 1.4 million t. The supply was made up of: 767 000 t elemental sulphur of which 62 per cent was converted to sulphuric acid, 1.8 million t of sulphuric acid recovered at nonferrous smelters and 193 000 t of imported acid. Canadian recovery of sulphuric acid and liquid sulphur dioxide at smelters was down 33 per cent from 1981 due to the lengthy shutdowns at several base-metal smelters; 6 months (and continuing into 1983) at Inco Limited and Falconbridge Limited in the Sudbury area, 4 months at Noranda Mines Limited in Valleyfield, 2 months in Murdochville and 1 month at Cominco Ltd. in Trail.

TABLE 1. CANADA, SULPHUR SHIPMENTS AND TRADE, 1981 AND 1982

	1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)
Shipments				
Pyrite and pyrrhotite[1]				
Gross weight	10 000	110	20 000	220
Sulphur content	5 000	110	9 000	220
Sulphur in smelter gases[2]	783 000	47,392	579 000	41,027
Elemental sulphur[3]	8 018 000	647,652	7 108 000	600,302
Total sulphur content	8 806 000	695,154	7 696 000	641,549
Imports				
Sulphur, crude or refined				
United States	4 633	838	2 159	395
Total	4 633	838	2 159	395
Sulphuric acid, including oleum				
United States	28 805	1,565	74 262	4,847
West Germany	35 750	1,317	74 405	2,480
Norway	12 695	497	22 390	913
United Kingdom	5 245	388	-	-
Other countries	-	-	21 458	840
Total	82 495	3,767	192 515	9,080
Exports				
Sulphur in ores (pyrite)				
United States	..	109	..	239
Total	..	109	..	239
Sulphuric acid, including oleum				
United States	336 363	7,072	259 716	8,404
Peru	1 143	85	-	-
Other countries	12	31	24	20
Total	337 518	7,188	259 740	8,424
Sulphur, crude or refined, nes				
United States	1 513 075	100,588	1 132 346	85,510
Morocco	518 661	65,988	464 886	61,544
Brazil	632 174	81,160	447 437	60,621
South Africa	486 598	59,692	453 333	59,748
Australia	591 400	70,191	467 266	58,234
Tunisia	403 269	50,752	349 829	45,432
India	497 042	62,854	373 237	43,172
People's Republic of China	221 164	28,087	309 904	41,449
U.S.S.R.	135 580	18,579	201 086	27,628
South Korea	236 430	29,082	194 235	26,058
New Zealand	230 939	26,694	208 409	25,864
Cuba	115 669	13,947	198 576	22,683
Mozambique	141 789	16,332	166 256	22,218
Italy	276 224	34,526	168 618	20,228
Taiwan	279 602	37,747	125 922	17,638
Israel	132 963	8,798	152 773	10,802
Other countries	896 637	104,426	697 298	90,999
Total	7 309 216	809,443	6 111 411	719,828

Source: Statistics Canada; Energy, Mines and Resources Canada.
[1] Producers' shipments of byproduct pyrite and pyrrhotite from the processing of metallic sulphide ores. [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 and synthetic crude oil.
P Preliminary; - Nil; .. Not available; nes Not elsewhere specified.

TABLE 2. CANADA, SOUR GAS SULPHUR EXTRACTION PLANTS, 1982

Operating Company	Source Field or Plant Location	H_2S in Raw Gas	Daily Capacity
	(Alberta, except where noted)	(%)	(tonnes)
Amerada Hess Corporation	Olds	11	384
Amoco Canada Petroleum	Bigstone Creek	19	382
Amoco Canada Petroleum	East Crossfield	34	1 757
Amoco Canada Petroleum	Windfall	16	1 175
Canada-Cities Service, Ltd.	Paddle River		19
Canadian Superior Oil Ltd.	Harmattan-Elkton	53	490
Canadian Superior Oil Ltd.	Lonepine Creek	12	157
Sulpetro Limited	Minnehik-Buck Lake		45
Canterra Energy Ltd.	Brazeau River		42
Canterra Energy Ltd.	Okotoks	36	459
Canterra Energy Ltd.	Rainbow Lake	4	139
Canterra Energy Ltd.	Ram River (Ricinus)	9-35	4 567
Chevron Standard Limited	Kaybob South	19	3 521
Chevron Standard Limited	Nevis	7	260
Dome Petroleum Limited	Steelman, Sask.	1	7
Esso Resources Canada	Joffre		17
Esso Resources Canada	Quirk Creek	9	300
Esso Resources Canada	Redwater	3	33
Gulf Canada Limited	Homeglen-Rimbey	1-3	333
Gulf Canada Limited	Nevis	3-7	295
Gulf Canada Limited	Pincher Creek	10	160
Gulf Canada Limited	Strachan	10	943
Home Oil Company Limited	Carstairs	1	72
Hudson's Bay Oil and Gas	Brazeau River	1	110
Hudson's Bay Oil and Gas	Caroline	1	22
Hudson's Bay Oil and Gas	Edson	2	284.5
Hudson's Bay Oil and Gas	Kaybob South (1)	17	1 064
Hudson's Bay Oil and Gas	Kaybob South (2)	17	1 064
Hudson's Bay Oil and Gas	Lonepine Creek	10	283
Hudson's Bay Oil and Gas	Sturgeon Lake		49
Hudson's Bay Oil and Gas	Zama		74
Mobil Oil Canada, Ltd.	Wimborne	14	168
Mobil Oil Canada, Ltd.	Teepee		29
PanCanadian Petroleum Limited	Morley		18
Petro-Canada	Gold Creek		43
Petro-Canada	Wildcat Hills	4	177
Petrogas Processing Ltd.	Crossfield (Balzac)	31	1 687
Saratoga Processing Company	Savannah Creek (Coleman)	13	389
Shell Canada Limited	Burnt Timber Creek	8-5	497
Shell Canada Limited	Innisfail	14	163
Shell Canada Limited	Jumping Pound	3-5	511
Shell Canada Limited	Rosevear		153
Shell Canada Limited	Simonette River	15	267
Shell Canada Limited	Waterton	18-25	3 066
Suncor Inc.	Rosevear		110
Texaco Exploration Company	Bonnie Glen		15
Westcoast Transmission	Fort Nelson, B.C.		1 100
Westcoast Transmission	Taylor Flats, B.C.	3	460
Western Decalta Petroleum	Turner Valley	4	24
Total daily rated capacity December 31, 1982			28 439

Sources: From Alberta Energy Resources Conservation Board publications.

TABLE 3. CANADIAN REFINERY SULPHUR CAPACITIES, 1982

Operating Company	Location	Daily Capacity (tonnes)
Gulf Canada Limited	Edmonton, Alberta	103
	Port Moody, B.C.	25
	Clarkson, Ontario	40
	Port Tupper, N.S.	(40)
Husky Oil Ltd.	Prince George, B.C.	5
Imperial Oil Ltd.	Edmonton, Alberta	36
	Dartmouth, N.S.	40
	Sarnia, Ontario	103
	Vancouver, B.C.	20
Irving Oil Ltd.	Saint John, N.B.	200
Sulconam Inc.	Montreal, Quebec	300
Newfoundland Refining Co. Ltd.	Come-by-Chance, Nfld.	(194)
Shell Canada Res. Ltd.	Shellburn, B.C.	15
	Oakville, Ontario	35
	Sarnia, Ontario	31
Suncor Inc.	Sarnia, Ontario	10
Texaco Canada	Nanticoke, Ontario	8
Res. Ltd.	Calgary, Alta.	10
Canadian Ultramar Limited	Montreal, Quebec	81
Total 1982		1 062

Sources: Oilweek, Chemical Economics Handbook.
( ) Not operational in 1980.

There were 45 sour gas plants in operation in Alberta and 3 in British Columbia, with a combined annual capacity of 10.4 million t of sulphur. The elemental sulphur production, at 5.6 million t was lower again in 1982, continuing the trend of declining production since 1973. To meet shipment commitments of 7.1 million t some 1.5 million t of sulphur was withdrawn from reserve stocks. However with the slackening demand, toward year-end, many producers were adding to their vatted stocks, while others were melting so that for some months the net withdrawals were very small.

In late October, the port of Vancouver was shutdown due to labour difficulties and did not reopen for about three weeks. Schedule changes for deliveries of sulphur to the port were made and consequently loadings for October and November were not greatly affected.

CANADIAN PROJECTS

One sour gas plant expansion should be completed and three new plants should be operating by the end of 1983. Shell Canada Resources Limited is increasing the capacity of the Jumping Pound plant from 511 tpd to 566 tpd elemental sulphur. Hudson's Bay Oil and Gas Company Limited is constructing a gas plant at Brazeau River, capable of producing 300 tpd of sulphur. Gulf Canada Resources Inc. has nearly completed a new plant in the Hanlan-Robb area, with a capacity of 1 478 tpd. Chieftain Development Co. Ltd. and Texaco Canada Resources Ltd. are planning a plant with 200 tpd capacity for the Hythe area.

Canadian Occidental Petroleum Ltd. is planning to construct a sour gas plant of 700 tpd sulphur capacity for operation in 1985. The plant, to be located near Alderside, Alberta has been named the Mazeppa Plant.

WORLD DEVELOPMENTS

In 1982 Poland was able to maintain exports at the reduced 1981 level which is about 400 000 t below the peak established in 1978. Sales to Africa, South American and the eastern bloc countries compensated for a 120 000 t reduction in sales to western Europe.

Mexican exports fell by about 240 000 t in 1982 as sales to the United States and to eastern European countries were reduced.

In the U.S.S.R. developments are under way in the Astrakhan gas field which could bring an additional 3 million tpy of elemental sulphur into the communist bloc market by 1986.

Saudi Arabia, which has been producing sulphur at three plants and whose stocks reached 1.4 million t, began shipping in March 1982. Due to the short distance to

TABLE 4. CANADA, PRINCIPAL SULPHUR DIOXIDE AND SULPHURIC ACID PRODUCTION CAPACITIES, 1982

Operating Company	Plant Location	Raw Material	Annual Capacity Sulphuric Acid[1]	S. equiv.
			(000 tonnes)	
Aluminum Company of Canada, Limited (Alcan)	Arvida, Que.	Elem. S.	80	26
Allied Corporation	Valleyfield, Que.	SO_2 zinc conc.	140	46
Brunswick Mining and Smelting Corporation Limited	Belledune, N.B.	SO_2 lead-zinc	160	52
Canadian Electrolytic Zinc Ltd.	Valleyfield, Que.	SO_2 zinc conc.	210	69
C-I-L Inc.	Beloeil, Que.	Elem. S.	65	21
Inco Metals Company	Copper Cliff, Ont.	SO_2 pyrrhotite	900	294
	Copper Cliff, Ont.	SO_2 copper	Liquified SO_2	45
NL Chem Canada Inc.	Varennes, Que.	Elem. S.	45	15
Falconbridge Limited	Sudbury, Ont.	SO_2 pyrrhotite	285	93
International Minerals & Chemical Corporation (Canada) Limited	Port Maitland, Ont.	Elem. S.	250	82
Gaspé Copper Mines, Limited	Murdochville, Que.	SO_2 copper	245	80
Canada Colors and Chemicals	Elmira, Ont.	Elem. S.	35	11
Kidd Creek Mines Ltd.	Kidd Creek, Ont.	SO_2 zinc conc.	410	134
Subtotal Eastern Canada			2 825	969
Border Chemical Company Ltd.	Transcona, Man.	Elem. S.	150	49
Cominco Ltd.	Kimberley, B.C.	SO_2 pyrrhotite	300	98
	Trail, B.C.	SO_2 lead-zinc	430	141
	Trail, B.C.	SO_2 lead-zinc	Liquified SO_2	40
Esso Chemical Canada	Redwater, Alta.	Elem. S.	965	316
Eldorado Resources Limited	Rabbit Lake, Sask.	Elem. S.	45	15
Inland Chemicals Ltd.	Fort Saskatchewan, Alta.	Elem. S.	200	65
	Prince George, B.C.	Elem. S.	35	11
Sherritt Gordon Mines Limited	Fort Saskatchewan, Alta.	Elem. S.	190	62
Western Co-operative Fertilizers Limited	Calgary, Alta.	Elem. S.	390	128
	Medicine Hat, Alta.	Elem. S.	530	173
Subtotal Western Canada			3 235	1 098
TOTAL			6 060	2 067

[1] 100% H_2SO_4.

India, the export company Saudi Sulfur Co. (SASULCO) was able to deliver several hundred thousand t of sulphur to ports in India at competitive prices, while maintaining an fob Persian Gulf price $5 to $10 above the price of Canadian sulphur fob Vancouver. SASULCO is expected to increase sales in 1983 and has the potential to supply about 1 million tpy for international trade.

Continued unrest in Iran and Iraq has kept deliveries from these countries to about 15 per cent of the over 1 million t total capacity at gas plants and the Mishraq mine.

PRICES

The value of Canadian elemental sulphur sales in 1982 was about $565 million or an average $80 per t fob plant. For offshore exports, contract prices fob Vancouver, held at $US 110/t through most of the year although lengthened credit terms and discounts lowered the effective price by about 5 per cent toward the end of the year.

For shipments within North America the price fob plant in Alberta rose from $65.42/t in February to $73.81/t in June, dropped back to $67.06/t in August and to $64.36/t by the end of the year.

In November, Sulphur Export Corp. (Amsulex), the United States marketing organization, announced a price reduction of $US 10/t effective January 1, 1983. This brought the price at Antwerp and Rotterdam to $US 140/t. This lead was followed by other major producers reducing the price in Vancouver to $US 100/t in early 1983.

TRADE

Canadian elemental sulphur exports in 1982 were 16 per cent lower than the previous year and the value on a customs clearance basis was down 11 per cent, at $719,829,000. The largest market was the United States although sales there fell by 25 per cent relative to 1981. Most other consumers also took less sulphur with the exception of Israel, Mozambique, Peoples Republic of China, Cuba, Finland and the U.S.S.R. Shipments to Cuba and Finland were reportedly re-exported to the U.S.S.R. which would bring its imports from Canada to over 400 000 t sulphur in 1982.

Contract problems between the Moroccan phosphate monopoly, Office Chérifien des Phosphate (OCP), and Cansulex Limited contributed to the decline in exports to Morocco although other Canadian sulphur exporters picked up contracts on most of the disputed tonnage.

Import of sulphuric acid more than doubled to compensate for lost acid production in eastern Canada due to temporary smelter closures. West Germany and the United States supplied most of the imported acid which accounted for 7 per cent of domestic acid consumption.

Acid exports from Canada fell by one third and only exceeded imports by 67 223 t, the lowest level since 1978. On the other hand, the value increased because of the tight supply situation and the value of pyrite exports doubled.

ISSUES

At the end of 1982, there were some 15 million t of sulphur in the reserve stocks in Alberta, an amount equivalent to the total international trade in elemental sulphur for one year. Annual production in Alberta amounted to another 5 million t. Facilities are in place to move up to 7.5 million tpy onto the export market from current production and stockpiles.

However, as demonstrated during the 1970s, the demand for sulphur is price-inelastic over a wide range of prices. Therefore, if the Alberta producers dispose of their reserve stocks as quickly as possible, prices would fall and, the reserve stocks would be sold at less than the long-term price trend. Thus, the reserve stocks could be more responsibly managed by liquidating them when the price rises above the long-term trend and by building them up when the price falls. Such a practice would ensure stable supplies and optimum returns to involuntary producers.

TABLE 5. CANADA, SULPHUR SHIPMENTS AND TRADE, 1966, 1971, 1978-82

	Shipments[1]				Imports	Exports	
	Pyrites	In Smelter Gases	Elemental Sulphur	Total	Elemental Sulphur	Pyrites[2]	Elemental Sulphur
	(tonnes)				(tonnes)	($)	(tonnes)
1966	147 226	453 870	1 851 924	2 453 020	131 955	981,000	1 269 157
1971	140 642	561 046	2 856 796	3 558 484	27 923	1,074,000	2 401 975
1978	4 602	676 278	5 752 208	6 433 088	8 130	57,000	4 984 546
1979	13 964	667 265	6 314 244	6 995 473	1 699	281,000	5 154 831
1980	14 328	894 732	7 655 723	8 564 783	1 767	386,000	6 850 143
1981	5 000	783 000	8 018 000	8 806 000	4 633	109,000	7 309 216
1982P	9 000	579 000	7 108 000	7 696 000	2 159	239,000	6 111 411

Source: Statistics Canada; Energy, Mines and Resources Canada.
[1] See footnotes for Table 1. [2] Quantities of pyrites exported not available.
P Preliminary.

TABLE 6. CANADIAN EXPORT MARKETS FOR SULPHUR, 1982P

Country or Area	Exports	Per cent of Total
	(million tonnes)	
United States	1.13	18.5
Europe	.73	12.0
Brazil	.45	7.4
Australia	.47	7.7
India	.37	6.1
South Africa	.45	7.4
Tunisia	.35	5.7
Taiwan	.12	2.0
South Korea	.19	3.1
New Zealand	.21	3.4
Others	1.64	26.7
Total	6.11	100.0

Source: Statistics Canada.
P Preliminary.

Over the past four years, the management of the stockpiles has meant withdrawals amounting to 5.5 million t. In late 1982, under the influence of the entry of Saudi Arabia on the market and the efforts of several of the involuntary producers to maintain market share, the price fell. In response, some suppliers of Canadian sulphur resumed stockpiling. Other suppliers, however, continued to re-melt their stocks and discount their price to maintain their market share offshore.

OUTLOOK

Competition for international trade in sulphur could reduce Canada's share by 1.5 million t in 1983, relative to 1982. Poland has become an aggressive seller in North Africa and South America; Saudi Arabia started shipping at the 800 000 tpy level; and Iran and Iraq are renewing exports of sulphur, albeit at a lower rate than in 1980. The cash flow from these sales is very important to Poland, Iran and Iraq so it is unlikely that a moderate decline in price will diminish their eagerness to make sales.

Government and industry are consistent in forecasting sulphur exports from Canada to drop by 1.5 million t in 1983. The revenue to be gained from the remaining sales will be determined by the marketing strategies of the Canadian gas producers and the management of their reserve stocks.

TABLE 7. CANADA, SULPHURIC ACID PRODUCTION, TRADE AND APPARENT CONSUMPTION, 1966, 1971, 1978-82P

	Production	Imports	Exports	Apparent Consumption
		(tonnes - 100% acid)		
1966	2 267 962	6 303	49 848	2 224 417
1971	2 660 773	4 492	91 711	2 573 554
1978	3 260 846	107 766	205 166	3 163 446
1979	3 666 080	170 618	139 425	3 697 273
1980	4 295 366	18 048	323 775	3 989 639
1981	4 116 860	82 495	337 518	3 861 837
1982P	3 130 854	192 515	259 740	3 063 629

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

TABLE 8. CANADA, CONSUMPTION[1] OF ELEMENTAL SULPHUR AND LIQUID SULPHUR DIOXIDE, 1981

	Elemental	Sulphur Dioxide
	(tonnes)	
Fertilizers, stock and poultry feed	554 111	-
Paper pulp	125 107	40 505
Paper and paper products	70 033	15 408
Miscellaneous chemicals and explosives	62 493	45
Rubber products	2 664	w
Abrasives, artificial	1 338	-
Foundry	328	w
Wire and cable	13	-
Other	108	2 312[2]
Total	816 195	58 270

[1] As reported by consumers. [2] Includes starch, foundry, sugar processing, glass and glass products, paint and varnish, and rubber products.
w Witheld to avoid disclosing company proprietary data; - Nil.

TABLE 9. WORLD PRODUCTION OF SULPHUR IN ALL FORMS, 1981

	Elemental	Other[1]	Total
		(000 tonnes)	
United States	10 607	2 183	12 790
U.S.S.R.	3 710	5 791	9 501
Canada	8 018	788	8 806
Poland	4 773	149	4 922
Japan	1 041	1 665	2 706
Mexico	2 052	84	2 136
France	1 970	157	2 127
West Germany	1 109	704	1 813
Spain	20	1 179	1 199
Italy	78	438	516
Iraq	145	-	145
Finland	45	413	458
Sweden	37	274	311
Iran	6	-	6
Other countries	1 964	6 434	8 398
Total	33 482	20 374	53 856

Source: British Sulphur Corporation Limited, Sulphur No. 164, January-February 1983.
[1] Sulphur in other forms includes sulphur contained in pyrites and contained sulphur recovered from metallurgical waste gases mostly in the form of sulphuric acid.
- Nil.

TABLE 10. CANADA, SULPHURIC ACID CONSUMPTION, 1980 AND 1981

	1980	1981
	(tonnes - 100% acid)	
Uranium mines	294 209	327 698
Miscellaneous metal mines	25 200	36 877
Crude petroleum and natural gas industry	9 800	5 336
Sugar, vegetable oil and miscellaneous food processors	4 218	8 702
Leather industries)	63 693	6 414
Textile industries)		
Pulp and paper mills	301 320	269 570
Iron and steel mills	8 801	5 174
Smelting and refining	254 890	264 343
Electrical products industries	16 026	17 949
Nonmetallic mineral products	2 390	313
Petroleum refineries and coal products	30 030	25 165
Fertilizers and other industrial chemicals	2 969 357	2 900 647
Plastics and synthetic resins	5 320	49 739
Soap and cleaning compounds	17 325	26 224
Explosives and miscellaneous chemical industries	58 130	78 750
Miscellaneous manufacturing industries	16 355	18 433
Other end uses[1]	31 928	34 163
Total	4 108 992	4 075 497

[1] Other end uses include automotive; hydro, municipal, utility and water; metal fabricating; and miscellaneous manufacturing industries.
Totals include spent acid.

PRICES

Canadian sulphur prices quoted in Alberta Energy Resources Industries monthly statistics December, 1982	($)
Sulphur elemental, fob plant, tonne	
North American deliveries	64.36
Offshore deliveries	80.44
Canadian sulphuric acid price quoted in Corpus Chemical Report, July 4, 1983	
Sulphuric acid, fob plants, East, 66° Be, tanks, per tonne	98.80
United States prices in U.S. currency, quoted in Engineering and Mining Journal, December 1982	($)
Sulphur elemental	
U.S. producers, term contracts fob vessel at Gulf ports, Louisiana and Texas, per long ton	
Bright	140
Dark	140
Export prices, ex terminal Holland, per long ton	
Bright	146-152.50
Dark	146-152.50
Mexican export, fob vessel, per long ton, U.S. currency	
Bright	110-115
Dark	125-135

fob Free on board.

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
92503-1	Sulphur of all kinds, other than sublimed sulphur, precipitated sulphur and colloidal sulphur	free	free	free	free
92802-1	Sulphur, sublimed or precipitated; colloidal sulphur	free	free	free	free
92807-1	Sulphur dioxide	free	free	free	free
92808-1	Sulphuric acid, oleum	9.4	9.4	25	6
92813-4	Sulphur trioxide	free	free	free	free

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
			(%)			
92808-1	9.4	7.5	5.6	3.8	1.9	free

UNITED STATES

418.90	Pyrites	free
415.45	Sulphur, elemental	free
416.35	Sulphuric acid	free

		1982	1983	1984	1985	1986	1987
				(%)			
422.94	Sulphur dioxide	5.3	5.1	4.9	4.7	4.4	4.2

Sources: The Customs Tariff and Commodities Index, 1982, Revenue Canada; Tariff Schedules of the United States annotated 1982, USITC Publication 1200; U.S. Federal Register Vol. 44, No. 241.

Talc

M. PRUD'HOMME

SUMMARY

Since 1980, demand for talc has increased toward high quality products reflecting higher unit value. Canadian producers are on an expanding trend producing a larger range of quality and increasing production capacity. Imports showed an important decrease in 1981 due to improved Canadian production and the economic situation, and the pattern was maintained in 1982. Paper, plastic and paint are the growing market sectors.

Talc is a hydrous magnesium metasilicate, $Mg_3Si_4O_{10}(OH)_2$, and is usually intimately associated with numerous other minerals such as serpentine, dolomite and quartz. The colour is characteristically a pale green, also grey or creamy white. It exhibits a pearly lustre, a soft hardness and a greasy feel or extreme smoothness. Talc is derived from the alteration of magnesian rocks in an intensive metamorphic environment. It occurs as veinlets, tabular bodies or irregular lenses. Talc is valued for its various properties: extreme whiteness, smoothness, high fusion point, low thermal and electrical conductivity and chemical inertness. Talc is produced in various grades which are usually classified by end-use: paint, ceramic, pharmaceutical and cosmetic. A special, high-quality block talc, used in making ceramic insulators and other worked shapes, is designated "steatite grade".

Soapstone is a massive, soft, greenish impure talcose rock from which blocks can be sawn. It has a soapy feel and is easily workable. Soapstone generally occurs in massive, compact deposits from which blocks are extracted. The durability of the stone depends on its chemical inertness and its non-absorbency.

Soapstone has been used since early times in many parts of the world for carving ornaments, pipes, cookware, lamps and other utensils. The art of carving this rock has survived among the Inuit people of Canada up to the present era. Present uses include metalworkers' crayons, refractory bricks, and blocks for sculpturing.

Pyrophyllite is a hydrous aluminum silicate, $Al_2Si_4O_{10}(OH)_2$, formed by hydrothermal alteration of acid igneous rocks, predominantly lavas which are andesitic to rhyolitic in composition. It occurs in low and medium grade metamorphic rocks rich in aluminum. Its physical properties are practically identical to those of talc and for this reason, pyrophyllite finds industrial uses similar to talc, notably in ceramic bodies and as a filler in paint, rubber and other products.

PRODUCTION AND DEVELOPMENT IN CANADA

Talc, soapstone. The earliest recorded production in Canada was in 1871-72 when 270 t of cut soapstone, valued at $1,800 was shipped from a deposit in Bolton Township, southern Quebec, by Slack and Whitney. In 1896 a deposit in Huntingdon Township, in the Madoc district of Ontario, was opened and over the next few years numerous deposits were discovered in this area and mined intermittently. Several deposits in southern British Columbia and one in southwestern Alberta were discovered prior to 1920 and some were worked on a small scale.

At present, talc is produced in two provinces, Quebec and Ontario, while pyrophyllite is produced only in Newfoundland.

Bakertalc Inc. produces talc and soapstone from an underground operation at South Bolton, Quebec, 95 km southeast of Montreal. Talc occurs as dykes and sills, associated with serpentine and magnesite, in Cambrian and Lower Ordovician schists. Ore is extracted at the Van Reet mine and is trucked 16 km south to the company's mill facilities at Highwater, Quebec. It produces around 5 000 tpy of high quality floated material for use principally in the pulp and paper industry, and a similar tonnage of

TABLE 1. TALC, SOAPSTONE AND PYROPHYLLITE PRODUCTION, TRADE 1980-82 AND CONSUMPTION 1979-81

	1980		1981		1982P	
	(tonnes)	($)	(tonnes)	($)	(tonnes)	($)
Production (shipments)						
Talc and soapstone						
Quebec[1]	..	1,399,946	..	1,356,142	..	1,475,000
Ontario[2]	..	1,437,114	..	2,102,319	..	3,429,000
Total	..	2,837,060	..	3,458,461	..	4,904,000
Pyrophyllite						
Newfoundland	..	1,039,596	..	1,003,264	..	551,555
Total production	91 848	3,876,656	82 715	4,461,725	72 182	5,455,555
Imports						
Talc or soapstone and pyrophyllite						
United States	50 545	5,903,000	28 657	4,517,000	34 213	5,579,000
United Kingdom	63	21,000	10	1,000	65	8,000
Italy	125	18,000	226	31,000	75	9,000
Japan	41	13,000	1 428	23,000	151	18,000
France	-	-	1	--	-	-
Taiwan	-	-	-	-	18	2,000
Total	50 774	5,955,000	30 322	4,572,000	34 522	5,616,000

	1979	1980	1981
		(tonnes)	
Consumption[3] (ground talc available data)			
Paints and varnish	10 143	7 473	9 724
Gypsum products	7 680	5 641	5 233
Pulp and paper products	7 311	6 810	5 762
Roofing products	7 442	7 129	5 565
Ceramic products	5 864	6 155	5 300
Toilet preparations	2 163	1 929	1 671
Chemicals	1 027	2 376	2 479
Rubber products	2 600	1 281	1 559
Other products[4]	2 710	1 665	1 691
Total	46 940	40 459	38 984

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Ground talc, soapstone, blocks and crayons. [2] Ground talc. [3] Breakdown by Energy, Mines and Resources, Canada. [4] Adhesives, floor covering, insecticides and other miscellaneous uses.
P Preliminary; .. Not available; - Nil; -- Too small to be expressed.

dry-milled talc as an industrial filler in paints, plastics and compounds. Soapstone is also supplied as sculpture blocks.

B.S.Q. Talc Inc. quarries talc and soapstone from two deposits near St. Pierre de Broughton in the Eastern Townships of Quebec. Occurrences are associated with ultrabasic intrusives in quartz-sericite-chlorite schists. B.S.Q. Talc produces off-white talc, containing some iron-oxide materials, for use as roofing shingles filler and in rubber. It also supplies soapstone products such as metalworker's crayons, sculpture blocks, refractory blocks and slabs through its subsidiary Benmic Inc. Capacity of the plant is around 22 000 t.

Canada Talc Industries Limited operates the Henderson and Conley talc underground mines at Madoc, Ontario. In 1981, William R. Barnes Co. Limited purchased the company. The orebodies occur in crystalline dolomite where tabular hydrothermal replacement have taken place. The talc is of exceptional whiteness and in places may contain accessory minerals such as sulphides, mica and prismatic tremolite. High-quality talc is suitable as a filler material for use in the paint, plastic, rubber and pharmaceutical industries. Dolomite terrazzo chips and talcose dolomite are also produced. Present plant capacity is about 20 000 tpy. In 1981, detailed mapping and drilling had outlined a new East Orebody. The company has expansion plans involving several millions dollars of investment to produce fine grained materials for the filler industries. The provincial government has granted $675,000 to assist expansion of its talc products line.

Steetley Talc Limited, a division of Steetley Industries Limited, produces talc from an open-pit mine in Penhorwood Township, 70 km southwest of Timmins. Talc occurs in talc-magnesite deposits derived from the alteration of ultrabasic volcanic rocks. The ore is processed by flotation and fine-grinding. The talc is a high purity, platy material and it is used mainly in the pulp industry as a pitch control agent. Other markets are in paints, plastics, paper and cosmetics. The capacity for the talc operation is around 23 000 tpy. In 1982, Steetley Talc Limited was granted $940,000 by the provincial government to expand and to improve production, as a part of a $3.76 million expansion plan due for completion by 1985.

Numerous deposits of talc and soapstone occur in the producing areas and in other parts of Canada. A soapstone deposit on Pipestone Lake in Saskatchewan was worked by Indians for the manufacture of pipes and various utensils. Reserves are reported to be considerable. High quality "blue" talc was investigated in the Banff area of Alberta and British Columbia during the 1930s. In the Northwest Territories, a few occurrences of soapstone are known from which Eskimos obtained material for carving. Showings of minor importance occur at several localities in Nova Scotia, Newfoundland and eastern Ontario.

Pyrophyllite. Newfoundland Minerals Limited, a subsidiary of American Olean Tile Company, Inc. (a division of National Gypsum Company), mines pyrophyllite from an open-pit operation near Manuels, 19 km southwest of St. John's, Newfoundland. The deposit appears to be a hydrothermal alteration of sheared rhyolite. Altered zones are associated mainly with extensive fracturing near intrusive granite contacts. Reserves are believed to be sufficient for about 40 years at the present production rate. The mine has operated continuously since 1955. Ore is crushed, sized and hand-cobbed at the mine site prior to being trucked a short distance to tidewater. Annual production varies between 30 000 and 45 000 t. The cut-off grade is 17 per cent aluminum oxide. High-quality crude ore is shipped to the parent company's operation at Lansdale, Pennsylvania, where it is used in the manufacture of ceramic tiles. Some lower grade pyrophyllite has been used in the local manufacture of joint cement, stucco, paints and other products, since 1975.

Other known pyrophyllite deposits in Canada include an extensive area of impure pyrophyllite near Stroud's Pond in the southern part of Burin Peninsula, Newfoundland; occurrences near Senneterre in Abitibi County, Quebec and deposits in British Columbia, near Ashcroft and on Vancouver Island.

TRADE AND MARKETS

The value of talc and soapstone shipments showed a strong increase during the 1980-82 period, averaging 18 per cent in terms of constant dollars. However, a notable decrease of tonnage appears for pyrophyllite as the demand for ceramics was low during the past year. During a 5-year period from 1978 through 1982, mine production increased by 34 per cent while the value increased by 200 per cent. Price increases reflect the

TABLE 2. CANADA, TALC AND PYROPHYLLITE PRODUCTION AND TRADE, 1970, 1975, 1978-82

	Production[1]	Imports
	(tonnes)	
1970	65 367	29 999
1975	66 029	30 428
1978	61 661	33 350
1979	90 330	50 322
1980	91 848	50 774
1981	82 715	30 322
1982P	72 182	34 522

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Producers' shipments.
P Preliminary.

inflation effect and higher unit value for high-quality material. Domestic production of talc had an average value of $76 per t in 1981 and $104 per t in 1982. Talc imports declined in 1981 as a new Canadian producer achieved a full year production. A slight 10 per cent increase is apparent for 1982 when inflation is taken into account, reflecting price increase. Canadian talc production is suitable for the export market and it is directed to the plastic, paint and industrial filler sectors. Pyrophyllite production is almost totally exported to the United States for use in ceramic. Canadian demand for talc is estimated at around 90 000 t for 1982, and it is expected to increase in the pulp and paper, plastics and fillers markets. Capacity for high-quality talc will follow expansion and displace imported materials for use especially in the paint and ceramic markets.

USES

Talc is used mostly in a fine-ground state; soapstone in massive or block form. There are many industrial applications for ground talc, but fewer than a dozen countries use ground talc on a major scale.

Talc is used as a filler material in the manufacture of high-quality paper where it aids in the dehydration of the pulp, improves sizing characteristics, reduces the tendency of papers to yellow and assures a well-bonded surface to promote ease of printing. Talc must be free of chemically active compounds such as carbonates, iron minerals and manganese, have a high reflectance, possess high retention characteristics in the pulp, and be free of abrasive impurities. Micronized material provides a high-gloss finish on coated papers.

The ceramic industry utilizes very finely ground talc to increase the translucence and toughness of the finished product and aid in promoting crack-free glazing. Talc must be low in iron, manganese and other impurities which would discolour the fired product.

High-quality talc is used as an extender pigment in paints. Specifications for a talc pigment, as established in American Society for Testing and Material (ASTM) Designation D605-69 (1976), relate to its chemical composition, colour, particle size, oil absorption and consistency and fineness of dispersion. A low carbonate content, a nearly white colour, a fine particle size with controlled particle size distribution and a specific oil absorption are important. However, because of the variety of paints, precise specifications for talc pigments are generally based on agreement between consumer and supplier. Paint characteristics influenced by the use of talc as extender are gloss, adhesion, flow, hardness and hiding power.

TABLE 3. WORLD PRODUCTION OF TALC, SOAPSTONE, AND PYROPHYLLITE, 1979-82

	1979	1980P	1981e	1982e
	(tonnes)			
Japan	1 708 860	1 748 795	1 547 021	1 632 930
United States	1 317 896	1 125 296	1 218 272	1 029 650
Republic of Korea	778 205	719 172	698 532	..
U.S.S.R.e	480 800	490 000	500 000	..
Brazil	365 477	435 448	455 000	..
India	386 707	346 111	346 000	..
France	302 470	301 077	308 987	317 510
Finland	267 179	317 900	300 005	317 510
Italy	157 382	165 905	200 034	181 440
North Korea	158 000	167 829	167 800	..
Australia	138 265	158 332	157 995	..
People's Republic of Chinae	150 000	150 000	150 000	..
Austria	116 900	116 707	115 030	..
Canada	90 330	91 848	82 715	72 182
Norway	87 484	85 000	25 038	..
Other countries	340 819	323 848	342 799	2 942 378
Total	6 846 774	6 743 268	6 615 228	6 493 600

Sources: U.S. Bureau of Mines Preprints 1981; Mineral Commodity Summaries, 1982; Energy, Mines and Resources Canada.
P Preliminary; e Estimated; .. Not available.

Pharmaceutical industries are wellknown users of talc for pharmaceutical preparations and cosmetics. Only the highest purity talc is acceptable, relying on its softness, hydrophobic property and chemical inertness. Finely ground, it is used as a filler in tablets and as an additive in medical pastes, creams and soaps. Stiff competition from corn starch is envisioned in baby powder products.

Lower-grade talc is used as a dusting agent for asphalt roofing and gypsum board, as a filler in drywall sealing compounds, as a filler material in floor tiles, in asphalt pipeline enamels, in auto-body patching compounds, as a carrier for insecticides and as a filler or dusting compound in the manufacture of rubber products. Other applications for talc include use in cleaning compounds, polishes, electric cable coating, plastic products, foundry facings, adhesives, linoleum, textiles and in the food industry.

Particle-size specifications for most uses require the talc to be minus 325 mesh. The paint industry demands from 99.8 to 100 per cent minus 325 mesh. For rubber, ceramics, insecticides and pipeline enamels, 95 per cent minus 325 mesh is usual. In the wall tile industry, 90 per cent minus 325 mesh is generally required. For roofing grades the specification is about minus 80 mesh, with a maximum of 30 to 40 per cent minus 200 mesh.

Soapstone has now only very limited use as a refractory brick or block, but, because of its softness and resistance to heat, it is still used by metalworkers as marking crayons. The ease with which it can be carved makes it an excellent artistic medium.

Pyrophyllite can be ground and used in much the same way as talc. In ceramics, it imparts a very low coefficient of thermal expansion to tile. It must be graded minus 325 mesh and contain a minimum of quartz and sericite which are common impurities. It may also be used in refractories as its expansion on heating tends to counteract the shrinkage of the plastic fraction. Massive pyrophyllite, the compact and homogenous variety, is chiefly used in the manufacture of refractories, although small amounts of the crystalline or radiating variety find similar use. Foliated or micaceous pyrophyllite will find proper use as a filler and ceramic raw material.

WORLD REVIEW

Talc is widely distributed throughout the world and many countries have been developing deposits. These widespread occurrences enjoy limited international trade except for high-grade materials, where small tonnage shipments compete with other substitutes. The majority of international trade takes place within Europe; in the Far East between Japan, the People's Republic of China and Korea; and in North America between Canada and the United States.

The United States, the world's largest talc producer, has seen its 1982 production decrease by 16 per cent, compared with 1981. From a 1978 basis, demand for talc and related minerals is expected to increase at an annual rate of about 2.6 per cent through 1990. In Finland, substitution of kaolin by talc as a filler for use in the paper industry has led to rapid growth in the past five years. Japan is the largest producer of pyrophyllite and also the world's largest importer of talc for use in the paper industry as a filler and coating material.

PRICES OF TALC

		($ US per short ton)
Canadian:	ground, bags carload, fob works	70
Vermont:	domestic, ordinary, off-colour, ground, bags, carload, fob works	136
California:	domestic, ordinary,ground, bags, carload, fob works	90
New York:	domestic, ground, bags, carload, fob works	84

Source: Chemical Marketing Reporter, December 27, 1982.
fob free on board.

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
71100-3	Talc or soapstone	10	12.8	25	8.5
29646-1	Talc for use in manufacture of pottery or ceramic tile (expires June 30, 1982)	free	free	25	free
29647-1	Micronized talc, not exceeding 20 microns	free	4.6	25	free
29655-1	Pyrophyllite	free	free	25	free

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
			(%)			
71100-3	12.8	12.1	11.4	10.7	9.9	9.2
29647-1	4.6	4.5	4.4	4.3	4.1	4.0

UNITED STATES

		1982	1983	1984	1985	1986	1987
523.31	Talc and soapstone, crude and not ground	0.02¢ per lb.					
523.33	Talc and soapstone, ground, washed, powered or pulverized	4.7%	4.2%	3.8%	3.3%	2.9%	2.4%
523.35	Talc and soapstone, cut or sawed, or in blanks, crayons, cubes, disks or other forms, per lb.	.1¢	.1¢	free	free	free	free
523.37	All other, not provided for	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%

Sources: The Customs Tariff and Commodities Index, January 1982, Revenue Canada; Tariff Schedules of the United States Annotated 1982, USITC Publication 1200; U.S. Federal Register Vol. 44, No. 241.

Tin

G.E. WITTUR

World tin consumption remained depressed in 1982 and prices weakened due to excess supply, necessitating vigorous price support operations to protect the floor price under the Fifth and subsequently the Sixth International Tin Agreement (ITA). The Sixth Agreement entered into force provisionally with reduced membership on July 1. Canada joined the Sixth ITA as a consuming member. Domestic tin consumption declined for the fourth successive year. Development work was suspended on a large tin deposit in Nova Scotia but its sale late in the year renewed prospects for development.

CANADA

Canada produces relatively little tin but ranks among the dozen largest, non-communist consuming countries. Production of tin in concentrates and tin-lead alloy declined in 1982 (Table 1) as one of the two byproduct producers ceased production.

Canada relies on imports for its tin requirements, except for comparatively small amounts recovered from recycled solders and detinning, and in primary tin-lead alloy production. Consumption has fallen for several years (Table 2) and this trend continued in 1982.

Tin concentrates are recovered as byproducts of base-metal mining by Cominco Ltd. at Kimberley, British Columbia and Kidd Creek Mines Ltd. at Timmins, Ontario. Cominco also recovers a tin-lead alloy containing about 8 per cent tin at its Trail, British Columbia smelter and produces small quantities of special high purity tin from imported commercial-grade metal. Some Yukon placer gold deposits contain tin and tungsten and small quantitites of these metals have been recovered in placer mining operations. Kidd Creek Mines Ltd. ceased production of tin concentrates in mid-1982 as low recoveries did not justify its continuation.

Tin mineralization is known in various parts of Canada, and higher prices in recent years encouraged exploration. The most promising reported discovery is the East Kemptville tin deposit near Yarmouth, Nova Scotia, discovered by Shell Canada Resources Limited in 1979. The deposit is estimated to contain some 40 million t grading about 0.2 per cent tin, recoverable by open-pit mining. Shell Canada Limited, the parent company, decided in early 1982 to withdraw from non-energy minerals exploration and offered all of its mineral properties for sale. The East Kemptville deposit was purchased in October by Rio Algom Limited of Toronto, which announced that it planned further work on the property.

Exploration work continued on several other tin occurrences in 1982 but no plans were announced for their development to production.

THE INTERNATIONAL TIN AGREEMENT

Tin is the only metal for which there is an intergovernmental agreement involving producing and consuming countries that contains economic provisions for market stabilization. Successive five-year pacts have been in force since 1956. The Sixth International Tin Agreement entered provisionally into force on July 1, 1982, to replace the Fifth Agreement that had been extended by one year to allow more time to negotiate its successor. Provision is made in the agreements for market stabilization measures, including purchases and sales under a buffer stock arrangement, and the implementation of export controls on producing members if buffer stock operations are insufficient to protect the floor price.

Upon its entry into force, countries that had either signed or ratified the Sixth Agreement comprised six producers (Australia, Indonesia, Malaysia, Nigeria, Thailand and Zaire), which together account-

TABLE 1. CANADA, TIN PRODUCTION, IMPORTS AND CONSUMPTION, 1981 AND 1982

	1981		1982P	
	(tonnes)	($)	(tonnes)	($)
Production				
Tin content of tin concentrates and lead-tin alloys	239	3,767,000	135	1,915,000
Imports				
Blocks, pigs, bars				
United States	1 991	35,566,000	1 920	33,200,000
Brazil	422	7,562,000	602	9,939,000
Bolivia	917	15,853,000	451	6,993,000
Malaysia	30	502,000	210	3,522,000
Belgium-Luxembourg	-	-	36	614,000
Other countries	431	7,544,000	16	287,000
Total	3 791	67,027,000	3 235	54,555,000
Tinplate				
United States	3 573	3,480,000	2 049	2,002,000
West Germany	-	-	2 295	1,882,000
United Kingdom	93	196,000	43	75,000
Total	3 666	3,676,000	4 387	3,959,000
Tin, fabricated materials, nes				
United States	670	2,338,000	294	1,137,000
United Kingdom	13	66,000	7	42,000
West Germany	4	13,000	2	11,000
Other countries	3	13,000	4	21,000
Total	690	2,430,000	307	1,211,000
Exports				
Tin in ores and concentrates				
United States	383	1,184,000	386	959,000
U.S.S.R.	-	-	46	672,000
Mexico	67	516,000	65	530,000
Spain	50	451,000	68	452,000
Other countries	13	300,000	36	77,000
Total	513	2,451,000	601	2,690,000
Tinplate scrap				
United States	3 376	339,000	2 145	222,000
Brazil	54	10,000	52	12,000
Philippines	91	26,000	31	8,000
Puerto Rico	-	-	22	2,000
Other countries	2 194	73,000	-	-
Total	5 715	448,000	2 250	244,000
Consumption				
Tinplate and tinning	1 937	..	..	..
Solder	1 548	..	..	..
Babbit	155	..	..	..
Bronze	42	..	..	..
Other uses (including collapsible containers, foil, etc.)	84	..	..	..
Total	3 766	..	..	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
P Preliminary; .. Not Available; - Nil.

ed for 70 per cent of reported 1982 world tin mine production (Table 5), and eighteen consuming members, including Canada, which together accounted for 51 per cent of 1982 world tin consumption (as defined in Table 4). Leading members of the Fifth Agreement that did not join the Sixth included the United States, U.S.S.R. and Bolivia.

The Sixth Agreement, as negotiated, provided for a buffer stock of up to 50 000 t of tin: 30 000 t financed by mandatory cash contributions from both producing and consuming members and 20 000 t by borrowing, with member government guarantees if necessary. Mandatory contributions from consuming members were introduced for the first time in the Sixth Agreement, replacing voluntary consumer contributions in the Fifth Agreement. The Sixth Agreement also provides for the imposition of export controls on producer members by a two-thirds majority vote when the buffer stock contains at least 35 000 t of tin, or by a simple majority vote when the buffer stock level reaches 40 000 t. Export controls are reviewed at each quarterly Tin Council meeting but may be eased automatically as the price improves.

Implementation of the Sixth Agreement required that countries accounting for at least 65 per cent of both production and consumption ratify the agreement by April 30, 1982. Although this level was not achieved on the consumption side, countries that had signed the agreement agreed to implement it provisionally on July 1, 1982. The member-financed buffer stock was reduced from 30 000 t to 19 666 t but the loan-financed portion remained at 20 000 t. Stockholdings necessary to permit implementation of export controls were reduced proportionately. Price levels established under the new agreement remained unchanged, with a floor of 29.15 Malaysian ringgets ($M) per kg and a ceiling of $37.89. The buffer stock must be a net buyer in the lower range ($29.15-$32.06) and a net seller in the upper range ($34.98-$37.89). These ranges were last changed in October 1981. Under the export control scheme, producers may stockpile excess tin in concentrates up to a maximum of about 25 per cent of their base annual production, to be held for smelting and sale upon removal of the controls.

ASSOCIATION OF TIN PRODUCING COUNTRIES

The Governments of Malaysia, Indonesia and Thailand were reported to have reached

TABLE 2. CANADA, TIN PRODUCTION, EXPORTS, IMPORTS AND CONSUMPTION, 1970, 1975 AND 1978-82

	Production[1]	Exports[2]	Imports[3]	Consumption[4]
	(tonnes)			
1970	120	268	5 111	4 565
1975	319	1 052	4 487	4 315
1978	360	943	4 809	4 922
1979	337	712	4 689	4 675
1980	243	869	4 527	4 517r
1981	239	513	3 791	3 766
1982p	135	601	3 235	3 400

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Tin content of tin concentrates shipped plus tin content of lead-tin alloys produced. [2] Tin in ores and concentrates and tin scrap, and re-exported primary tin. [3] Tin metal. [4] Current coverage exceeds 90 per cent, whereas until 1972, coverage was in the order of 80-85 per cent.
p Preliminary; r Revised.

agreement in principle in mid-1982 to establish a tin producers association. This initiative appeared to have developed momentum at least in part out of concern that the Sixth International Tin Agreement either would not be implemented or would prove ineffective in supporting tin prices. Proposed objectives of the producers association included increased research and development on tin uses, market promotion, and market stabilization through joint marketing, stockpiling and production controls. Malaysia pressed for market stabilization provisions, to be implemented should the Sixth ITA prove ineffective. However, disagreements among the three countries regarding the incorporation of such measures and also on voting provisions prevented the signing of an accord scheduled for August. Subsequently, the proposed association was discussed at a meeting of seven major tin producers and agreement was reached on the desirability of establishing an Association of Tin Producing Countries (ATPC). Differences regarding market intervention measures and voting procedures were not resolved, however, and the seven countries - the original three plus Australia, Bolivia, Nigeria and Zaire - agreed to a meeting of officials in February 1983 to seek agreement on a draft charter, in preparation for a ministerial meeting in March.

TIN MARKETS AND PRICES

Trends in reported annual world tin production, consumption and prices since 1970 are shown in Table 3. Consumption has trended downwards since 1973 because of substitution away from tin in important end uses and because of depressed economic trends. Conversely, primary production has shown a modest upward trend. Average annual prices in current dollar terms rose substantially after 1972, reflecting periodic upward revisions of the support price range under successive International Tin Agreements in response to reported production cost increases in member countries.

In 1982, overall consumption continued to decline (Table 4) while mine production fell for the first time in several years (Tables 5 and 6), primarily due to export controls implemented under the Fifth and Six International Tin Agreements. The average annual price declined for the second successive year.

Statistics in the accompanying tables do not include information on most centrally planned countries. Leading producers among these countries include the U.S.S.R. and the People's Republic of China, for which the United States Bureau of Mines estimates production in 1982 at 37 000 t and 15 000 t, respectively. The Democratic Republic of Germany is estimated to have produced 1 900 t in 1982. Most of this tin is consumed domestically, although China is a net exporter to the West (estimated at 4 000 to 5 000 t in 1982) while the U.S.S.R. and East Germany had estimated, combined net imports from the West of about 26 000 t in 1982. A substantial tonnage of tin production, which is included in the accompanying tables, is classified as being of unspecified origin. In 1982, this was estimated at nearly 10 000 t compared with 6 000 t in 1981; most is channeled through the free port of Singapore where it is either smelted or re-exported to smelters elsewhere. Its origin is believed to be largely southeast Asian countries, having been smuggled out of these countries to avoid payment of royalties and export duties and, in 1982, to bypass export controls.

Tin markets and prices in 1981 were strongly influenced by a large scale tin buying campaign on the London Metal Exchange that was initiated about mid-year by unidentified principals ("mystery buyers"). Trade sources estimated that these interests eventually acquired control of between 30 000 t and 50 000 t of tin, and prices consequently rose from a U.S. dollar equivalent of about $5.70 a pound in June 1981 to over $7 by year-end. In November

TABLE 3. WORLD[1] TIN PRODUCTION CONSUMPTION AND PRICES, 1970 TO 1982

	Production			Prices	
	Tin in Conc.	Primary Metal	Consumption	Malaysia[2]	N.Y. Dealer[3]
	(000 t)				
1970	185	185	185	10.99	1.74
1971	188	187	189	10.44	1.67
1972	196	191	192	10.36	1.77
1973	189	188	215	11.35	2.27
1974	184	182	200	18.79	3.96
1975	181	179	173	15.94	3.40
1976	180	183	194	18.96	3.75
1977	188	180	185	26.26	5.33
1978	197	194	185	28.82	5.89
1979	200	201	186	32.42	7.07
1980	201	198	174	35.72	7.86
1981	205	197	163	32.34	6.80
1982	190	180	157	30.09	6.20

Source: International Tin Council.
[1] Coverage is the same as in Tables 4, 5 and 6. [2] Cash price ex-smelter for Grade A tin, shipment within 60 days, in Malaysian ringgits per kilogram, the ringgit being the unit used to define price levels under successive International Tin Agreements. [3] Median of prices for Grade A tin, in U.S. dollars per pound, ex-dock New York, submitted by participating dealers for delivery within seven business days.

TABLE 4. WORLD[1] CONSUMPTION OF PRIMARY[2] TIN, 1970, 1981 AND 1982

	1970	1981	1982
	(tonnes)		
EEC, total[3]	58 246	41 603	39 966
West Germany	14 062	13 260	13 163
France	10 500	9 024	8 187
United Kingdom	16 951	7 144	6 979
Italy	7 200	4 300	4 200
Netherlands	5 467	5 123	5 142
Belgium/ Luxembourg	3 000	2 195	1 889
United States	53 807	40 229	36 100
Japan	24 710	30 492	28 707
Brazil	2 139	2 891	4 953
Poland	..	2 216	4 575
Spain	3 040	4 400	4 400
Czechoslovakia	3 420	3 900	3 500
Canada	4 640	3 766	3 400
Australia	3 837	3 200	2 700
Romania	..	2 800	2 500
Total, incl. Others	184 800	162 700	157 100

Source: International Tin Council.
[1] Excludes countries with centrally planned economies, except Bulgaria, Czechoslovakia, Hungary, Poland, Romania and Yugoslavia.
[2] May include secondary tin in some countries. [3] Includes all 1982 members in all years except Greece in 1970.
.. Not available.

1981, the mystery buyer began to buy cash metal instead of three month forward contracts, which threatened to create a market squeeze. Therefore, the LME Committee decided in February 1982 to limit the premium of cash metal over delivery the following day. Prices on the LME peaked in late February and then collapsed as the mystery buyer began to sell off its holdings, transferring the burden of price support to the buffer stock manager. Under this pressure and because of uncertainty relating to ITA decisionmaking and the future of the Agreement, prices declined fairly steadily until mid-1982 (Table 7). Prices then recovered with implementation of the Sixth Agreement, with its renewed buffer stock resources and increased export controls.

Current fluctuations, particularly affecting the value of the British pound, but also the Malaysian dollar, complicated price trends in 1982 but the buffer stock manager successfully defended the floor price on the Penang market throughout 1982. Prices at times fell well below the floor equivalent on the London Metal Exchange during 1982, however.

TABLE 5. WORLD[1] PRODUCTION OF TIN-IN-CONCENTRATES, 1970, 1981 AND 1982

	1970	1981	1982
	(tonnes)		
Malaysia	73 794	59 938	52 342
Indonesia	19 092	35 268	33 800
Bolivia	30 100	29 830	26 773
Thailand	21 779	31 474	26 207
Australia	8 828	12 925	12 308
Brazil	3 610	8 297	8 279
United Kingdom	1 722	3 870	4 175
South Africa	1 986	2 811	3 035
Zaire	6 458	2 346	2 174
Nigeria	7 959	2 383	1 708
Total, incl. Others	184 900	204 700	190 100

Source: International Tin Council.
[1] Excludes countries with centrally planned economies, except Czechoslovakia, Poland and Hungary.

The United States General Services Administration (GSA) continued offerings of tin from the strategic stockpile, and sales in 1982 totaled 4 172 t compared with 5 920 t in 1981 (all GSA figures are in long tons). Total sales by the end of 1982 were 10 117 t under a program that began in 1980. The goal for the U.S. strategic stockpile is 42 674 t whereas the stockpile actually contained 193 527 t at the end of 1982, of which 23 685 t were approved for disposal. Major producing countries have been strongly critical of the U.S. tin disposal program at a time of excess new production.

The buffer stock manager under the International Tin Agreement operated extensively in both the London Metal Exchange and Penang, Malaysia, markets in 1982. Whereas his holdings of tin totalled 2 940 t at the end of 1981, these rose to 23 525 t on March 31, 1982 and to 50 860 t on June 30 when the Fifth Tin Agreement expired. Of the latter tonnage, 21 719 t was left in the Fifth buffer stock to be liquidated over two years, 1 475 t was returned to the United States out of an original 1 500 t direct contribution by that country, and 27 666 t was transferred to the Sixth

TABLE 6. WORLD[1] PRODUCTION OF PRIMARY TIN METAL, 1970, 1981, AND 1982

	1970	1981	1982
		(tonnes)	
Malaysia	91 945	70 326	62 836
Indonesia	5 190	32 519	29 755
Thailand	22 040	32 636	25 479
Bolivia	300	19 937	18 980
Brazil	3 100	7 639	9 297
United Kingdom	22 035	6 863	8 164
Singapore	..	4 000	4 000
Australia	5 211	4 286	3 105
Spain	3 908	3 070	2 750
Netherlands	5 937	3 500	2 500
South Africa	1 491	2 174	2 194
United States	4 540	2 087	2 000
Nigeria	8 069	2 489	1 691
Total, incl. Others	184 900	196 600	179 800

Source: International Tin Council.
[1] Excludes countries with centrally planned economies, except Czechoslovakia, Poland and Hungary.
.. Not available.

buffer stock (to allow the immediate implementation of export controls). As the initial purchasing power under the Sixth Agreement was 39 666 t, this transfer of 27 666 t from the Fifth to the Sixth buffer stock left a remaining purchasing power under the latter of 12 000 t. Subsequently, holdings of the Sixth buffer stock rose to 32 726 t on September 30 and fell to 31 061 t on December 31, 1982.

Trends in buffer stock holdings reveal only part of its operations during the year. While few details are released about operations of the buffer stock manager, other than quarterly holdings, it is evident that he was required to buy heavily early in March, leading to a decision by the International Tin Council to authorize purchases of up to 42 000 t of tin, compared with the previous maximum of 27 500 t. This level was again raised to 45 000 t in April and 50 000 t in May. A 15 per cent export reduction was also implemented for producing members on April 27. These decisions give an indication of the intense pressures on the buffer stock manager in his efforts to protect the floor price during the first half of 1982.

Upon implementation of the Sixth International Tin Agreement on July 1, export cutbacks imposed on producing members were raised to 36 per cent, and the buffer stock manager was authorized to borrow funds equivalent to an additional 20 000 t of tin. Subsequently, he was also authorized to use broker financing that enabled him to control additional amounts of tin by borrowing tin purchased by brokers on his behalf. Quarterly buffer stock data reveal tin holdings purchased directly by the buffer stock manager, but not the tin borrowed from brokers. It is believed that the latter mechanism was heavily used during the last five or six months of 1982, and some sources estimated that as much as 30 000 t may have been controlled by the buffer stock manager in this way alone. If so, tin controlled by the buffer stock manager by this mechanism, as well as in the Fifth and Sixth buffer stocks, could have totalled over 80 000 t at times during the latter part of 1982. This would be equivalent to nearly half the world's annual production, and would be valued at \$1.3 to \$1.5 billion (Cdn).

WORLD DEVELOPMENTS

Tin mine production in Australia declined slightly in 1982 but primary tin metal output fell by 28 per cent. Most producers experienced much reduced profitability due to the imposition of export controls, lower tin prices and, in some cases, temporary closures. Renison Gold Fields Consolidated Pty., Australia's largest producer, decided to defer the construction of a tin fuming plant at its Tasmania mine despite its apparent feasibility. The plant would upgrade low-grade concentrates and improve tin recovery. Aberfoyle Limited, the second largest producer and controlled by Cominco Ltd. of Vancouver, continued efforts to improve productivity and head grades at its Cleveland, Tasmania mine. It also completed tests of a matte-fuming process at its pilot plant at Kalgoorlie, Western Australia, and continued exploration of its Queen Hill prospect in Tasmania, where reserves in three orebodies are reported to total over 6 million t at 0.7 per cent tin, or 3 million t at 1 per cent. Remaining reserves at the company's Ardlethan mine in New South Wales are limited but operations are expected to continue at least another two or three years. Additional, deeper mineralization is still being explored. Both Renison and Aberfoyle planned temporary closures beginning in December 1982, amounting to one

TABLE 7. MONTHLY AVERAGE TIN PRICES[1], 1982

	Canada Cdn ¢/lb	Dealer, NY US ¢/lb	London Metal Exch. US Equiv. ¢/lb	Penang (Malaysia) US Equiv. ¢/lb
January	938.05	726.75	731.20	696.64
February	916.30	712.67	724.80	660.04
March	828.91	596.87	578.61	589.42
April	815.31	583.86	572.10	571.17
May	829.04	580.25	577.44	583.50
June	788.07	501.59	502.55	566.24
July	789.30	526.57	513.31	561.93
August	790.63	566.96	552.84	564.64
September	800.89	578.48	574.72	571.97
October	762.27	570.00	562.91	559.55
November	752.95	548.00	543.32	559.91
December	760.89	550.30	543.81	562.56
Yearly Average	814.38	586.86	580.51	587.30

Sources: Metals Week; U.S. General Services Administation; Northern Miner.
[1] Prices are for Grade A (in the U.S.) or High Grade - 99.85 per cent tin or more - except the LME price which is for Standard Grade - 99.75 per cent tin or more.

month and six weeks, respectively. Pacific Copper Mines Ltd. of Edmonton purchased a 51 per cent interest in Queensland alluvial producer, Territory Mining Pty. Ltd. Production subsequently was stopped at the latter's Tate River operation but the company was considering the development of its Kangaroo Creek property for production in 1983. A feasibility study was completed for the large, low-grade Taronga tin-silver property in New South Wales, owned by Newmont Mining Corporation, ICI Australia Ltd. and two other Australian companies. Open-pit reserves are reportedly 37.5 million t grading 0.153 per cent tin and several g/t of silver. However, no plans were announced to proceed with development.

Associated Tin Smelters Pty. Ltd., which operates Australia's largest primary tin smelter, announced that it would reduce the scale of operations at its Alexandria, New South Wales plant to restore profitability. Greenbushes Tin N.L. operates a small smelter in Western Australia. Near year-end, this company was seeking additional equity financing to continue the development of its large, recently discovered tin-tantalum-cobalt property. Plans for a 1 million tpy underground operation were scaled down to 250 000 tpy but sharply lower tantalum prices have reduced the attractiveness of the operation for at least the present, and further development work was subsequently deferred.

Bolivian tin mine and refinery production declined by 10 per cent and 5 per cent, respectively, in 1982, due to continuing labour strife and rising production costs. Bolivia, not being a member of the Sixth ITA, was not subject to export controls after mid-1982, but stated that it would voluntarily restrict its exports in line with the export controls on ITA member producers. In the face of continuing severe inflation and government financial problems, the Bolivian tin industry and particularly state-owned Corporacion Minera de Bolivia (Comibol) experienced numerous work stoppages during the year due to workers' demands for higher wages. Production cost pressures were eased by a large devaluation of the Bolivian peso in early 1982 plus the subsequent repeal of a 7 per cent export tax on tin that was imposed with the devaluation. Presumed production costs (in dollars) used in calculating royalties were lowered twice in 1982 but, in November, the royalty was raised by 30 per cent. The new government that replaced the former military government in October announced that it would reactivate a restructuring plan for Comibol to improve productivity. The company's new La Palca volatization plant near Potosi, which experienced initial production problems and closed in early 1982, was reopened in April but was reported to be still experiencing problems at year-end. This plant is designed to upgrade 3.5-4 per cent tin concentrates to 50-52 per cent for smelting at the Empresa Nacional de Fundiciones (ENAF) smelter at Vinto.

Brazil is the world's fastest growing tin producer but is not a member of the International Tin Agreement. While the International Tin Council reports its 1982 mine production at 8 279 t, metal production was 9 297 t and this is projected to rise to 11 000 to 12 000 t in 1983. Paranapenema SA, Brazil's largest tin producer, operates three mines in Rondônia and one in Para State, and opened a fifth mine on the Pitinga River north of Manaus, Amazonas, in mid-1982. The company's total production is slated to rise from 3 624 t in 1982 to a rate of 6 500 tpy by the end of 1983, 3 500 t of which will come from Pitinga. Number two producer, Brascan Recursos Naturais S.A. (BRN), embarked on a three-year, $US 50 million tin exploration and development program in 1982. BRN in 1980 acquired Companhia Estanifera do Brazil (Cesbra) from the Patino Group, which included a 6 800 tpy smelter in Volta Redonda and tin mines in Rondônia. Brascan Limited of Canada, which formerly owned 99 per cent of BRN, sold half of its interest in 1981 to British Petroleum Limited. The third largest producer Empresas Brumadinho plans to expand its production from 1 880 t in 1981 to 4 000 tpy by 1986 through expansion of its Rondônia operations and a new mine in Goias state.

In Burma, where 1982 tin mine production is estimated at about 1 600 t, financing by the World Bank and Asian Development Bank is intended to considerably expand production. A new smelter near Rangoon began production in mid-1982; it was built with assistance from the Government of North Korea.

Indonesia's tin mine production fell by 4 per cent in 1982 while refined production declined by 8 per cent, reflecting export controls under the ITA. Government-owned P.T. Tambang Timah, which accounts for 75 to 80 per cent of Indonesian tin production, maintains an active exploration program and new reserves discovered in recent years, primarily in offshore areas, are sufficient to justify a considerable increase in production rates. In 1982, the company was building its third large bucket dredge capable of working in water depths of 45 m, this one to work in the Kundur Laut area near Singkep Island. P.T. Tambang also announced that it would be the majority shareholder in a new $US 96 million tin plate mill to be built at Cilegon, West Java, and designed to produce 130 000 tpy of tin plate.

In Malaysia, reported mine production of tin declined by about 13 per cent in 1982 to the lowest level since 1960, owing to the implementation of export controls under the ITA, exhaustion of ore reserves and the closure for these and cost reasons of 84 of the 593 gravel pump mines and 17 of the 60 dredges. Over 7,000 of the country's 36,000 tin miners have been laid off. Refined metal production from domestic and imported concentrates fell by 11 per cent. Concentrates are imported from a number of countries but by far the majority comes from Australia. In October, the Malaysian government announced an increase in the threshhold price for calculating tin export taxes from 23.15 to 26.40 ringgets per kg and an alteration of the graduated formula to reduce export taxes payable by the tin industry. The threshold price had last been revised in December 1981.

Another phase in a series of mergers that created Malaysia Mining Corp. (MMC), the world's largest tin producer, was the acquisition of a 42 per cent interest in the tin smelter operated by Straits Trading Co. Ltd. MMC, which is controlled by the national equity company, is a 30 per cent partner in the initial 200 million ringget development of the large but deep Kuala Langat alluvial tin deposits, where tin production is scheduled to begin in 1985. Production could eventually reach 9 000 tpy. MMC also announced that it would open a tin marketing office in New York, to replace an independent dealer now marketing the company's tin. MMC already has marketing offices in London and Tokyo.

At least two Malaysian states, Perek and Selangor, are also expanding their ownership of tin operations through the acquisition of equity in private sector tin producers, most commonly by accepting shares in return for renewing mining leases.

Nigerian tin production fell sharply in 1982 to a 70 year low of 1 700 t, compared with over 9 000 tpy during the late 1960s. Existing alluvial deposits are nearing depletion and a number of operations have closed or cut production. Development of more deeply buried deposits will require large capital expenditures and, in late 1982, the government drew up a plan to rationalize the country's tin mining industry through the merger of the five major producers into a new, government funded Nigerian Tin Mining Company. The government already holds majority shares in all five companies. The Makeri Smelting Co. Ltd. continued to treat all Nigerian tin concentrates in 1982.

In Rwanda, a 3 000 tpy tin smelter was started in early 1982 as part of a five-year, $US 12.4 million investment plan by Société des Mines du Rwanda to expand tin production. Production in 1982 is estimated at 1 200 t, down slightly from that in 1981.

The Singapore tin smelting company, Kimetal (PVT) Ltd., joined with a South Korean company to reactivate a 3 000 tpy tin smelter in Korea that had closed in 1981. The smelter depends on imported concentrates. Kimetal's Singapore smelter, completed in 1978 and rebuilt with electric arc furnaces in 1980, has an annual tin capacity of 8 000 tpy. Production is reported to be 4 000 tpy, also using imported concentrates.

Thailand's reported tin mine production fell by nearly 17 per cent while refined production declined by 22 per cent in 1982 in response to ITA export controls, depleting reserves particularly in the important suction boat sector, and rising mining costs. Thai miners pay a sliding scale, 20 to 40 per cent royalty on the value of tin in concentrates, and are also subject to a 4.4 per cent export tax. These relatively high rates have contributed to a serious problem of unreported production, illegal exports and, in late 1982, the government announced plans to reduce royalties to discourage smuggling and to ameliorate the financial problems of many miners.

Sea Minerals Ltd., a Thai-Malaysian joint venture financed privately and by a World Bank affiliate, received approval for a deep water exploration project in the Andaman Sea. The Thai government in co-operation with the United Nations continued its offshore tin survey along the Andaman coast. Prospects for both ventures appear favourable but newly discovered resources will entail dredging to water depths of up to 65 m. Thai Pioneer Enterprises which started Thailand's second tin smelter in 1981, ceased operations in May 1982. The smelter was to produce 3 600 tpy initially, rising to 5 200 tpy by 1985, but was reported to have experienced a shortage of concentrates. Subsequently, two Thai mining companies were reported to be negotiating an interest in the smelter and a commitment to supply concentrates. Thai Present Smelter had planned to open a third, 10 000 tpy smelter in 1983 but this plant appears to have been delayed, at least. Thailand already has excess smelting capacity and competition has been strong for concentrate supplies from domestic and foreign sources.

In the United Kingdom, production continued to increase at several tin mines in Cornwall and reached the highest level since 1918. Although the United Kingdom is a member of the ITA, it is classed as a consumer and therefore production is not constrained by export controls. Ownership of the South Crofty mine, the United Kingdom's largest, as well as the small Pendarves mine, was acquired 60 per cent by Charter Consolidated Ltd. and 40 per cent by the RTZ Group. Both mines are being expanded. RTZ also owns a minority interest in Geevor Tin Mines PLC and, through wholly owned Carnon Consolidated Tin Mines Ltd., operates the Wheal Jane and Mount Wellington mines. R.T.Z. Bristol Ltd. owns the 15 000 tpy capacity Capper Pass & Son Ltd. tin smelter in North Humberside. This is now the only tin smelter in the United Kingdom and it specializes in treating lower grade and complex concentrates, both domestic and imported, and a wide range of tin bearing wastes and residues. In late 1982, Capper Pass announced plans for a modernization program, including a new electric arc smelting furnace, a new coal-fired boiler and environmental control facilities. The Williams Harvey & Son Ltd. smelter owned by Amalgamated Metal Corp. Ltd. (AMC) ceased treating residues and other tin-bearing materials in 1982 and closed permanently. AMC, controlled by Preussag AG of West Germany, also has interests in tin smelters in Australia, Malaysia and Nigeria. Marine Mining (Cornwall) Ltd. received planning permission for offshore dredging in St. Ives Bay, with final concentration ashore, beginning in 1983. Billiton (UK) Ltd. optioned a 50 per cent interest in the Hemerdon Ball tungsten-tin property in Devon. The other 50 per cent is owned by AMAX Inc. Reserves are reported to total 45 million t grading 0.17 per cent WO_3 and 0.025 per cent tin. Application has been made for permission to mine the deposit by open-pit methods.

OCCURRENCE AND RECOVERY

About 80 per cent of the world's tin output is derived from alluvial deposits. The principal production methods are bucket-line dredging and gravel pump operations. Suction dredges are also used, but they tend to be less efficient than the bucket-line method. Other methods are hydraulicking and dulang washing. Tin is recovered as cassiterite (SnO_2) and is often associated with other heavy minerals such as ilmenite, zircon, wolframite (tungsten), tantalite and others.

Economic grades of placer deposits generally range from 0.15 to 0.40 kg of tin per cubic metre of sand, or from 0.008 to 0.02 per cent tin. Leaders in placer tin production are Malaysia, Indonesia, Thailand and, more recently, Brazil.

Lode mining, though less important than alluvial mining, still accounts for most of the tin output of Bolivia, Australia, Britain and South Africa. Countries of the communist bloc, notably The People's Republic of China and the U.S.S.R., are also important producers of tin from lode as well as alluvial deposits. Viable lode deposits normally range in tin grade from 0.4 per cent or less in open-pit mines to 0.9-1.0 per cent or more in underground mines. Silver, tungsten, bismuth and lead are common byproducts of lode mines. Cassiterite is the predominant tin-bearing mineral of lode deposits but stannite, a copper-tin-iron-bearing sulphide, is of some importance.

Average grades in both placer and lode mining tended to decline during the 1970s and early 1980s, and this trend is expected to continue. Productivity improvements have offset part but not always all of this decline and real tin production costs have risen, exacerbated by high royalty and tax rates levied by some producing countries.

Concentrating processes for alluvial and most lode tin are based on relatively simple gravity separation methods that produce concentrates ranging from 50 to 76 per cent tin. Magnetic and electrostatic separation are also used. However, mill recoveries of tin from lode deposits often are quite low by base-metal standards and some companies have installed flotation cells in their beneficiating plants to complement gravity separation and improve the recovery of tin and other metals. Fuming processes, which can recover tin as tin oxide from slags, residues, low-grade concentrates and even directly from ores, are being used increasingly to improve overall tin recovery. The impure oxide is converted to metal in conventional smelters.

USES

The major use of tin is in tinplate and tinning, which account for over 40 per cent of the world's consumption. The manufacture of solders is the second-largest use of tin, accounting for just over one quarter of the world's total. Tin is also used in the manufacture of babbit, bronze and brass alloys, pewter, and a wide range of tin chemicals.

Tin use in tinplate generally remained flat over the past few years in most industrial countries or has declined. In the United States, tin plate consumption has fallen as aluminum almost totally replaced tinplate in the large beverage can market but there has so far been relatively little penetration of aluminum into the food can market. For the remaining market, tin is being used more efficiently as tin used in tinplating declined from about 5½ t per thousand t of steel in the mid-1960s to about 4 t in 1982. Tinplate consumption has remained relatively stable in western Europe and Japan, where there has been only limited penetration by aluminum into can markets. Moreover, tin used per thousand t of steel in tinplate is higher in both markets, at about 5 t and over 6 t, respectively. Both areas are also significant exporters of tinplate but the growing production of tinplate in developing countries is likely to curtail this trade in the future.

The solder and bronze/brass markets, other important uses for tin, are both relatively mature. In solder uses, the strong growth in electronics applications is tempered by increasing miniaturization, which reduces the amount of solder used per unit. The use of solders in automobile production is declining as alternative materials and fabricating techniques are introduced. Any large scale substitution of aluminum for copper radiators would significantly reduce solder and therefore tin use. Bronze, brass and other tin-containing alloys are widely used in construction, machinery and equipment and consumer durables. Growth in these applications has tended to be relatively slow and some are vulnerable to substitution, for example by plastics in plumbing and aluminum in refrigeration and air conditioning.

Tin consumption prospects are more promising in a wide range of chemical, including agricultural, applications. While no particular developments stand out as individually larger tin users, future market growth in this area is likely to be stronger than in the traditional tinplate, solder and other alloy applications. Organotin chemicals in particular have a wide range of applications in wood preservatives, anti-fouling paints, plastics and crop protection.

The International Tin Research Council, which is the only major organization conducting research and development on tin applications and promoting the use of tin, celebrated its 50th anniversary in 1982. Its headquarters and research facilities are on the outskirts of London, England, and Tin Information Centres are located in Australia, Belgium, West Germany, Japan and United States, with part-time representatives in Brazil, Italy and The Netherlands. Funding is contributed by the Governments of Indonesia, Malaysia, Nigeria, Thailand and Zaire. Bolivia was a member until 1981, and Australian tin producing companies contribute voluntarily.

The Tin Review for 1978 gives a more detailed description of the many uses of tin.

PRICING MECHANISMS AND TARIFFS

The principal tin markets are centred on the Penang market in Malaysia, on which local smelters purchase tin concentrates and sell metal, and the London Metal Exchange, which trades in both cash (spot) metal and three months future contracts. Tin prices elsewhere generally reflect Penang and LME prices with adjustments for currency differences, transport costs, and sales commissions. The Kuala Lumpur (Malaysia) Commodities Exchange announced in 1981 that it intended to extend commodities traded from palm oil, initiated in 1980, to rubber and tin. The Penang market switched quotes on January 1, 1981 from ringgets per picul (133 1/3 lb) to ringgets per kg. It operated six days weekly until the beginning of 1982, when it changed to five days per week.

The tariffs of Canada and the United States are listed in the Tariff table. Neither has tariffs on tin ores, concentrates or wrought tin, and both agreed during the Tokyo Round of GATT to reduce MFN rates on tin-containing manufactures over an eight-year period beginning in 1980. Tariffs levied by the European Community and Japan are broadly similar to those of the United States, being free for ore, concentrates and unwrought metal from all sources and mostly between 4 and 8 per cent on tin products (MFN) or free from developing countries.

OUTLOOK

World tin consumption (as defined in Table 4) peaked in 1973 at 214 900 t, a level that has never since been matched. Rising prices during the 1970s encouraged efforts to find substitutes and it is only in the developing countries, where the use of tinplate for containers is rising, that growth has been at all consistent. Rising tin prices are attributed to cost pressures in the face of generally falling ore grades. While higher prices have encouraged greater interest in tin exploration, this was initially slow to impact on tin supply. However, tin surpluses began to emerge in 1979 and increased significantly until at least into 1982. While the imposition of export controls in 1982 was expected to eventually reduce production rates below consumption levels, excess inventories will decline only slowly and export controls are likely to be necessary for several more years.

Tin consumption is expected to grow only slowly at best during the 1980s, with strength in developing countries largely offset by stagnating or even continued declines in major industrial countries. Therefore, prices are expected to remain in the lower to middle segments of the ITA price range in the medium term. Continued production cost increases, exacerbated by reduced production rates, may prompt producing members of the International Tin Agreement to press for further increases in the buffer stock price range but this will be resisted by consuming members at least until consumption and production achieve greater equilibrium, on grounds that higher prices would further discourage tin consumption. The prospective formation in 1983 of the Association of Tin Producing Countries has caused some concern among consuming countries but such an association is likely to direct its attention primarily toward research and development of new tin uses and the promotion of tin consumption, which could further help to stabilize tin markets in the longer term.

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
32900-1	Tin in ores and concentrates	free	free	free	free
33507-1	Tin oxides	free	14.1	25	free
33910-1	Collapsible tubes of tin or lead coated with tin	10	14.8	30	free
34200-1	Phosphor tin	5	6.8	10	4.5
34300-1	Tin in blocks, pigs, bars or granular form	free	free	free	free
34400-1	Tin strip waste and tin foil	free	free	free	free
38203-1	Sheet or strip, iron or steel, corrugated or not, coated with tin	10	11.8	25	7.5
43220-1	Manufactures of tin plate	14.8	14.8	30	9.5

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
			(%)			
33507-1	14.1	13.8	13.4	13.1	12.8	12.5
33910-1	14.8	13.9	12.9	12.0	11.1	10.2
34200-1	6.8	6.5	6.3	6.0	5.8	5.5
38203-1	11.8	11.0	10.3	9.5	8.8	8.0
43220-1	14.8	13.9	12.9	12.0	11.1	10.2

UNITED STATES (MFN)

601.48	Tin ore and black oxide of tin	free
622.02	Unwrought tin other than alloys of tin	free
622.04	Unwrought tin, alloys of tin	free
622.06	Unwrought tin, other	free
622.10	Tin waste and scrap	free

		1982	1983	1984	1985	1986	1987
				(%)			
622.15	Tin plates, sheets and strips, not clad	4.7	4.2	3.8	3.3	2.9	2.4
622.17	Tin plates, sheets and strips, clad	9.3	8.4	7.5	6.6	5.7	4.8
622.20	Tin wire, not coated or plated with metal	2.4	2.4	2.4	2.4	2.4	2.4
622.22	Tin wire, coated or plated with metal	5.3	5.1	4.9	4.7	4.4	4.2
622.25	Tin bars, rods, angles shapes and sections	5.3	5.1	4.9	4.7	4.4	4.2
622.35	Tin powder and flakes	5.3	5.1	4.9	4.7	4.4	4.2
622.40	Tin pipes, tubes and blanks	4.7	4.2	3.8	3.3	2.9	2.4
644.15	Tin foil	13.6	12.3	10.9	9.6	8.3	7.0

Sources: The Customs Tariff and Commodities Index, 1982, Revenue Canada; Tariff Schedules of the United States Annotated 1982, USITC Publication 1200; U.S. Federal Register, Vol. 44, No. 241.

Titanium and Titanium Dioxide

M.A. BOUCHER

SUMMARY

In 1982, the economic recession in the United States and in western Europe reduced the demand for both titanium dioxide and titanium metal. Also, consumer stocks were decreased due to high interest rates, which added to the bearish nature of the market. Prices remained weak in general.

In Canada, exports of titanium dioxide were strong due mainly to the low value of the Canadian dollar with respect to U.S. and some European currencies.

CANADA

QIT-Fer et Titane Inc. (QIT) is the only company that mines titanium ore in Canada. Ilmenite, a titanium-bearing mineral, is mined at Havre St. Pierre, Quebec and smelted in electric furnaces at Sorel, Quebec for the production of titania slag (Sorelslag that grades 70-72 per cent TiO_2) and two high quality pig iron products (Sorelmetal D-1 and Sorelmetal F-1). The following table shows production by products at QIT for the year 1981 and preliminary data* for 1982.

Product	Production 1981	(000 t) 1982
Ilmenite	1 988	1 735
Sorelslag	747	669
Sorelmetal	531	458

* Source: QIT (personal communication).

QIT continued work on modernizing its equipment at Sorel during the year. The project, which will require several years to complete, will allow the company to produce a titania slag grading at least 80 per cent TiO_2. Such a product would reduce the quantity of sulphuric acid consumed in the production of titanium pigments, would reduce water polution at pigment producer sites, and would increase QIT's ability to compete with other producers of titania slag.

Most of the Sorelslag and Sorelmetal produced at QIT is exported to the United States and Europe. Approximately 10 to 15 per cent of Sorelslag production is sold in Canada to two producers of titanium pigments, NL Chem Canada Inc. and Tioxide Canada Inc. In 1982, both pigment companies operated near full capacity of 36 000 tpy each.

Although the construction and automobile industries, which are two major markets for titanium pigments, were depressed in 1982 in the western world, exports of pigments were strong due mainly to the low value of the Canadian dollar with respect to U.S. and some European currencies.

Both pigment companies are expecting to operate at capacity rates in 1983, with the possibility of expansions during the next few years. The cost of sulphuric acid, a necessary ingredient in the production of pigments, increased substantially during the year largely as a result of the seven-month shutdown at Inco Limited. Inco is a major producer of sulphuric acid.

Ti-Ltée of St-Laurent, Quebec is a titanium metal fabricator that supplies parts and components for the chemical, petrochemical, pulp and paper, and metal refining industries in Canada and abroad. Although most markets for titanium metal were depressed during the year, the company reported good sales; the major reason being that the consuming industries are switching to titanium because of the excellent physical and chemical properties of the metal. Ti-Ltée imports titanium metal, mainly from the United States.

MAJOR WORLD DEVELOPMENTS

Titanium minerals and oxide

Australia: Murphyores Holdings Ltd. continued its study on mining rutile, zircon and

TABLE 1. CANADA, TITANIUM PRODUCTION AND TRADE, 1981 AND 1982

	1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)
Production (shipments)				
Titanium dioxide, slag	..	131,669	..	106,006
Imports				
Titanium dioxide, pure				
United States	3 797	6,913	3 344	6,470
West Germany	971	1,348	1 351	1,794
Spain	420	679	438	753
Belgium-Luxembourg	218	322	297	418
United Kingdom	144	220	182	281
Other countries	1 436	1,895	125	176
Total	6 986	11,377	5 737	9,892
Titanium dioxide, extended				
United States	116	257	135	340
Spain	54	103	163	284
United Kingdom	144	230	69	112
Switzerland	-	-	2	8
Total	314	590	369	744
Titanium metal				
United States	463	23,594	389	15,881
Japan	11	182	91	1,708
United Kingdom	33	875	18	334
Belgium-Luxembourg	3	379	3	321
Other countries	42	1,100	3	188
Total	552	26,130	504	18,432
Exports[1] to the United States				
Titanium metal, unwrought including waste and scrap	1 345	5,439	211	1,364
Titanium metal, wrought	554	4,617	432	7,616
Titanium dioxide	14 252	17,288	19 880	25,135

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] U.S. Department of Commerce, U.S. General Imports, Report F.T. 135. Canadian export statistics do not provide separate categories.
P Preliminary; - Nil; .. Not available.

ilmenite from beach sands near Gladstone, Queensland.

Norway: Titania A/S is expected to supply ilmenite to a new titania slag operation to be built at Tyssedal by the government-owned DNN Aluminium. The plant is expected to consume over 300 000 tpy of ilmenite for the production of 200 000 tpy of 75 per cent titanium dioxide.

South Africa: Union Corporation Limited of South Africa and QIT-Fer et Titane, co-owners of Richards Bay Minerals (RBM) at Richards Bay, are expanding the mining side of their operations, which will have the effect of raising rutile and zircon production capacity. When the expansion is completed in early 1983, the product mix and annual capacity in tonnes will be: 65 000 t rutile; 150 000 t zircon; 400 000 t of 85 per cent TiO_2 slag; 217 000 t high purity iron; 130 000 titaniferous magnetite.

Titanium sponge and metal

In 1982, the decline in orders for commercial airplanes in the United States continued, and

TABLE 2. CANADIAN TITANIUM PRODUCTION, IMPORTS AND CONSUMPTION, 1970, 1975, 1978-82

	Production		Imports			Consumption	
	Ilmenite[1]	Titanium Dioxide Slag[2]	Titanium Dioxide Pure	Titanium Dioxide Extended[3]	Total Titanium Dioxide Pigments	Titanium Dioxide Pigments	Ferro-titanium[4]
				(tonnes)			
1970	1 892 290	766 300	2 523	7 415	9 938	40 290	24
1975	1 543 480	749 840	2 467	241	2 708	..	25
1978	1 809 990	850 030	6 595	498	7 093	..	34
1979	1 004 260	477 030	9 815	1 515	11 330	..	23
1980	1 853 270	874 710	6 135	148	6 283	..	7
1981	2 008 117	759 191	6 986	314	7 300	..	9
1982	1 735 000	669 000	5 737	369	6 106	..	..

Sources: Energy, Mines and Resources Canada; Statistics Canada; Company reports.
[1] Ore treated at Sorel; from company reports. [2] Slag with 70 to 72 per cent TiO_2; from company reports. [3] About 35 per cent TiO_2. [4] Ti contents.
P Preliminary; .. Not available.

TABLE 3. TITANIUM SLAG AND IRON PRODUCTION, QIT-FER ET TITANE INC., 1970, 1975 AND 1978-1982

	Ore Treated	Titanium Slag	Iron
		(tonnes)	
1970	1 892 290	766 300	539 720
1975	1 543 480	749 840	499 890
1978	1 809 990	850 030	595 000
1979	1 004 260	477 030	339 660
1980	1 853 270	874 710	622 330
1981	2 008 117	759 191	540 334
1982P	1 735 000	669 000	458 000

Sources: Kennecott Corporation Annual Report and QIT-Fer et Titane Inc. personal communication.
P Preliminary.

capital investment in the chemical industries of both the United States and western Europe were considerably reduced. Consequently, production and consumption of titanium decreased substantially.

However, the industry is positive about the long-term outlook for titanium and several countries are building or considering building new plants.

In the United States, the Osaka Titanium Co. Ltd. new 5 000 t sponge plant is expected to start operation in early 1983. The plant represents the latest in Kroll process technology.

International Titanium Corp. started production at its new sponge plant in March 1982. The plant has an annual capacity of 5 000 tpy. It was reported that the plant was built at a very low cost, using a new Japanese process.

Deeside Titanium Ltd., in the United Kingdom, started production in late 1982 at its new sponge plant. The plant has an annual capacity of 5 000 t.

A Johnson & Co. of Lionville, Pennsylvania, started operation of its electron beam furnace, which has capacity to produce 1 360 tpy of ingot. The furnace will be used to produce electrodes from light scrap for subsequent consumable electrode melting and slabs for conversion to plate and strip.

PROCESSING AND USES

Nearly 90 per cent of all titanium ore produced is used in the production of titanium dioxide pigments. The demand for titanium dioxide relates to its high index of refraction, which gives pigments their extreme whiteness and opacity. Titanium dioxide can be produced from titanium ores by two processes; the sulphate method, which uses ilmenite or ilmenite slag, or the chloride method, which uses natural or synthetic rutile.

In the sulphate process, ilmenite is digested in concentrated sulphuric acid to produce a solution which is then clarified to remove insoluble heavy metals and impurities. After cooling, the iron is precipitated in the form of hydrated iron sulphate and the remaining liquid is hydrolyzed to form insoluble hydrated titanium dioxide, which precipitates with the addition of seed crystals. The precipitate is then washed and calcined to obtain titanium dioxide. In the chloride process, rutile is chlorinated in the presence of carbon to produce titanium tetrachloride. The tetrachloride is separated from other chloride products by distillation, and then vaporized and oxidized to produce titanium dioxide and chlorine. The chlorine is recovered and recycled.

Table 7 indicates that close to two thirds of the titanium pigments produced in the world are consumed by the paint industry.

TABLE 4. PRODUCTION OF ILMENITE CONCENTRATE BY COUNTRIES, 1980-82

	1980	1981P	1982e
	(000 tonnes)		
Australia	1 336	1 337	1 216
Norway	828	658	562
Canada[1]	875	759	669
United States	498	462	236
U.S.S.R.e	417	426	426
Malaysia	189	145	122
Indiae	168	189	159
Finland	159	159	145
Republic of South Africa	344	370	381
Sri Lanka	34	80	..
China	-	136	136
Other countries	17	18	82
Total	4 865	4 739	4 134

Sources: U.S. Bureau of Mines, Minerals Yearbook Preprint, 1981; U.S. Bureau of Mines, Mineral Commodity Summaries, January 1983.
[1] Titanium slag containing 70-71% TiO_2.
P Preliminary; e Estimated; .. Not available; - Nil.

TABLE 5. PRODUCTION OF RUTILE BY COUNTRIES, 1980-82

	1980	1981P	1982e
	(000 tonnes)		
Australia	294	229	227
United States	w	w	w
U.S.S.R.e	9	9	9
Indiae	5	9	8
Sri Lanka	13	13	14
Republic of South Africa	48	50	50
Sierra Leone	47	51	50
Total	416	361	358

Sources: U.S. Bureau of Mines, Minerals Yearbook Preprint, 1981; U.S. Bureau of Mines, Mineral Commodity Summaries, January 1983.
P Preliminary; e Estimated; - Nil; w withheld to avoid disclosing company proprietary data.

TABLE 6. TITANIUM SPONGE PLANTS UNDER CONSTRUCTION AND UNDER CONSIDERATION

Country	Company	Planned Capacity (tonnes/year)	State of the Project
Australia	Consolidated Rutile Ltd.	10 000	Feasibility study.
Brazil	Metais de Minas Gerais	3 000	Pilot plant under construction.
Japan	Showa Denko KK Ishizuka	3 000	Financing underway.

Note: A 10 000 tpy sponge plant requires about 30 mW of electrical power.

TABLE 7. TiO_2 VOLUME CONSUMED BY END USE

	Europe	Americas	Africa	Middle East	Far East Pacific	Total
			(per cent)			
Paint						
waterbased	24.3	30.0	33.7	41.2	18.7	26.4[1]
other paints	42.6	24.5	52.3	44.4	42.0	34.9
Total paint	66.9	54.5	86.0	85.6	60.7	61.3
Paper	8.0	20.0	1.4	-	6.1	12.7
Plastics/flooring	15.9	16.1	6.6	7.4	14.3	15.5
Rubber	1.1	2.0	0.7	1.3	4.3	1.9
Ink	2.0	1.6	1.2	0.6	3.8	2.1
Textile fibres	2.6	2.1	1.2	2.2	5.0	2.7
Ceramics	1.6	1.6	0.5	1.6	3.5	1.8
Others	1.9	2.1	2.4	1.3	2.3	2.0
Total	100.0	100.0	100.0	100.0	100.0	100.0
Average	39.2	43.2	2.0	1.5	14.1	100.0

Source: Tioxide International Ltd.

The paper and plastic industries combined consume close to 30 per cent.

Approximately 10 per cent of the titanium ore produced is used in the production of titanium metal. The demand for titanium alloys is closely linked to the aerospace industry, which requires titanium metal and its alloys because of their high strength-to-weight ratio. Titanium metal is also used in water desalination plants and in the pulp and paper, chemical and petrochemical industries.

PRICES

The price of ilmenite remained stable at about $US 70 a t during 1982, while Sorelslag prices increased from $US 133 a t in 1981 to $US 148 a t in 1982.

As a result of a sharply reduced production of commercial aircraft and the general recession in the United States, the price of titanium metal sponge decreased from $US 16.87 a kg to $US 12.10 a kg during the year. The price of titanium sponge is expected to continue to decrease in 1983.

Prices of selected titanium commodities, U.S. currency unless stated otherwise, 1980, 1981 and 1982

	1982 ($)	1981 ($)	1980 ($)
Titanium ore, fob cars Atlantic and Great Lake ports			
Rutile, 96%, per t, delivered within 12 months	496.00-524.00	443.00-467.00	468.00-495.00
Ilmenite, 54%, per t, shiploads	69.00-74.00	69.00-74.00	54.00
Slag, 70%, per t, fob Quebec	148.00	133.00	113.00
Titanium sponge, U.S., per kg	12.10	16.87	15.48
Mill products, per kg delivered			
Billet (Ti - 6AL-4V)	33.07	33.07	11.55-15.72
Bar (Ti - 6AL-4V)	39.70	39.70	18.01-23.66
Titanium dioxide, anatase, dry milled, Canadian dollars[1]			
Bags, carlots, delivered eastern Canada, per kg	1.54	1.54	1.533
Bags, carlots, rutile regular, per kg	1.65	1.65	1.410

Source: Metals Week, December 1982.
[1] Chemical Marketing Report, December 1982.

OUTLOOK

World production and consumption of titanium dioxide should increase moderately in 1983 as western world economies recover, interest rates are reduced and consumer inventories are liquidated. Prices for rutile and ilmenite are not expected to increase substantially because production was increased in both 1980 and 1981.

Production and consumption of titanium sponge and mill products are expected to worsen in 1983. Prices could also decrease because sponge and ingot production capacity were substantially increased in 1982, at a time when demand was weak.

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
32900-1	Titanium ore	free	free	free	free
34715-1	Sponge and sponge briquettes, ingots, blooms, slabs, billets, and castings in the rough, of titanium or titanium alloys for use in Canadian manufactures (expires June 30, 1983)	free	free	25	free
34735-1	Tubing of titanium or titanium alloys for use in Canadian manufactures (expires June 30, 1983)	free	free	25	free
34736-1	Sheet, strip or plate of titanium or titanium alloys, cold-rolled, not more than 0.2015 inch in thickness, for use in the manufacture of tubes (expires June 30, 1983)	free	free	25	free
34745-1	Bars, rods, plate, sheet, strip, foil, wire, coated or not; forgings and mesh of titanium or titanium alloys, for use in Canadian manufactures (expires June 30, 1983)	7.5	7.5	25	5
37506-1	Ferrotitanium	free	4.8	5	free
92825-1	Titanium oxides	free	11.6	25	free
93207-6	Titanium whites, not including pure titanium dioxide	free	11.6	25	free

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
				(%)		
37506-1	4.8	4.7	4.5	4.3	4.2	4.0
92825-1	11.6	11.3	10.9	10.6	10.3	10.0
93207-6	11.6	11.3	10.9	10.6	10.3	10.0

TARIFFS (cont'd)

UNITED STATES (MFN)

		1982	1983	1984	1985	1986	1987
					(%)		
422.30	Titanium compounds	6.5	6.2	5.9	5.6	5.2	4.9
473.70	Titanium dioxide	6.9	6.8	6.6	6.4	6.2	6.0
601.51	Titanium ore	Remains free					
606.46	Ferrotitanium and ferro-silicon titanium	4.8	4.6	4.4	4.1	3.9	3.7
629.12	Titanium metal, waste and scrap	14.0	12.6	11.3	9.9	8.6	7.2
629.14	Titanium metal, unwrought	17.5	17.0	16.5	16.0	15.5	15.0
629.20	Titanium metal, wrought	17.5	17.0	16.5	16.0	15.5	15.0

Sources: The Customs Tariff and Commodities Index, 1982, Revenue Canada; Tariff Schedules of the United States Annotated (1982), USITC Publication 1200; U.S. Federal Register Vol. 44, No. 241.

Tungsten

D.G. LAW-WEST

CANADIAN DEVELOPMENTS

Canadian production of tungsten trioxide (WO_3) during 1982 was estimated at 368 700 metric ton units (mtu), compared to 251 500 mtu in 1981.

Nearly all of 1982 Canadian production, about 358 000 mtu WO_3, came from Canada Tungsten Mining Corporation Limited (Cantung) at Tungsten, Northwest Territories. At mid-year, poor market conditions caused Cantung to reduce production about 15 per cent, which was achieved primarily by mining lower-grade ore. Later in the year when market conditions continued to deteriorate, Cantung scheduled an additional production cutback of 15 per cent and the layoff of 36 employees beginning November 21. On December 20, the company announced the shutdown of operations at Tungsten for an indefinite length of time beginning January 21, 1983, at which time the remaining 165 employees would be laid off. Cantung planned to maintain the townsite until at least the end of the current school year.

Despite the 30 per cent production cutback by Cantung during the year, 1982 output was 30 per cent above that of 1981 when the operation was closed by a six month strike.

Dimac Resource Corp. accounted for the balance of Canadian production during 1982. The company operated a 110 tpd gravity and flotation mill on its Silence Lake property near Clearwater, British Columbia from January to November. Dimac then suspended these operations, due in part to the poor tungsten market and in part to the exhaustion of mineable ore reserves. All 16 company employees were laid off. There is a possibility that this operation could be restarted in 1983 if market conditions turn around and if Dimac is able to develop additional ore reserves.

Preproduction construction and development at the Mount Pleasant Mines Limited tungsten-molybdenum mine-mill complex in New Brunswick was 95 per cent complete early in the fourth quarter of 1982. The 2 000 tpd mill was scheduled for tune-up production at year-end, with full production planned for mid-1983. This operation is expected to employ some 240 people of which about 70 will be involved in mining.

Mount Pleasant is a joint venture of Sullivan Mining Group Ltd. (through its 89 per cent ownership of Brunswick Tin Mines Limited) and Billiton Canada Ltd. The latter will manage the operation and market the annual output of concentrates containing some 1 800 t of WO_3 and 600 t of molybdenite (MoS_2).

Amax Northwest Mining Company Limited continued to evaluate the Mactung scheelite deposit on the Yukon-Northwest Territories boundary during 1982. A firm production decision was not announced, mainly because of weakness in the tungsten market; both price and demand fell drastically during the year.

INTERNATIONAL DEVELOPMENTS

Western world production of tungsten concentrates declined by about 14 per cent in 1982 to 21 000 t contained tungsten.

In the United States, the Strawberry mine, operated by Teledyne Wah Chang, was the only tungsten producers that did not reduce output during 1982. Union Carbide Corporation placed its Emerson mine on development status in April 1982 but closed its Pine Creek mine in September. The Springer mine, owned by General Electric Company, was brought on-stream at mid-year. However, the low price and weak demand for tungsten forced its closure shortly afterwards. NRD Mining Ltd.

TABLE 1. CANADA, TUNGSTEN PRODUCTION, IMPORTS, 1981 AND 1982 AND CONSUMPTION 1980 AND 1981

	1981		1982P	
	(kilograms)	($)	(kilograms)	($)
Production[1] (WO_3)	2 515 000	..	3 687 700	..
Imports				
Tungsten in ores and concentrates				
United States	14 000	263,000	8 000	104,000
Total	14 000	263,000	8 000	104,000
Ferrotungsten[2]				
United States	6 000	147,000	7 000	160,000
West Germany	-	-	--	5,000
Total	6 000	147,000	7 000	165,000
Tungsten carbide powder				
United States	302 000	10,545,000	249 000	4,973,000
West Germany	9 000	332,000	12 000	484,000
Other countries	40 000	1,658,000	13 000	373,000
Total	351 000	12,535,000	274 000	5,830,000
	(number)	($)	(number)	($)
Tungsten carbide rotary rock drill bits				
United States	5 679	18,721,000	6 829	32,327,000
Other countries	9 183	1,071,000	3 395	3,616,000
Total	14 862	19,792,000	10 224	35,943,000
Tungsten carbide percussion rock drill bits				
United States	18 850	1,336,000	19 043	1,452,000
Ireland	47 834	812,000	68 744	1,277,000
Other countries	149	32,000	1 738	109,000
Total	66 833	2,180,000	89 525	2,838,000
Tungsten carbide tools for metal work				
United States	..	8,230,000	..	5,835,000
Other countries	..	3,005,000	..	1,595,000
Total	..	11,235,000	..	7,430,000
	1980		1981	
	(kilograms)	($)	(kilograms)	($)
Consumption (W content)				
Tungsten metal and metal powder	232 659	..	187 785	..
Other tungsten products[3]	57 820	..	106 125	..
Total	290 479	..	293 910	..

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

[1] Producers' shipments. [2] Gross weight. [3] Includes tungsten ore, tungsten carbide and tungsten wire.
P Preliminary; .. Not available; - Nil; -- Small amount not quantified.

announced the shutdown of its newly developed Rawhide mine for an indefinite length of time beginning in March.

Other tungsten producing countries also experienced major production cutbacks in 1982. Both major producers in Australia, Peko-Wallsend Ltd. at King Island and Queensland Wolfram at Mt. Carbine, reduced production by about one third during the year. All but one of the other six smaller Australian operations were closed and will remain idle until the market situation improves.

Tungsten producers in Thailand, Bolivia and South Korea all announced production cutbacks of about 30 per cent during 1982.

USES

Tungsten materials can be divided into several major classes, depending upon the product form and its use. The main product classes include tungsten carbide, tungsten-bearing steels, superalloys, mill products made essentialy from pure metal, and chemicals.

Tungsten carbide (WC) is one of the hardest materials known and accordingly, has widespread applications where intense wear and abrasion are encountered. This product is the preferred metalworking material for the cutting edges of machine tools and as a metal surface in forming and shaping dies. It is produced by the chemical combination of tungsten metal powder and finely divided carbon. Tungsten carbide is compacted to the desired form, using cobalt as a binder, and sintered to produce cemented tungsten carbide. Cutting tools of cemented tungsten carbide are used for machining steel, cast iron and nonferrous metals, and for shaping in the woodworking and plastics industries. Cemented tungsten carbide is also used to make dies for wire and tube drawing, punches and dies for metal forming, and bits and tools for drilling equipments and wear-resistant parts. With the addition of tantalum, titanium and columbium carbides, the coefficient of friction of cemented tungsten carbides is lowered, thereby producing grades better suited to the machining of specific items, particularly steel products. Other uses of tungsten carbide are in tire studs, spikes for golf shoes, armour-piercing projectiles and welding electrodes.

As an alloy constituent, tungsten is used primarily in the production of high-speed steels, and tool and die steels. Tungsten is added to steels either as ferrotungsten (80 per cent tungsten), melting base (30-35 per cent tungsten), scheelite ($CaWO_4$) or as tungsten-bearing scrap. Tungsten-bearing steels are used for the same applications as carbides, especially where lower operating temperatures are encountered. Tungsten is also used in some stainless steels for application in high-temperature environments.

Tungsten is an important constitutent in a wide variety of superalloys and nonferrous alloys. Tungsten-containing superalloys are being used increasingly in high-temperature applications and in highly corrosive environments because of their high-temperature strength and oxidation resistance. In making the alloys, tungsten is usually added in the form of tungsten metal powder, although tungsten scrap can be used to satisfy part of the tungsten requirements. Superalloys can be classified into three principal types: nickel base, iron base and cobalt base or "Stellite" superalloys. While only small amounts of tungsten are currently used in the nickel and iron base superalloys, several companies are developing new superalloys containing larger amounts of tungsten, a factor which could significantly expand the market for tungsten.

Mill products made from pure or nearly pure tungsten metal powder are used in significant quantities by the electrical industries. The relevant important properties of tungsten for electrical applications include its high-melting point, low-vapour pressure, hardness, good electrical conductivity and low coefficient of thermal expansion. Tungsten mill products such as rods, wire and flat products are made by compressing tungsten metal powder into the desired shape and then sintering.

Discs cut from tungsten rods are used as electrical contacts to improve resistance to heat deformation resulting from sparking and associated high temperatures. Pure tungsten contacts are used principally in ignition circuits of automobiles and aircraft. However, the trend to electronic ignition systems without tungsten contacts has resulted in a decline in its use for this application. Tungsten discs are also used as heat sinks in semiconductor applications and, in combination with other elements, as electrical contacts and breakers for industrial use.

TABLE 2. CANADA, TUNGSTEN PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975-82

	Production[1]	Imports: Tungsten Ore[2]	Imports: Ferro-tungsten[3]	Consumption[2]
	(kilograms)			
1970	1 690 448	82 645	90 718	446 687
1975	1 477 731	1 000	45 359	451 336
1976	2 168 153	-	77 111	337 345
1977	2 284 409	-	103 000	449 365
1978	2 885 619	1 200	73 000	388 146
1979	3 254 000[r]	11 000	28 000	380 229
1980	4 007 000	6 000	7 000	290 479
1981	2 515 000	14 000	6 000	293 910
1982P	3 687 700	8 000	7 000	290 479

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

[1] Producers' shipments of scheelite (WO_3 content); [2] W content; [3] Gross weight.
P Preliminary; [r] Revised; - Nil.

Tungsten wire is used for filaments in incandescent lamps, and heating elements in both fluorescent lamps and vacuum tubes. The overall demand for tungsten wire is increasing in response to the upward trend in the manufacture of lamps and new uses such as de-icing and defogging elements in automobile windshields.

Flat products are used for various parts of electron tubes and radiation shields as well as for very high-temperature applications in reducing or inert atmospheres.

Tungsten is used for counterweights and balances, especially by the aircraft industry, but it is being replaced by depleted uranium which has about the same density.

Minor amounts of tungsten are used to make chemicals and compounds for nonmetallurgical applications. Some of the end-uses include dyes, toners, phosphors, chemical reagents, corrosion inhibitors and catalysts.

PRICE STABILIZATION

International discussions on stabilizing the tungsten market resumed at The 14th Session of the United Nations Committee on Tungsten, which was held in Geneva from

TABLE 3. WORLD TUNGSTEN PRODUCTION IN ORES AND CONCENTRATES, 1980-82

	1980	1981P	1982e
	(tonnes of contained tungsten: W content)		
People's Republic of China	15 014	13 517	11 340
U.S.S.R.	8 709	8 845	8 845
Canada	3 178	1 993	2 420
Australia	3 575	3 318	2 313
Bolivia	2 664	2 736	2 313
Republic of Korea	2 737	2 642	2 268
United States	2 754	3 605	1 451
Portugal	1 568	1 402	1 361
Austria	1 495	1 450	1 179
Brazil	1 136	1 200	1 179
Thailand	1 615	1 302	998
Burma	823	815	680
Mexico	266	199	181
Turkey	365	370	91
Other central economy countries	2 279	2 279	2 268
Other market economy countries	3 557	3 475	3 220
World Total	51 735	49 148	42 107

Sources: United States Bureau of Mines Minerals Yearbook Preprint 1981; USBM Mineral Commodity Summaries, 1983; Energy Mines and Resources Canada.

P Preliminary; e Estimated.

October 25-29, 1982. The deliberations proved somewhat more fruitful than past discussions, in that the Committee avoided the perennial producer-consumer confrontation regarding the negotiation of a commodity agreement. A major portion of the dialogue centred on two reports prepared by the Secretariat concerning current market conditions and price indicators, as well as the statistical information that is collated by the Secretariat. The session concluded with a request to the Secretariat to solicit additional information on tungsten products, price indicators, and other relevant statistical material.

During late March 1982, the Government of Thailand hosted the first meeting of the Working Party of Tungsten Producing-Exporting Countries in Bangkok. According to the final report of this first meeting, the aim of the working party was to consider detailed proposals for the formation of a producer organization which could consider courses of action to improve market stability. The first meeting was attended by representatives of Australia, Bolivia, Republic of Korea, Peru, Portugal, Rwanda, Spain and Thailand. Representatives of Brazil, People's Republic of China, France and the Primary Tungsten Association were also in attendance in an observer capacity.

Participants of the First Working Party meeting agreed to study proposals regarding the formation, function and financial implications of an association of tungsten producing and exporting countries. Thailand agreed to act as co-ordinator of further work until a formal group is established. A second meeting of the Working Party was tentatively scheduled for the first half of 1983.

PRICES

Tungsten prices, which started to weaken late in 1981, continued to decline throughout much of 1982. The International Tungsten Indicator weakened from \$US 125.60 per mtu WO_3 in January to \$US 102 by the end of November. During the same period, the Metal Bulletin quotation fell from \$US 124.50-\$US 128.75 per mtu WO_3 to \$US 81-\$US 86. These depressed prices, which had not been at such low levels since the early 1970s, were an indication of the extreme weakness in the tungsten market.

OUTLOOK

The short-term outlook for tungsten is somewhat uncertain. Additional production cutbacks or mine closures will follow if tungsten prices and demand continue to weaken. A precondition for market recovery is the strengthening of business activity in the major end-use industries, mainly in the manufacture of cemented tungsten carbide products for use in the oil field, mining and metal working sectors.

A gradual increase in tungsten demand, currently forecast to begin in mid-1983, could be accommodated by increasing mine operating rates. In the unlikely event of a rapid turnaround in the current economic situation, a real shortage of tungsten would occur because a large number of tungsten mines are closed and most tungsten consumers have low inventories.

In the longer term, mine developments now under way could create a situation for market instability. Large production capacities are coming on-stream in Canada and in other countries at the same time that tungsten scrap recycling is increasing. If consumption does not expand to absorb the new production the resulting market imbalance will create a strong downward pressure on tungsten prices.

It remains to be seen whether the UNCTAD Committee on Tungsten will be successful in its goal of market stabilization and whether the proposed association of tungsten producing-exporting countries, with prices stabilization as its objective, will be established. Both of these events could have a significant impact on the tungsten market in the long term.

PRICES

	December 31, 1982	December 31, 1981
	($US)	
Tungsten ore, 65% minimum WO_3		
G.S.A. domestic, duty excluded, per short ton unit of WO_3	99.600	120.735
G.S.A. export, per short ton unit of WO_3	95.090	129.74
L.M.B. ore quoted by **London Metal Bulletin,** cif Europe, per metric ton unit of WO_3	76.00-84.00	120.00-126.00
Ferrotungsten, per pound W, fob Niagara Falls, low-molybdenum	list price suspended	list price suspended
Tungsten metal, per pound, fob shipping point Hydrogen reduced: 99.5%, depending on Fisher No. range	13.100-13.720	13.90-15.50

Source: Metals Week.
cif Cost, insurance and freight; fob Free on board.

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
32900-1	Tungsten ores and concentrates	free	free	free	free
34700-1	Tungsten metal in lumps, powder, ingots, blocks or bars and scrap of tungsten alloy metal, for alloying purposes	free	free	free	free
34710-1	Tungsten rod and tungsten wire	free	free	25	free
35120-1	Tungsten and alloys in powder, pellets, scrap, ingots, sheets, strips, plates, bars, rods, tubing, wire, for use in Canadian manufactures (expires June 30, 1983)	free	free	25	free
37506-1	Ferrotungsten	free	4.8	5	free
37520-1	Tungsten oxide in powder, lumps and briquettes, for use in the manufacture of iron and steel	free	free	5	free
82900-1	Tungsten carbide in metal tubes for use in Canadian manufactures	free	free	free	free

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
			(%)			
37506-1	4.8	4.7	4.5	4.3	4.2	4.0

UNITED STATES (MFN)

601.54	Tungsten ore, per pound tungsten content	17¢

		1982	1983	1984	1985	1986	1987
			(% unless otherwise specified)				
422.40	Tungsten carbide, on tungsten content	5¢/ lb + 12.5	12.5	12.0	11.5	11.0	10.5
422.42	Other tungsten compounds	11.2	11.0	10.7	10.5	10.2	10.0
606.48	Ferrotungsten and ferro-silicon tungsten, on tungsten content	8.8	8.2	7.5	6.9	6.2	5.6
629.25	Tungsten metal waste and scrap, not over 50% tungsten	6.6	6.3	5.9	5.6	5.2	4.9
629.26	Tungsten metal waste and scrap, over 50% tungsten	4.2	4.2	4.2	4.2	4.2	4.2
629.28	Tungsten metal, unwrought, other than alloys: lumps grains and powders, on tungsten content	15¢/ lb + 12.5	9¢/ lb + 12.5	3¢/ lb + 12.5	12.1	11.3	10.5
629.29	Tungsten metal, unwrought, other than alloys: ingots and shot	9.8	9.0	8.3	7.5	6.8	6.0
629.30	Other unwrought tungsten metal	11.5	10.5	9.6	8.6	7.6	6.6
629.32	Unwrought tungsten alloys, not over 50% tungsten	6.1	5.9	5.6	5.3	5.0	4.7
629.33	Unwrought tungsten alloys, over 50% tungsten	11.5	10.5	9.6	8.6	7.6	6.6
629.35	Wrought tungsten metal	10.3	9.5	8.8	8.0	7.3	6.5

Sources: The Customs Tariff and Commodities Index, 1982, Revenue Canada; Tariff Schedules of the United States Annotated 1982, USITC Publication 1200; U.S. Federal Register Vol. 44, No. 241.

Uranium

R.T. WHILLANS

The short-term prospect for the uranium industry remained unchanged throughout 1982, as estimates of projected nuclear generating capacity, and in turn uranium requirements, were once again adjusted downward. The combination of general economic malaise, uranium supply exceeding demand, and swelling uranium inventories, led to further production cutbacks, mine closures and project deferrals, most notably in the United States. In response to this attrition, the United States considered legislation that could impose new uranium import restrictions, thereby contributing significantly to the uncertainty within the uranium industry worldwide. (See Markets and Prices). Although the uranium market remained depressed during the year, some signs of recovery were evident by year-end as the uranium spot-market price rose slightly from the seven-year low reached in August 1982.

Despite limited short-term market opportunities, prospects for the longer term continued to offer promise. In Canada, the momentum developed by the uranium industry during the late 1970s was still much in evidence. Encouraged by projections that indicate the need for additional uranium production capability by the mid-1990s, some companies acquired properties with future development potential, and continued with major exploration programs even though levels of exploration decreased overall. Off-property exploration activity was further reduced in favour of sustaining on-property exploration and development efforts; significant new uranium resources have been proven up as a result of this concentration of activity.

Two Canadian uranium mines ceased production during the summer. On June 30, Eldorado Nuclear Limited closed its Beaverlodge mine near Uranium City, Saskatchewan, and in early July, Madawaska Mines Limited placed its operation near Bancroft, Ontario, on standby. These closures affected some 840 and 390 employees, respectively.

In Ontario, rehabilitation work progressed on schedule at the Elliot Lake properties of Denison Mines Limited and Rio Algom Limited. In Saskatchewan, the Key Lake Mining Corporation (KLMC) kept its project on schedule and Cluff Mining proceeded toward finalizing its Phase II development plan. In October, Eldorado concluded the purchase of all shares of Gulf Minerals Canada Limited and Uranerz Canada Limited thereby securing a resource base capable of supporting production well into the 1990s.

The Canadian uranium industry has thus adjusted during a period of limited short-term prospects; the rate at which new production capacity will be committed remains uncertain, at least over the next few years.

PRODUCTION AND DEVELOPMENT

Canada had seven primary uranium producers until mid-1982, at which time Eldorado and Madawaska ceased operating. (See Table 1 for primary uranium production). Of Canada's total uranium shipments in 1982, some 60 per cent was attributable to the four Ontario operations, principally from the two largest producers at Elliot Lake, with the balance coming from the three Saskatchewan operations. (See Table 2).

Full design production levels were met at the Elliot Lake, Ontario, operation of Denison Mines Limited. Throughput at the ore processing plant, which has a capacity of 13 600 t of ore a day (t/d), averaged 10 645 t/d during the year. Some 3 651 419 t of ore with an average grade of 0.670 kg U per t were milled in 1982; the uranium recovery rate averaged 91.3 per cent. A production record was achieved as uranium output increased by 29 per cent over the 1981 level. Underground development at Denison's adjoining Stanrock/Can-Met properties progressed on schedule with completion expected by 1985. In June, the first deliveries of ore from these rehabilitated areas was received at the hydrometallurgical plant. Completed during the year were the

TABLE 1. URANIUM PRODUCTION IN CANADA, BY COMPANY, 1981 AND 1982

Company	Location	Production 1981	Production 1982
		tonnes U[1]	
Agnew Lake Mines Limited	Agnew Lake, Ont.	123	65
Cluff Mining (Amok Ltd/SMDC)	Cluff Lake, Sask.	1 290	1 469
Denison Mines Limited	Elliot Lake, Ont.	1 824	2 359
Eldorado Nuclear Limited	Eldorado, Sask.	375[2]	282[3]
Gulf Minerals Canada Limited[4]	Rabbit Lake, Sask.	1 207	1 210
Madawaska Mines Limited	Bancroft, Ont.	245	153
Rio Algom Limited - Quirke	Elliot Lake, Ont.	1 832	1 672[5]
- Panel		826	865
Total Canada[6]		7 722	8 075

Source: Company annual reports.
[1] One metric ton (tonne) of elemental uranium (U), written as tU, is equivalent in terms of uranium content to 1.2999 short tons of uranium oxide (U_3O_8). [2] Includes 2 tU from Cenex Limited property ore. [3] Beaverlodge operation only. [4] Joint operation with Uranerz Canada Limited; operation acquired by Eldorado Nuclear Limited (see text). [5] Does not include uranium recovered from Panel ore processed at Quirke, or from acid raffinate from Eldorado Nuclear Limited. [6] Primary uranium production only.

expansion programs at the No. 1 and No. 2 shaft areas, the Southwest ventilation raise, and the plan for an underground railway haulage system at the No. 3 shaft, which services the Stanrock/Can-Met areas.

During the year, Denison conducted tests on heap-leaching lower-grade ore at the mining face. In October, some 70 000 t of underground stockpiled ore were brought under spray and trickle leach. More extensive testing was planned for 1983 with the hope of demonstrating the feasibility of a large-scale, underground heap-leaching operation. If test results continued to be positive, it was expected that heap-leaching could eventually account for a significant percentage of the company's overall output.

At Rio Algom Limited's Elliot Lake facilities, uranium production at the 2 990 t/d Panel operation was similar to that of 1981, although output at the 6 350 t/d Quirke operation decreased slightly. During the year, the Panel mill processed some 1 009 491 t of ore; the Quirke mill processed some 2 087 355 t of ore, including 1 836 t from the Panel mine. Rio Algom reported that the average mill recovery was 94.2 per cent, close to the 1981 average of 94.1 per cent. Deliveries to customers from the Panel and Quirke operations totalled some 2 412 tU. Among the factors that affected production levels in 1982 were the decision to extend the normal vacation shutdowns in the third quarter, the reported decline in the grade of ore mined, and the planned reduction in output at Quirke to more closely match production with deliveries to be made under existing contracts.

TABLE 2. URANIUM OUTPUT[1] IN CANADA BY PROVINCE, 1981 AND 1982

	1981 (t)	1981 ($000)	1982P (t)	1982P ($000)
Ontario	4 859	525,806	4 955	550,586
Saskatchewan	2 648	268,406	3 234	264,599
Total	7 507	794,212	8 189	815,185

[1] Shipments of uranium (U) in concentrate from ore processing plants; one metric ton (tonne) of elemental uranium, written as tU, is equivalent, in terms of uranium content, to 1.2999 short tons of uranium oxide (U_3O_8).
P Preliminary.

The rehabilitation of Rio Algom's Stanleigh property progressed on schedule and within budget toward a mid-1983 completion date. Start-up of the 4 540 t/d capacity mill was scheduled for July 1983;

TABLE 3. PRODUCTION OF URANIUM IN CONCENTRATES BY MAJOR PRODUCING COUNTRIES, 1975-82

	United States	Canada	South Africa	Namibia	France	Niger	Gabon	Australia	Other[1]	Total[2]
	(tonnes U)									
1975	8 900	3 560	2 490	-	1 730	1 310	800	-	330	19 120
1976	9 800	4 850	2 760	650	1 870	1 460	..	360	340	22 090
1977	11 500	5 790	3 360	2 340	2 100	1 610	910	355	385	28 350
1978	14 200	6 800	3 960	2 700	2 180	2 060	1 020	515	455	33 890
1979	14 400	6 820	4 800	3 840	2 360	3 620	1 100	705	465	38 110
1980	16 800	7 150	6 150	4 040	2 630	4 100	1 030	1 560	510	43 970
1981	14 800	7 720	6 135	3 970	2 560	4 360	1 020	2 860	670[3]	44 100
1982P	10 330	8 075	5 820	3 780	2 860	4 260	960	4 500	700[4]	41 285

Sources: Data derived principally from "Uranium: Resources, Production and Demand, February 1982, a biennial report jointly produced by the Nuclear Energy Agency of the Organization for Economic Co-operation and Development, and the International Atomic Energy Agency, and, for 1981, from the annual "MINEMET" report of IMETAL SA; 1982 data derived from miscellaneous sources.

[1] Includes Argentina, Federal Republic of Germany, Japan, Portugal, Spain, and Sweden (1975 only). [2] Totals (rounded) are of listed figures only. [3] Includes Belgium, Brazil, India and Israel. [4] Includes Belgium and Brazil plus estimates for India and Israel.
P Preliminary; - Nil; .. Not available.

production by March 1984 should reach 3 855 t/d, the rate planned to satisfy contracted quantities over the near term. Mine production capacity is some 6 350 t/d although actual operating tonnage will be less. To the end of the first quarter of 1982, some $243 million had been spent or committed at Stanleigh; total reported capital cost of the rehabilitation is $385 million. Ontario Hydro is financing the project and purchasing its total output.

Madawaska Mines Limited was advised on March 18, 1982 that its long-term sales contract with the Italian state-owned agency AGIP S.p.A. would be terminated. (See Markets and Prices.) AGIP agreed to accept concentrates up to a specified limit until the June 30th contract termination date, and to provide funds to assist in defraying the mining suspension costs should operations be phased out. Production to early July, when all mining and milling operations ceased, amounted to 153 tU. The Bancroft, Ontario, facility will be maintained in standby condition pending an improvement in the uranium market.

At the salvage leaching operation of Agnew Lake Mines Limited, 90 km east of Elliot Lake, environmental programs preparatory to final shutdown progressed satisfactorily through the year, the major effort being the disposal of the surface stockpile to the tailings area. In November it was decided that the operation was no longer economic and that the leach solution from the underground stopes would be drained in preparation for the closure of the mine during 1983. At year end, diluted ore in place, broken in stopes and on the surface leach pile totalled an estimated 8 142 890 t containing some 2 750 tU.

Since production began in 1977, an overall extraction of uranium of 60 per cent was achieved, that is, 58 per cent from the underground stopes and 65 per cent from the surface leach pile. During 1982, overall plant recovery efficiency was 92.8 per cent; plant availability was 99 per cent.

Expectations were that the company would receive final approval from government regulatory agencies in early 1983 for the ultimate close-out of the operation. Some 54 employees will be affected by the closure.

Eldorado closed its Beaverlodge mine near Uranium City, Saskatchewan, on June 30, after more than 30 years of production. The mill remained in operation until October to complete the processing of uranium-bearing material still in the circuit inventory. Some 150 315 t of ore, with an average grade of 1.92 kg U per t were processed

TABLE 4. 1981 ESTIMATES[1] OF CANADA'S MINEABLE URANIUM RESOURCES

Mineable at Uranium prices[3]	(Uranium contained in mineable ore)[2] ('000 tonnes U) Measured		Indicated		Inferred[5]	
Up to $110/kg U	45	(67)[4]	153	(163)	142	(214)
$110 to $160/kg U	2	(6)	12	(22)	39	(101)
Subtotal	47	(73)	165	(185)	181	(315)
$160 to $320/kg U	24	(NA)	41	(NA)	44	(NA)
Total	71	-	206	-	225	-

[1] Interim revisions; comprehensive assessments for selected properties only. [2] Milling losses have not been deducted. [3] The dollar figures refer to the market 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 milling losses expected. [4] The bracketed figures are from the 1980 assessment which used price ranges of up to $135/kg U and $135 to $200/kg U. [5] Principal properties only.
NA Not assessed.

during 1982. Mill throughput averaged 945 t/d although recovery slipped to 84 per cent. A workforce of 110 remained on site to complete the salvage and reclamation (decommissioning) programs, as approved by federal and Saskatchewan regulatory agencies; close-out work was expected to be completed by mid-1983. Eldorado's assistance costs related to the closure of Beaverlodge, including those under the various relocation incentive programs (see Government Affairs) will amount to about $10 million, of which nearly $8 million goes directly to employees.

On October 1, Eldorado announced the conclusion of the purchase of all shares of Gulf Minerals Canada Limited and Uranerz Canada Limited in exchange for approximately 4 000 tU from Eldorado's inventory. With the acquisition of both companies' interests, Eldorado became the sole owner of the Rabbit Lake complex - held previously by Gulf companies (51 per cent) and Uranerz (49 per cent) - and of significant uranium resources tributary to it. In December, Eldorado Nuclear Limited underwent a corporate restructuring; operations at Rabbit Lake will continue under the name Eldor Mines, a division of the newly formed Eldorado Resources Limited.

Mining was suspended in June 1982 at the Rabbit Lake open-pit, although it was expected to resume in late 1983. Ore stockpiles are sufficient to provide feed to the mill until 1985. During 1982, 615 986 t of ore, averaging 2.04 kg U per t, were processed at the Rabbit Lake mill; recovery increased to 93.5 per cent and output exceeded that of 1981. Given project approval, Eldor proposes to develop the nearby Collins Bay "B" orebody in order to maintain throughput at the 1 500 t/d capacity Rabbit Lake mill. The Collins Bay proposal was examined by the Government of Saskatchewan and found to be technically acceptable; final approval was pending at year-end. The "B" zone reportedly contains some 12 000 tU in ore with an average grade of 0.38 per cent U; this resource could support an annual output of some 2 000 tU until 1991, assuming production commenced in 1985.

Similar annual output could be realized from the Collins Bay "A" and "D" zone resources, reported to contain 6 654 tU in ore grading 9.5 per cent U, and 1 935 tU in ore grading 1.6 per cent U, respectively. The development of these deposits would extend the life of the Rabbit Lake mill well into the 1990s.

At the northern Saskatchewan operation of Cluff Mining, owned 80 per cent by Amok Ltd. and 20 per cent by Saskatchewan Mining Development Corporation (SMDC), production from stockpiled ore during the year was close to the nominal Phase I capacity of 1 500 tU/year. In Phase I, the mining and stockpiling of the 5 000 tU "D" orebody occurred between June 1980 and October 1981. The processing of "D" material is expected to continue until mid-1984.

Production from the first of two types of stockpiled material in 1982 involved the processing of 2 025 t of high-grade ore, averaging 291 kg U per t; this material was crushed, ground and sent directly to acid leach. The second type of ore, totalling 46 466 t at an average grade of 30 kg U per t, was pre-concentrated before processing. This preconcentration stage, or gravimetric process, upgraded the ore to 4 058 t, averaging 230 kg U per t, before grinding and acid leaching. The rejected material from the gravimetric process will be processed during Phase II. The high-grade feed contained 590 tU, the gravimetric concentrate 938 tU; recovery on production was 96.4 per cent.

Development plans for Phase II, still under consideration at year-end, will determine the mining method and sequence of exploitation for the other, nearby, lower-grade deposits. Available for exploitation are the Claude, O-P and NRF deposits reportedly containing 4 800 tU, 1 800 tU and 5 000 tU in ore averaging 0.5, 0.65 and 0.35 per cent U, respectively. Some $100 million will be spent on Phase II from 1983 to 1985 and will provide for a major mill expansion to handle the increased tonnages of lower-grade ores.

In mid-year, approval was obtained to complete a small experimental surface mining operation on the Claude orebody to verify ore grade and to optimize the mining method planned for Phase II. Some 36 000 t of ore averaging 4.92 kg U per t were recovered by November.

Installation of a small, solvent extraction circuit in the Cluff mill began prior to year-end for the processing of the remaining Phase I ore residues. Over the sixteen months that it is expected to be in operation, the circuit will recover an estimated 577 tU from these gravimetric residues, which average 27 kg U per t. The Phase II decision was expected in early 1983; subject to federal and provincial regulatory agency approvals, development could be under way in early 1984.

Stripping of the Gaertner deposit by Key Lake Mining Corporation (KLMC) proceeded ahead of schedule at Key Lake in north central Saskatchewan. Removal of the sandy overburden was completed by year-end permitting the stripping of the cobble ore, above the orebody proper, to begin. By mid-1982, over 85 per cent of the engineering work at the construction site had been completed and all equipment had been purchased. Despite a three-month strike by five trade unions during the summer, site construction remained on schedule; the mill complex was more than 50 per cent complete by December. First production from the 700 t/d capacity mill was expected by August 1983, with full production possible by mid-1984. Stripping operations at the Deilmann deposit are planned for the mid-1980s in anticipation of resource depletion at the Gaertner deposit around 1990.

The Key Lake uranium leach process will consist of a two-stage counter-current acid leach system with the first stage at atmospheric pressure and the second under pressure of oxygen. The process will provide flexibility to achieve extractions of more than 99 per cent on a variety of ore types while producing an optimum pregnant solution for solvent extraction.

The KLMC venture is jointly owned by SMDC (one-half), Uranerz Exploration and Mining Limited (one-third), and Eldor Resources Limited, wholly-owned by Eldorado Nuclear Limited (one-sixth).

In late-October 1981, ESI Resources Limited, a wholly-owned subsidiary of Earth Sciences Inc. of Golden, Colorado, ceased full-scale operations at its Calgary, Alberta, byproduct uranium facility; uranium had been recovered from phosphoric acid produced at an adjacent plant operated by Western Co-operative Fertilizers Limited. To the end of 1981, some 12 tU* was reportedly delivered to the two New England utilities with ESI contracts. During 1982, the operation was idle as ESI sought additional capital for plant modifications. In October it was reported that Urangesellschaft Canada

* Output from ESI is not included in Canadian production totals, since the uranium recovered is from phosphate rock imported from the United States.

TABLE 5. URANIUM UNDER EXPORT CONTRACTS REVIEWED[1] SINCE SEPTEMBER 5, 1974

Country	Tonnes U
Belgium	3 030
Finland	2 000
France	3 850
Italy	1 120
Japan	22 630
South Korea	5 140
Spain	4 230
Sweden	3 880
Switzerland	150
United Kingdom	7 700
United States	25 570
West Germany	7 660
Total	86 960

[1] Reviewed and accepted under Canadian uranium export policy. Totals adjusted to reflect new and amended contracts as of December 1982.

Limited had become a limited partner in the operation, acquiring a 49 per cent interest for some $6 million. Production was expected in late 1983 at a rate of some 45 tU annually.

In late-1981 it was announced that development would be deferred at the Midwest Lake project, some 24 km west of Rabbit Lake, Saskatchewan. Close-out work at the property, managed by Canada Wide Mines Ltd. (CWML) - a wholly-owned subsidiary of Esso Resources Canada Limited - was completed by year-end 1982. Although uranium exploration had been suspended at Midwest Lake in the fall of 1981, ore reserve calculations, further metallurgical tests, and an evaluation of alternative mining methods continued into 1982; pilot plant studies were completed in June.

EXPLORATION

Based on its most recent annual uranium exploration survey (completed during 1982), Energy, Mines and Resources Canada (EMR) determined that 1981 uranium exploration expenditures in Canada amounted to $102 million, 20 per cent less than the 1980 total of $128 million, and that exploration and surface development drilling for uranium had dropped by 30 per cent to some 359 000 m, down from the record 503 000 m in 1980. The sharp decline in activity reflected the continued erosion of both the spot-market price and short-term sales prospects for uranium. During 1981, over 80 per cent of the total uranium exploration expenditure and drilling activity took place in Saskatchewan and the Northwest Territories; this concentration of expenditure and effort has been maintained since 1978.

Although the uncertainties in financing exploration programs resulted in several companies withholding estimates of their exploration intentions for 1982, it appeared, from those respondents providing figures, that uranium exploration expenditures could drop by as much as 30 per cent in 1982 and drilling activity by as much as 35 per cent.

The survey also revealed that the number of exploration projects totalled 324 in 1981 compared to 377 in 1980. It is worth noting that on each of 24 projects, expenditures in excess of $1 million were incurred each year from 1979 to 1981 inclusive!

The 10 operators with responsibility for the largest exploration budgets in 1981 - accounting in aggregate for some 63 per cent of the $102 million total - were, in alphabetical order, Aberford Resources Ltd. (formerly Pan Ocean Oil Ltd.), AGIP Canada Limited, Amok Ltd., Asamera Inc., BP Minerals Limited, Eldorado Nuclear Limited, Gulf Minerals Canada Limited, SERU Nuclear (Canada) Limited, Saskatchewan Mining Development Corporation (SMDC) and Uranerz Exploration and Mining Limited (UEML).

In 1981 over 55 per cent of the total uranium exploration expenditure in Canada was committed by companies whose majority interests were held outside of Canada. Of this non-Canadian portion of total expenditures, half was accounted for by United States companies and half by companies with ties to western European countries and Japan.

Although the general level of uranium exploration declined in 1981 with several additional companies deciding to terminate all such activity, several major uranium exploration programs were continued in 1982 in areas of proven favourability. This effort by a handful of companies resulted in the delineation and/or confirmation of significant new uranium resources.

TABLE 6. CURRENT AND PLANNED UF_6 CONVERSION CAPACITY OF WESTERN WORLD URANIUM REFINERS

Company	Location	Current UF_6 Nameplate Capacity	% of Total Capacity	Planned Expansion in Nameplate Capacity (commercial operation)
Allied Corporation	Metropolis, Illinois, U.S.A.	12 700	26.0	-
British Nuclear Fuels Limited	Springfields, Lancashire, England	9 500	19.5	2 000 (?)
Comurhex Company	Malvesi and Pierrelatte, France	12 000	24.6	2 000 (?)
Eldorado Nuclear Limited	Port Hope, Ontario, Canada	5 500	11.3	9 000 (1984)
Kerr-McGee Corporation	Sequoyah, Oklahoma U.S.A.	9 090	18.6	-
	Current total	48 790	100.0	
Brazil		-	-	500 (1985)
Japan		-	-	200 (1983 ?)
South Africa		-	-	400 (1983 ?)

Source: Derived from "Uranium Refining and Conversion Practice in the Western World: An Overview", paper by A.W. Ashbrook, Eldorado Nuclear Limited, presented at the 12th Annual Hydrometallurgical Meeting, Toronto, Canada, August 30, 1982.

At the Carswell Structure, in the western Athabasca Basin of northern Saskatchewan, persistence by Amok Ltd. led to the discovery in 1981 of the Peter River deposit about 1 km north of Cluff Lake. Drilling effort was maintained during 1982 toward the establishment of proven reserves; the vein-type mineralization occurs within the basement rocks.

Along the eastern rim of the Athabasca Basin, within the Collins Bay-Eagle Point mineralized zone, fill-in drilling by principals Gulf Minerals, SMDC, and Noranda Exploration Company, Limited, confirmed previous resource estimates for Eagle Point.

To the west, similar work was continued along the Dawn Lake-Midwest Lake belt by such companies as Asamera, Canadian Occidental Petroleum Ltd. (CanOxy), Inco Metals Company and SERU Nuclear. Based on continued drilling results and a redetermination of assays from earlier holes, Asamera reported that reserves at its Dawn Lake property were increased by over 50 per cent to some 15 400 tU. In October, Asamera concluded an agreement with Idemitsu Kosan Co. Ltd., Japan's largest independent oil company, for the sale of the 12 per cent interest that Asamera held in the adjacent Waterbury Lake property. At that property, SERU Nuclear maintained its program of evaluating areas of uranium mineralization and announced early in 1983 drill intersections with values up to 11.4 per cent U over 6.7 m at depths up to 440 m.

About 10 km north of their McClean deposits, Inco and CanOxy discovered a new mineralized zone, named the JEB deposit, with interesting uranium values at a depth of 100 m. Further delineation drilling to determine the size of the deposit was deferred beyond 1983.

In the Otish Mountains area of central Quebec, exploration by Eldorado Nuclear, Uranerz and SERU Nuclear et. al. continued.

URANIUM RESOURCES

A review of priorities within EMR in 1981 led to the decision to adopt a biennial schedule for publishing the uranium resource assessment results compiled by the Uranium Resource Appraisal Group (URAG) of EMR; the next formal URAG report, based on the 1982 assessment, will be published in 1983.

During 1982, URAG revised its 1980 estimates of Canada's mineable uranium resources based on a reassessment of selected Canadian deposits. The reassessments were primarily of an economic rather than a geologic nature, whereby modified mining-economic parameters were applied to previously assessed deposits. These interim revisions of Canada's Measured, Indicated and Inferred resources, as of December 31, 1981, are shown in Table 4. Areas in Canada in which these resources occur are illustrated in Figure 1. The resource categories, which reflect different levels of confidence in the quantities reported, are sub-divided into three levels of economic exploitability related to the current market price of uranium. The interim (1981) assessment was carried out using a lower price range, limited by the uranium market price established in Canadian dollars at \$110/kg U, a middle price range, from \$110 to \$160 kg/U, and an upper price range, spanning the \$160-\$320/kg U interval. The \$110/kg U price, determined in December 1981 when data gathering for the interim assessment began, was the weighted average price for 1981 under market-related export contracts (including spot sales) made by Canadian producers for deliveries in 1981.

In comparing the 1981 interim estimates of Canada's mineable uranium resources with the 1980 resource estimates, the most significant change to note is the shift of resources from the lower price categories into the new higher price category. Considering only the two lower price ranges for the years shown, the estimates indicate a 36 per cent drop in measured resources, an 11 per cent decrease in indicated resources, and a 43 per cent drop in inferred resources.

The major factor contributing to the change in resource estimates was the continued increase in production costs without comparable increases in the price of uranium, which necessitated the adoption by URAG of higher cut-off grades for resource assessment at some properties. The overall result was a reduction in the level of resources that are of economic interest in the immediate and near term.

Also of importance in the case of certain properties was the assumption of greater mining thicknesses, in recognition of the continued shift to more mechanized mining methods, and the application of modified assessment techniques, e.g., geostatistics and computerized multiple cut-off grade evaluations.

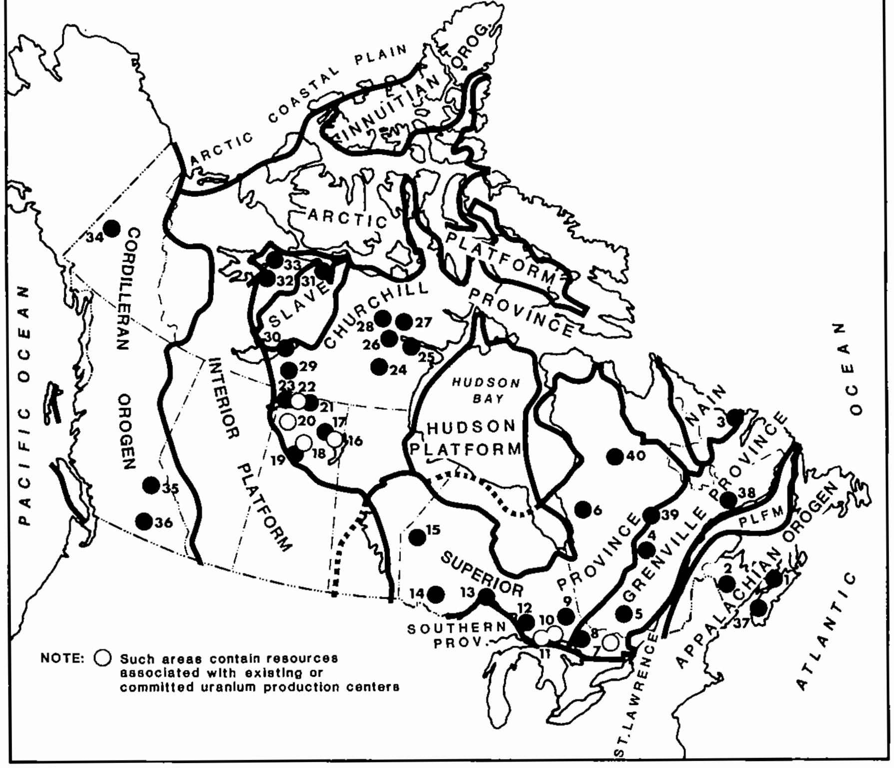
The significance of these factors can be appreciated if the upper price range, as provided for 1981, is included in comparing the 1980 and 1981 results. One then sees a slight decline in the measured category, an overall increase in the indicated category, and a moderate decrease in the inferred category.

GOVERNMENT AFFAIRS

In early 1981 the Nova Scotia legislature appointed a Select Committee to report on the environmental impact of uranium exploration within the province. By September, however, mounting public concern prompted the provincial Cabinet to place a moratorium on new uranium exploration licences, including those coming up for renewal. As the Select Committee was not reactivated after the fall provincial election, Nova Scotia Premier John Buchanan appointed Judge Robert McCleave, in January 1982, as a one-man commission to investigate all aspects of uranium exploration and mining within the province. Informal presentation sessions were held between April and October; opportunity for debate was scheduled to permit a summation by year-end prior to the commencement of the formal second phase of the inquiry.

In July 1981, Uranium Canada, Ltd. (UCAN), a federal Crown company, and five other companies involved in uranium production in Canada, were charged under Section 32(1)(c) of the Combines Investigation Act. UCAN's preliminary inquiry date was scheduled for May 17, 1982. In March, UCAN's counsel applied for a Writ of Prohibition, to prohibit the Judge of the Ontario Provincial Court from proceeding with the preliminary inquiry; the Supreme Court of Ontario issued an Order on April 23, 1982, prohibiting the Provincial Court from proceeding. An Appeal was then lodged in the Court of Appeal by the Attorney General of Canada. In June 1982, the Court of Appeal of Ontario confirmed the Judgement that UCAN is immune from prosecution under the Act. A further appeal taken by the Federal Crown in the Application for Prohibition was heard by the Supreme Court of Canada on January 27, 1983. Judgement was reserved.

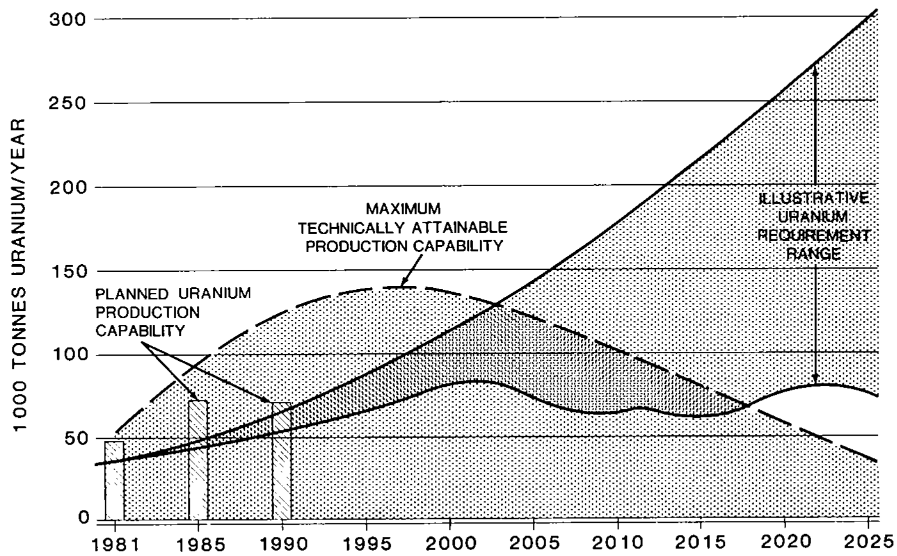
AREAS IN CANADA WITH URANIUM RESOURCES ASSOCIATED WITH IDENTFIED DEPOSITS



(numbers refer to locations on map above)

1. Cobequid Mountains
2. Lake George
3. Makkovik-Seal Lake
4. Crevier Alkalic Complex
5. Mont Laurier
6. Sakami Lake
7. Bancroft-Sharbot Lake
8. Lake Nipissing
9. Cobalt Embayment
10. Agnew Lake
11. Elliot Lake
12. Kapuskasing Zone
13. Prairie Lake
14. Kenora-Dryden
15. Favourable Lake
16. Rabbit Lake - Collins Bay
17. Midwest Lake - McClean Lake
18. Key Lake
19. Wollaston Lake Belt
20. Carswell Structure (Cluff Lake)
21. Fond-du-Lac
22. Beaverlodge
23. Maurice Bay
24 Angikuni - Yathkeyd
25. Baker Lake
26. Schultz Lake
27. Amer Lake
28. Thelon Basin
29. Nonacho Lake
30. East Arm - Great Slave Lake
31. Bathurst Inlet
32. West Bear Province
33. Hornby Bay - Dismal Lakes
34. Central Yukon (Tombstone Mt.
35. Birch Island (Rexspar)
36. Kelowna-Beaverdell
37. South Mountain Batholith
38. Johan-Beetz
39. Otish Mountains
40. Dieter Lake - Gayot Lake

ANNUAL WORLD URANIUM REQUIREMENTS AND PRODUCTION CAPABILITIES -ILLUSTRATIVE LONG-TERM PROJECTIONS-



DERIVED FROM: URANIUM-RESOURCES, PRODUCTION AND DEMAND, NEA/IAEA, FEBRUARY 1982.

On September 13, 1982, Minister of State for Mines, Judy Erola, announced details of a five-year federal research program aimed at speeding the development of technology to address the environmental effects of wastes resulting from the mining and milling of uranium. The $9.5 million program, stemming from the recommendations of the National Technical Planning Group on Uranium Tailings Research, will be administered by a National Tailings Program Office to be established in Ottawa. Although the Planning Group's report had recommended establishment of a joint program involving the uranium-producing provinces of Ontario and Saskatchewan, these provinces had not confirmed their participation as of December 1982.

As a party to the Mobility Incentive Agreement with the federal Department of Employment and Immigration, Eldorado Nuclear agreed to pay at least 50 per cent of the relocation expenses to its employees affected by the closure of the company's Beaverlodge operation at Uranium City, Saskatchewan; a maximum of $9,000 per family was made available. In September, a similar agreement between the Saskatchewan and federal governments was announced. It provided for relocation costs up to $9,000 for qualifying Uranium City area residents not employed by Eldorado but nonetheless affected by the closure.

On October 19, Saskatchewan Energy and Mines Minister Colin Thatcher announced the repeal of the requirement of compulsory Crown participation in mineral development. Under the provisions of Sections 110 and 111 of the Minerals Dispositions Regulations, companies had previously been required to offer the Government of Saskatchewan up to 50 per cent equity interest in any new mineral development project in the province.

The Minister for Justice and Public Services of the Government of the Northwest Territories, George Braden, announced in November the formation of a multi-agency group which would draft guidelines for uranium exploration in the Northwest Territories. In providing clear direction for management of a uranium exploration program, the working group will cover health and safety issues, environmental concerns, and land and water use. Representatives from industry, labour, federal and territorial governments will form the working party.

MARKETS AND PRICES

Canadian producers were quite active in the uranium market during 1982; new export contracts totalling some 7 500 tU were reviewed and accepted by the federal government. As shown in Table 5, these contracts brought to some 87 000 tU the total amount of uranium under export contracts reviewed since September 5, 1974. This total reflects scheduled deliveries under 70 contracts, 33 of which remain active. As of December 1982, forward export commitments under all active contracts, including those in place prior to September 5, 1974, were estimated at almost 60 000 tU. Forward domestic commitments approached 80 000 tU.

The uranium sales contract between Madawaska and AGIP S.p.A. was terminated on June 30, 1982. Efforts by Madawaska to procure a replacement contract, including a bid to supply Ontario Hydro with some 2 300 tU, proved unsuccessful. In June, Ontario Hydro contracted for the purchase of some 5 200 tU from the Key Lake project in northern Saskatchewan. The agreements with UEML and Eldorado, representing 60 and 40 per cent of the total respectively, reportedly cover one-third of Hydro's uranium requirements from 1985 to 1993; the contracts were valued at between $380 million and $500 million. The uranium will make up for the amounts deferred and reduced as a result of Hydro's contract renegotiations with Rio Algom and Denison in late 1981.

Later in the year, Madawaska sold some 17 tU to Ontario Hydro at a price of $C66/kg U; the uranium was surplus to the AGIP contract termination settlement.

The uranium spot-market price slide, which had levelled off during the latter half of 1981, continued through 1982 as indicated by the Nuclear Exchange Corporation[1] (Nuexco) monthly exchange value[2] (EV). From January to August, 1982, the EV slipped from $US 60/kg U to $US 44/kg U ($23 to $17/lb U_3O_8). In October, it rose for the first time in four years to $US 45.50/kg U ($17.50/lb U_3O_8), continuing to $US 52.65/kg U ($20.25/lb U_3O_8) at year-end. The NUKEM GmbH[3] spot market price displayed a similar decline and partial recovery during 1982, the December price ranging from $US 52.78 to $56.81/kg U.

Results of the bi-annual survey of U.S. uranium marketing activity, conducted by the United States Department of Energy (USDOE), indicated that as of January 1, 1982, the weighted average price of domestic uranium for delivery in 1982 was $US 92.43/kg U ($35.55/lb U_3O_8), compared to the final weighted average price for 1981 deliveries of $US 90.09/kg U ($US 34.65/lb U_3O_8).

In Canada, prices for 1982 deliveries under uranium export contracts were similar to the average price reflected in the USDOE survey and significantly higher than the Nuexco EV. Calculations made in December, as part of the continuing URAG exercise, indicated a price of $C 113/kg U as the weighted average price for 1982 under all export contracts made by Canadian producers for deliveries in 1982. Spot sales, accounting for about 1 per cent of total export sales, were included although litigation settlements were not. If converted to U.S. dollars at year-end exchange rates, the above price would be equivalent to about $US 92/kg U ($35.50/lb U_3O_8). Rounded to $C 115/kg U, it will serve to define the lower price category for the purpose of assessing Canada's uranium resources as estimated on December 31, 1982.

REFINING

At Eldorado Nuclear Limited's uranium processing facilities at Port Hope, Ontario, uranium concentrates are first refined to high purity uranium trioxide (UO_3)[4] prior to conversion into either uranium hexafluoride

[1] A California-based uranium brokerage firm.

[2] Nuexco's judgement of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month.

[3] A West German-based company which provides services within the nuclear fuel cycle.

[4] Uranium trioxide is the initial refined product from which either UO_2 or UF_6 is produced.

(UF_6)[5] for foreign utilities that operate light water reactors, or ceramic-grade uranium dioxide (UO_2) for CANDU-type heavy water reactors. Eldorado processed mine concentrates containing more than 6 300 tU during 1982, a 6 per cent increase over 1981. Some 4 762 tU as UF_6 were produced, up about 2 per cent from 1981, while output of natural ceramic-grade uranium dioxide rose by 18 per cent to 1 577 tU as UO_2.

Eldorado spent a total of $114 million during 1982 on the expansion of its processing facilities, capacity at which will almost triple by the end of 1983. Some $68 million was spent on the refinery project at Blind River, Ontario, where all processing to nuclear-grade UO_3 will be consolidated. Capable of producing some 18 000 tU as UO_3 annually, the plant was scheduled to be in-service by mid-1983. At year-end it was 77 per cent complete.

In the second quarter of 1982, Eldorado received approvals for the construction of a second UF_6 conversion facility at Port Hope, Ontario. Some $46 million was spent during 1982, bringing the plant to 30 per cent completion by year-end. The new facility, capable of producing some 9 000 tU as UF_6 yearly, was expected to be in service in late 1983. Table 6 summarizes current and planned UF_6 conversion capacity in the western world.

NUCLEAR POWER DEVELOPMENTS

The International Atomic Energy Agency reported that at year-end 1982, 294 nuclear power reactors, with a combined generating capacity of some 173 108 electrical megawatts (MWe), were on-line in national grids in 25 countries. A further 215 reactors with a combined capacity of 197 860 MWe were under construction in 27 countries while an additional 156 reactors of 152 605 MWe combined capacity were planned. During 1982, 21 reactors were connected to national grids, adding 17 812 MWe to the world nuclear capacity total. There were seven new orders placed, totalling 6 693 MWe, although 18 previously ordered plants were cancelled, all but two of these in the United States. In Canada, 10 CANDU reactors with an aggregate net output capacity of 5 248 MWe were in service (i.e. in commercial operation) at year-end and a further 14 reactors with an aggregate capacity of some 9 885 MWe were either in the pre start-up phase, under construction or committed (see Table 8).

Some 34 per cent of the total electrical energy generated by Ontario Hydro during 1982 came from nuclear-electric units; 33 per cent was derived from hydroelectric sources and 33 per cent came from coal-fired plants.

Ontario Hydro's nuclear reactors maintained their standing among the world's best performers. To the end of 1982, seven of Hydro's eight in-service CANDU's were in the top 10 in terms of lifetime capacity factor[6] out of some 153 commercial reactors, rated at 500 MWe or greater, in service around the world.

At the Bruce Nuclear Power Development near Kincardine, Ontario Hydro received Atomic Energy Control Board approval for a 5 per cent increase in the thermal operating power level of its four-reactor Bruce "A" Nuclear Generating Station (NGS). At the site, the Bruce-3 CANDU reactor set a record by running continuously at full electrical power for 494 days, from May 11, 1981 to September 17, 1982.

East of Toronto at Ontario Hydro's four-reactor Pickering "B" NGS, unit 5 achieved criticality on October 23, produced electricity for the first time on December 19, and reached 25 per cent of full power at year-end. The scheduled in-service date for the Pickering-5 reactor was April 1, 1983.

In November, Ontario Hydro announced an extension of the construction schedule for reactors 3 and 4 at the Darlington NGS near Bowmanville (see Table 8). The in-service dates for units 1 and 2 remain on target for May 1988 and February 1989, respectively.

Some 40 km southwest of Saint John, New Brunswick, at the Point Lepreau NGS, fuel loading was authorized on March 26, 1982. The reactor achieved criticality on July 25, and first electricity was produced on September 11. Point Lepreau was declared in service on January 31, 1983.

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[5] Uranium hexafluoride is the required feed material for the uranium enrichment process.

[6] Lifetime capacity factor is the ratio of electricity produced, from the in-service date of the reactor, relative to that which could have been produced had the reactor operated at 100 per cent power output for 100 per cent of the time.

TABLE 7. EXPORTS[1] OF RADIOACTIVE ORES AND CONCENTRATES[2] FROM CANADA, 1975-82

	United States[3]	U.S.S.R.	United Kingdom	Italy	France	Japan	Norway	South Korea	Total
					($000)				
1975	28,129	-	21,987	-	-	986	-	-	51,101
1976	46,850	-	20,541	-	-	-	-	-	67,392
1977	72,848	-	2,590	-	-	-	-	-	75,438
1978	163,911	-	39,106	3,348	-	791	-	-	207,156
1979	347,388	-	18,851	12,613	-	9	-	-	378,862
1980	218,013r	-	10,319	-	1	-r	-	2,329	230,662
1981	152,473	3,182	18,845	-	-	-	2,862	2,022	179,384
1982P	346,891	-	11,690	-	-	-	-	-	358,581

Source: Statistics Canada.
[1] Material that cleared Canadian customs with destination as indicated. [2] Includes uranium in concentrates. [3] For years 1975-76, uranium almost entirely destined for transshipment, primarily to western Europe and Japan, following conversion and enrichment; for subsequent years, figures represent a mixture of sales to U.S. and others, primarily in western Europe and Japan.
P Preliminary; r Revised; - Nil.

TABLE 8. EXPORTS[1] OF RADIOACTIVE ELEMENTS[2] AND ISOTOPES FROM CANADA, 1975-82

	United States[3]	U.S.S.R.[4]	UK	West Germany	France	Belgium Luxembourg	Netherlands	Finland	Argentina	Japan	South Korea	Other	Total
							($000)						
1975	69,596	6,295	1,109	304	227	-	-	-	119	787	-	3,937	82,374
1976	151,427	24,471	3,786	288	375	-	-	-	84	1,068	-	4,198	185,697
1977	151,869	6,133	356	384	685	75	-	10	287	288	-	1,078	161,165
1978	269,903	101,619	38,602	6,918	19,046	23	-	10	12,177	1,017	-	1,668	450,983
1979	293,577	170,500	5,147	26,159	1,762	221	629r	5,493	94,038	1,101	87	3,363r	602,077
1980	199,001	77,235	2,104	20,406	144,013	4,847	374r	6,408	27,766	1,911	137,002	4,312r	625,379
1981	382,418	20,192	2,081r	40,092	213,051	339	7,506	-	248	1,577	67	2,915	670,486r
1982P	299,246	34,854	796	37,250	36,213	291	-	199	214	19,617	123	5,230	434,033

Source: Statistics Canada.
[1] Material that cleared Canadian customs with destination as indicated. [2] Includes uranium hexafluoride (UF_6) and radioisotopes for medical and industrial purposes. [3] For years 1975-76, UF_6 component destined for transshipment, primarily to western Europe and Japan, following enrichment; for subsequent years, figures would also include UF_6 sales to the U.S. market. [4] UF_6 component destined entirely for transshipment to western Europe, following enrichment.
P Preliminary; r Revised; - Nil.

TABLE 9. NUCLEAR POWER PLANTS IN CANADA, DECEMBER 1982

Reactors	Owner	Net Output (MWe)	In-Service Dates (Expected)
Nuclear Power Demonstration	Atomic Energy of Canada Limited	22	1962
Douglas Point	Atomic Energy of Canada Limited	206	1968
Pickering 1 to 4	Ontario Hydro	2 060	1971-73
Bruce 1 to 4	Ontario Hydro	2 960	1977-79
Point Lepreau	New Brunswick Electric Power Commission	635	1983
Gentilly 2	Hydro-Québec	638	(1983)
Pickering 5 to 8	Ontario Hydro	2 064	(1983-85)
Bruce 5 to 8	Ontario Hydro	3 024	(1984-87)
Darlington 1 to 4	Ontario Hydro	3 524	(1988-92)[r]
Total net output expected by 1992		15 133 MWe	

[r] Revised.

During 1982, the National Energy Board granted approval to the New Brunswick Electric Power Commission (NBEPC), the owner of the facility, to export to New England some 335 MWe under nine electric power export licences.

At Hydro-Québec's Gentilly 2 Nuclear Power Station, near Bécancour, fuel loading was also authorized on March 26. The reactor achieved criticality on September 11 and went on-line December 4. In January 1983, the station was operating in excess of 35 per cent capacity; the scheduled in-service date was mid-September 1983.

In the Republic of South Korea, the Wolsung 1 - 600 MWe CANDU reactor achieved criticality on November 21, just five years after the first concrete was poured, and was synchronized to the South Korean grid on December 31. A similar CANDU at Rio Tercero in Cordoba province, Argentina, was nearing completion at year-end and scheduled for service in 1983.

INTERNATIONAL HIGHLIGHTS

During 1982, United States Senator Pete Domenici of New Mexico introduced an amendment to the Nuclear Regulatory Commission (NRC) Appropriations Bill for fiscal years 1982 and 1983 by sponsoring a proposal that would require an investigation to be initiated, under Section 232 of the Trade Expansion Act of 1962, if uranium imports were seen to exceed 37.5 per cent of total U.S. requirements in any two consecutive years over the next decade. During the investigation, the results of which could lead to the imposition of import restrictions, a two-year moratorium would be placed on new contracts for the purchase of foreign uranium. Steps would also be taken to revise U.S. Department of Energy enrichment contract criteria to enhance the use of feed material of domestic origin. The amendment eventually won Senate approval but was rejected by the U.S. House of Representatives on December 2 by a vote of 241 to 148. Later in the month Congress passed a compromise proposal, negotiated by Senator Domenici with the Administration, whereby the aforementioned two-year moratorium was deleted from the essentially intact original amendment.

In early 1982 the Organization for Economic Co-operation and Development (OECD) released the results of the eighth in a series of world uranium supply assessments conducted jointly by the Nuclear Energy Agency (NEA) of OECD and the International Atomic Energy Agency (IAEA)[7]. The study showed that Canada accounts for some 13 per

7 Uranium-Resources, Production and Demand, NEA/IAEA, February 1982.

TABLE 10. 1981 ESTIMATES OF WORLD[1] URANIUM RESOURCES

Country	Reasonably Assured Resources (RAR) Recoverable at costs[2] up to $80/kg U	Reasonably Assured Resources (RAR) Recoverable at costs[2] up to $130/kg U[3]	Estimated Additional Resources (EAR) Recoverable at costs[2] up to $80/kg U	Estimated Additional Resources (EAR) Recoverable at costs[2] up to $130/kg U[3]
	('000 tonnes U)			
Australia	294	317	264	285
Brazil	119	119	81	81
Canada	230	258	358	760
France	59	75	28	47
Namibia	119	135	30	53
Niger	160	160	53	53
South Africa	247	356	84	175
United States	362	605	681	1 097
Others	157	267	25	169
Total (rounded)	1 750	2 290	1 600	2 720

Source: Uranium - Resources, Production and Demand, NEA/IAEA, February 1982.
[1] Excluding the U.S.S.R., Eastern Europe and the People's Republic of China; [2] Costs expressed in January 1981, U.S. dollars; [3] Includes resources recoverable at costs up to $80/kg U.

cent of the world's[8] "low-cost" Reasonably Assured Resources,[9] ranking fourth behind Australia, South Africa, and the United States (see Table 9). Of greater significance in terms of Canada's future capability as a uranium supplier was its position with respect to Estimated Additional Resources.[9] Of the world total of some 2.7 million tU reported in this category, in deposits mineable at "costs"[9] up to $US 130/kg U, Canada accounts for 28 per cent, ranking second behind the United States.[10]

In the aforementioned NEA/IAEA assessment[11], a comparison is made of uranium production capability and requirements to the year 2025 for the World Outside Communist Areas (WOCA). Figure 2 presents a range of annual uranium requirements the upper and lower limits of the range being based on a high and a low nuclear power growth scenario, respectively. Both scenarios employ a mix of reactor types; the high case assumes a limited introduction of fast breeders while the low case assumes their rapid deployment in OECD Europe, Japan and the United States after 2000. This illustrated range of annual uranium requirements is compared with a projection of the maximum attainable production capability that could be supported by the principal resource categories containing resources recoverable at costs up to $130/kg U.

Given sufficient incentives to permit production from resources recoverable at costs up to $130/kg U, it would be technically possible to increase production capability at a sufficient rate to meet any of the annual requirement projections illustrated until at least the year 2000. However, based only on existing and committed production centres, planned production capability would fall short of projected requirements beginning in the early 1990s. Indeed, actual production could fall short of requirements during the 1990s, if not sooner, should these new projects operate at less than full capacity.

OUTLOOK

The International Atomic Energy Agency (IAEA) reported that during 1981 total installed nuclear power capacity in the world increased by 13 per cent, and predicted that

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[8] Excluding the U.S.S.R., Eastern Europe and the People's Republic of China.

[9] International resource terms used by the NEA of OECD and the IAEA; for purposes of international comparison, Canada's low and high "price" categories may be considered equivalent to the NEA/IAEA's low and high "cost" categories, respectively.

[10] URAG's 1980 uranium resource data were incorporated into this world assessment.

[11] Uranium - Resources, Production and Demand, NEA/IAEA, February 1982.

the proportion of the world's electricity produced by nuclear power plants would increase from the 1981 level of 9 per cent to 17 per cent by 1985. The IAEA concluded that nuclear power plants will continue to incur electricity generation costs substantially lower than those of oil-fired plants, and that they can compete with coal-fired plants except in locations with low-cost coal supplies. As noted previously (see Nuclear Power Developments), another 21 reactors were connected to national grids during 1982, adding 17 GWe[12] to the world nuclear capacity.

Supporting this optimistic outlook for the longer term, the Uranium Institute's most recent forecasts[13] of future nuclear generating capacity reaffirmed an annual rate of increase in excess of 7 per cent in the period 1982-1995 under the "most probable" growth scenario, despite the continued cancellation and deferral of reactor construction. Under the same growth scenario, annual uranium requirements in the 1982-1995 period are forecast to increase by 5 per cent. Compared with the 1981 forecast, the most recent projections of production capability from operating facilities were higher by 6 per cent in 1982 and 15 per cent in 1990. The increase reflects new and expanded capacity coming on-stream sufficient to offset losses in productive capacity through announced cutbacks and shutdowns.

However, the combined uranium production capability of facilities operating and under construction has decreased slightly compared with the Uranium Institute's 1981 forecast, attributable primarily to decisions to bring new facilities on-stream well below nameplate capacity. The Institute's study concluded that although sufficient production capacity will be available to supply the **existing** reactor program at least until 1995, exploration efforts must not be allowed to relax if the capability of supplying an **expanded** reactor program is to be maintained.

The problem facing the industry today is one of uranium oversupply and excess production capability, a situation that could persist into the 1990s. Beyond these short-term difficulties however, there is greater concern that the uranium industry may lose its momentum and in turn its ability to respond in a timely manner to anticipated longer-term requirements. It is evident that the decline in uranium prices, the loss of confidence in the market, and the decline in uranium exploration activity could have an impact on the realization of these long-term prospects.

In Canada, the continued uncertainty brought about by the depressed uranium market has had little overall effect on the industry's production capability. Production increased by almost 5 per cent in 1982 and is expected to exceed 10 000 tU in 1984. The industry's potential for additional expansion throughout the 1990s has not been seriously affected, although some loss in exploration momentum could delay the industry's response to the need for new production late in that decade. Prospects for growth beyond the 1990s are good, and Canada's uranium mining industry can look to the future with continued confidence.

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12 GWe = 10^9 watts.

13 **The Uranium Equation in 1982** - a paper presented at the Uranium Institute's Seventh Annual Symposium, London-September 1982, and updating "The Uranium Equation: The Balance of Supply and Demand, 1980-1995," Uranium Institute, 1981.

Vanadium

D. SHAW

Vanadium is derived from natural ores and from vanadium-containing residues such as byproducts from crude oil refining. The basic feedstock used to obtain all other vanadium products is vanadium pentoxide (V_2O_5), which is not currently produced in Canada. One domestic company, Masterloy Products Limited, produces ferrovanadium from imported vanadium pentoxide. Canada is not a major user of vanadium, consuming less than 800 tpy of ferrovanadium.

In 1982, vanadium consumption of the non-communist world fell severely from the previous year. Vanadium production rates throughout the industry fell in response, and several mine and mill closures were put into effect. The resultant excess capacity and weak demand put significant downward pressure on all vanadium product prices. Competition within the industry became so severe that reports of discounting on published prices occurred, even after these list prices had been revised downward.

Non-communist world consumption is predicted to turn around in 1983 from the 1982 results, but not above 1981 levels. Although product prices are forecast to stabilize during 1983, high-cost operations are expected to remain closed indefinitely.

CANADIAN DEVELOPMENTS

Vanadium occurrences are widespread throughout Canada. The most common type of occurrence is vanadium contained in titaniferous magnetites. While the grade of the best deposits, at 0.6 per cent V_2O_5, is comparable to the grade of some deposits now being worked in other countries, it is only about one-third the grade of titaniferous magnetites being mined for vanadium in the Republic of South Africa. There is also vanadium associated with uranium ores in Canada, but the grade is too low to warrant economic recovery. There are a few known occurrences in Canada where vanadium is the principal metal of interest. Typically these occur as vanadium minerals dispersed in a bed of sandstone, limestone or shale; however, the grade, at less than 0.3 per cent V_2O_5 is less than one-third the grade of a primary vanadium deposit now being worked in the United States.

The best prospect for commercial recovery of vanadium in Canada at present is the vanadium associated with the bitumen of the Alberta Tar Sands. The bitumen itself contains only 0.02 to 0.05 per cent V_2O_5. However, the fly ash, or residue remaining after the petroleum is extracted from the bitumen contains 2 to 4 per cent V_2O_5. The Great Canadian Oil Sands Division of Suncor Inc.'s operation provides a potential resource of nearly 800 t of contained vanadium each year. However, for mineralogical reasons, the fly ash is not amenable to treatment by the Petrofina hydrometallurgical process. Additional research will be required to demonstrate a commercially viable extraction before this potential source can be exploited economically.

Presently, no vanadium pentoxide is being produced in Canada. However, Masterloy Products Limited imports vanadium pentoxide for the production of ferrovanadium at its Ottawa plant, which has an annual capacity of approximately 1 400 t.

Canadian consumption of ferrovanadium as reported by Statistics Canada was 674 t in 1981. The principal consumers are: Stelco Inc.; The Algoma Steel Corporation, Limited; Dofasco Inc.; Atlas Steels Division of Rio Algom Limited; and Sydney Steel Corporation. Although no statistics are collected on the consumption of vanadium chemicals in Canada, vanadium salts are known to be used as an oxidation catalyst in the manufacture of sulphuric acid and maleic anhydride, as well as in the production of paints.

TABLE 1. CANADA, VANADIUM IMPORTS AND CONSUMPTION, 1980-82

	1980		1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Imports						
Ferrovanadium						
United States	522	5,984	491	6 065	180	2,596
Other Countries[1]	-	-	71	1 060	61	860
Total	522	5,984	562	7 125	241	3,456
Consumption						
Ferrovanadium						
Gross weight	708	..	674	..	..	..
Vanadium content	571	..	543	..	..	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
P Preliminary; .. Not available; - Nil.
[1] Other countries includes United Kingdom, Austria, Belgium, Luxembourg, Netherlands and South Africa.

WORLD DEVELOPMENTS

Non-communist world vanadium consumption including exports to communist countries dropped 22 per cent to an estimated 34 900 t of V_2O_5 equivalent in 1982. The decline can be attributed to the severity of the global recessionary effects upon the world steel industry, which began in mid-1981. In particular, weak demand for oil pipeline and automotive steel products led the downturn. In response, non-communist world production declined 14 per cent to an estimated 40 100 t of V_2O_5 equivalent. The decline in production was achieved mainly through reduced production rates across the industry, but also by temporary shutdowns of high-cost operations.

Republic of South Africa. The Republic of South Africa is both the world's leading producer and exporter of vanadium. The country's four leading producers - Highveld Steel and Vanadium Corporation Limited, Ucar Minerals Corporation, Transvaal Alloys (Pty) Limited, and Thermometallurgical Corporation (Pty) Limited - have captured 50 per cent of non-communist world's production. South Africa's estimated production was 19 500 t of V_2O_5 equivalent during 1982.

Highveld, the world's largest single producer of vanadium curtailed production to the operation of only one of its six roasters. The depressed market conditions were instrumental in the decision to postpone Highveld's planned expansion of its Witbank plant to 18 800 tpy capacity, which initially had been approved in 1980.

Ucar, a subsidiary of Union Carbide Corporation, reduced vanadium production levels at its Brits plant during the year. The company's second major plant, Bon Accord, discontinued production of V_2O_5 in November 1980, but the plant has continued to produce specialty products such as Carvan.

United States. United States vanadium consumption in 1982 totalled 6 800 t of V_2O_5 equivalent, a 50 per cent reduction from 1981. The United States is the world's second largest producer of vanadium. Vanadium production in the United States was estimated at 10 000 t of V_2O_5 equivalent in 1982, which represents a U.S. capacity utilization rate of 62 per cent. Production rates were also depressed in response to falling demand for its coproducts such as uranium (from carnotite ores) and molybdenum (from the processing of vanadium-bearing spent catalysts).

Union Carbide Corporation began shutdowns of its Hot Springs, Arkansas mine and mill and its Uravan vanadium/uranium facility in Rifle, Colorado in mid-1982. Most other major producers such as Atlas Corporation, Cotter Corporation, Foote Mineral Company, The Pesses Co., Gulf Chemical & Metallurgical Co., and Reading Alloys, Inc. reduced production of vanadium well below normal production rates. Kerr McGee Chemical Corporation managed to maintain production of vanadium pentoxide near capacity from its ferrophosphorus ores at Soda Springs, Idaho.

Finland. Rautaruukki Oy, a state-owned enterprise involved in the production and processing of ferrous metals, is Finland's only producer of vanadium. Rautaruukki is western Europe's leading producer of vanadium pentoxide. Total capacity at its Otanmäki and Mustavaara mines, estimated at 5 200 tpy, represents approximately 10 per cent of total world capacity. Rautaruukki produced approximately 4 800 t of V_2O_5 equivalent in 1982.

Other Producting Countries. China, Norway, Japan and Australia, which presently account for approximately 16 per cent of world capacity, produced about 5 700 t of V_2O_5 equivalent during 1982.

MINERALS, PRODUCTS, AND PROCESSES

Vanadium is found in most parts of the world, but rarely occurs as the sole component of economic interest. The principal economic minerals are:

Carnotite - $K_2O.2U_2O_3.V_2O_5.3H_2O$
Roscoelite - $2K_2O.2Al_2O_3(Mg,Fe)O.3V_2O_5.10SiO_2.4H_2O$
Descloizite - $4(Cu,Pb,Zn)O.V_2O_5.H_2O$
Titaniferous Magnetite - $FeO.TiO_2.FeO(Fe,V)O_3$ and V_2O_5 in solid solution
Phosphate Rock - $Ca_5(PO_4)_3$ (F,Cl,OH) with VO_4 replacing some PO_4 ions

Vanadium is sold in three basic forms: as an oxide concentrate, as technical grade vanadium pentoxide, and as fused vanadium pentoxide.

The processing stream for all V_2O_5 concentrates is similar. The concentrate is crushed, ground and mixed with sodium salt, usually sodium chloride or sodium carbonate. This mixture is then roasted and the vanadium is recovered as sodium metavanadate, a water-soluble salt. Following leaching with water and pH adjustment, the vanadium is recovered as sodium hexavanadate, also known as red cake. The sodium hexavanadate is fused at 700°C and a dense black product known as technical grade vanadium pentoxide, which contains about 85 per cent V_2O_5 is produced. A

TABLE 2. ESTIMATED NON-COMMUNIST WORLD CONSUMPTION AND PRODUCTION OF V_2O_5 EQUIVALENT, 1980-82

	1980	1981	1982
		(tonnes)	
Consumption			
Western Europe	15 000	15 500	13 700
United States	11 400	13 500	6 800
Japan	5 100	6 500	6 500
Eastern Europe	4 500	4 600	3 900
Other Countries	5 200	4 400	3 900
Total	41 200	44 500	34 800
Production			
South Africa	22 700	21 000	19 500
United States	12 000	13 900	10 100
Finland	5 000	5 200	4 800
China	3 200	4 500	4 500
Other Countries[1]	1 600	1 800	1 200
Total	44 500	46 400	40 100

Source: Engineering Mining Journal, (March, 1983), Vol. 184, #3.
[1] Other Countries includes Norway, Japan, Australia and Venezuela.

further processed form, fused vanadium pentoxide, can be produced by dissolving the technical grade vanadium pentoxide in an aqueous solution of sodium carbonate. Other metallic impurities are then precipitated out of the solution by adjusting the pH level. The vanadium is recovered as ammonium metavanadate, calcined and roasted to produce fused vanadium pentoxide, which contains 99.8 per cent V_2O_5. While this process is usually applied to vanadium concentrates only, it is also the basic form of concentration for some of the uranium-vanadium ores in the United States. In these cases, the uranium is recovered by washing the red cake (sodium hexavanadate) with acid and refiltering.

For the recovery of vanadium from the titaniferous magnetites of the Republic of South Africa, the process is more involved. Highveld Steel and Vanadium Corporation Limited have developed their own process whereby the ore, containing the equivalent of about 1.75 per cent V_2O_5, is first partially reduced in a kiln. The hot discharge is then fed into an electric furnace where the vanadium and iron are separated from the titanium. The vanadium and iron are recovered jointly in a high vanadium pig iron, while the titanium goes into the slag. To produce a vanadium concentrate, the pig iron is blown with oxygen and the vanadium is oxidized and carried off in a second slag. The slag contains about 25 per cent V_2O_5 and constitutes Highveld's oxide concentrate.

USES

The steel industry accounts for more than 90 per cent of total vanadium consumption in the form of standard ferrovanadium or other vanadium ferroalloys. The addition of vanadium to steel retards the crystallization and grain growth of the austenite phase and promotes the nucleation phase. Grain refining increases the yield strength of most carbon steels and is the principal means for increasing the toughness of a steel. Vanadium's ability to form stable carbides and nitrides within the iron matrix of a steel imparts further increases in yield strength and improves weldability, wear resistance, and high temperature strength.

Vanadium is used in making steels that require high strength and toughness or are subject to severe wear conditions. The vanadium content of most steels is low, usually between 0.02 and 0.08 per cent. Additions to steel in the forms of standard ferrovanadium or as iron or carbon-vanadium alloys usually contain anywhere from 30 to 80 per cent vanadium.

TABLE 3. VANADIUM APPARENT CONSUMPTION IN THE UNITED STATES STEEL INDUSTRY

	1979	1980	1981e
		(tonnes)	
Product			
HSLA	2 200	1 800	2 000
Full Alloy	1 400	1 300	1 400
Carbon	1 000	1 000	1 100
Tool Steel	800	500	600
Unidentified	800	500	600
Total	6 200	5 100	5 700

Source: Weihs, G.J., "The U.S. Vanadium Industry: Vital and Volatile", Metal Bulletin Monthly, October, 1981.

The United States steel industry's consumption of vanadium is presently distributed among high-strength, low-alloy (HSLA) steels (35 per cent), full alloy steels (25 per cent), carbon steels (20 per cent), tool steels (10 per cent), and other unidentified end uses (10 per cent).

The HSLA steels are the largest single market where vanadium finds application. HSLA steels were developed in response to the demand for structural steels of a higher yield strength than provided by ordinary carbon or carbon-manganese steels. These steels have resulted in a cost saving with respect to steel, transportation, and welding cost to its consumers. The major uses of HSLA steels are in pipelines, concrete reinforcing bars, structural applications, and automobile components.

Vanadium in HSLA steels has found its widest acceptance in the manufacture of pipe for the transmission of petroleum products and natural gas. One increasingly economic method of moving larger volumes of these commodities has been the use of pipelines which can withstand a higher line pressure. Since the yield strength of ordinary carbon steels is insufficient to tolerate increases in line pressure, vanadium containing HSLA steels have been widely used in several countries. Large quantities of vanadium-bearing HSLA steels have been manufactured and used in the United States, West Germany and the United Kingdom for petroleum products and natural gas pipelines. Vanadium has also been used in pipeline steels designed to operate in extreme environments, such as the Arctic.

In recent years, yield-strength requirements for concrete reinforcing bar have risen and this trend is expected to continue in the future. While these higher yield strengths can be achieved with the addition of more carbon and manganese, the two traditional steelmaking additives, the resulting loss in weldability makes this practice undesirable. HSLA steels are finding increased application in structures such as bridges, elevated roadways, and in transportation equipment such as rail cars and automobiles. However, this implied increase in demand for vanadium cannot be quantified at this stage due to competition from substitute additives in HSLA steelmaking.

The earliest use of vanadium in steel was as an addition to tool steels, used for high-speed machining. Vanadium inhibits grain growth and enables the steels to maintain their hardness and therefore their cutting edge at the high temperatures generated in the tool tip from high-speed machining. This remains an important application for the metal. Vanadium, which is added in concentration levels 1 to 5 per cent, is used in both the high-tungsten tool steels that were first developed and in the later generation of molybdenum-tungsten tool steels.

Vanadium is also used in making high-temperature steels such as those employed in steam power plants for steam pipes and headers. Other areas where vanadium is used in the iron and steel industry include: heavy iron and steel castings; forged parts, such as crankshafts; automobile parts, such as gears and axles; springs, ball bearings, hammers and dies.

The most important use of vanadium in nonferrous alloys is in the aircraft industry. A vanadium-aluminum alloy is added to titanium to increase the high temperature strength of titanium, a property that is essential in jet engines, high speed air frames and rocket engine parts. Also, the addition of the vanadium-aluminum alloy effects a weight saving, a factor that is always important in aircraft design. Vanadium is also used in iron-base superalloys employed in jet engines and turbine blades where high-temperature strength is essential. In addition, vanadium is added to copper-base alloys to control gas content and refine the microstructure, and a small amount is added to aluminum alloys for internal combustion engine pistons to improve high-temperature operating properties. A potential use for vanadium alloys is as a cladding material in fast-breeder nuclear reactors. Vanadium has a low neutron capture cross-section (i.e., permits relatively free movement of neutrons within the reactor core), good resistance to corrosion by liquid sodium (the reactor coolant), and good high-temperature operating properties.

Vanadium is used in making vanadium carbide, employed in the manufacture of both hand and machine tools, and in the production of various chemical salts. Compounds of vanadium are used in the chemical industry as catalyst in the production of sulphuric acids and the cracking of petroleum products. Other uses in the chemical industry include the colouring of glass and ceramics, driers in paints and varnishes, and processing of colour film.

PRICES

European price quotations of vanadium products remained stable during the first half of 1982. However, by the latter half of the year all product prices experienced considerable downward pressure. Standard ferrovanadium (50-60 per cent V) prices in the first half of 1982 were quoted at $US 13.50 to $US 14.50 per kg, while vanadium pentoxide prices varied between $US 5.60 and $US 6.10 per kg. The year-end prices, by comparison, had fallen by approximately 50 per cent to ranges between $US 7.60 and $US 8.40 per kg for standard vanadium, and between $US 2.65 and $US 3.10 per kg for vanadium pentoxide.

Highveld's vanadium pentoxide list price was $US 6.90 per kg at the beginning of the year but this price could not be sustained in the declining market. After suspending its list price in August, Highveld re-established a new list price of $US 5.30 per kg in November.

In the United States, ferrovanadium producer prices remained stable for the first three quarters of 1982, then softened in the fourth quarter due to the severity of the recession on the U.S. steel industry. Union

Carbide's Carvan and Foote Mineral's Ferovan were $US 17.10 per kg early in 1982. The corresponding year-end prices were lowered to $US 16.23 and $US 16.53 per kg, respectively. U.S. producer prices of vanadium pentoxide remained stable throughout the year ranging between $US 7.40 and $US 8.05 per kg. However, Union Carbide introduced a new European list price of $US 5.30 per kg in the final quarter of 1982 in response to Highveld's revised list price.

OUTLOOK

Vanadium consumption in 1983 is expected to improve significantly from its current depressed state. World consumption of vanadium is projected to grow by 7 per cent in 1983, then average approximately 4 per cent per annum between 1984 and 1987. The growth areas expected to fuel this recovery are pipe for oil and gas transmission and brisk demand for HSLA steels in the production of automobiles.

However, this increase in demand is not expected to be sufficient to alleviate the industry's excess capacity situation. A "shake out" of present supply sources, with increased replacement of traditional suppliers by China and Australia (from magnetite ores), Venezuela (from the treatment of heavy oil), and the United State (from residue fly ash and spent catalysts) is expected to continue over the longer term.

PRICES

United States vanadium prices published in "Metals Week".

	December 1981		December 1982
		($US)	
Vanadium pentoxide, per kilogram of V_2O_5, fob mine or mill			
Air dried (technical)	9.04 - 10.08		9.04 - 10.89
Fused (metallurgical)	7.39 - 8.05		7.39 - 8.05
Ferrovanadium, per pound of V, packed, fob shipping point			
U.S. Producer, 80% V	8.50		8.50
Carvan	7.75		7.36
Ferovan	7.75		7.50

fob - Free on board

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
32900-1	Vanadium ores and concentrates	free	free	free	free
37520-1	Vanadium oxide	free	free	5	free
35101-1	Vanadium metal, not including alloys	free	4.6	25	free
37506-1	Ferrovanadium	free	4.8	5	free

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
				(%)		
35101-1	4.6	4.5	4.4	4.3	4.1	4.0
37506-1	4.8	4.7	4.5	4.3	4.2	4.0

UNITED STATES

601.60	Vanadium ores	free
422.60	Vanadium pentoxide (anhydride)	16%
422.62	Other vanadium compounds	16%
427.22	Vanadium salts	12.8%

		1982	1983	1984	1985	1986	1987
					(%)		
606.50	Ferrovanadium	5.7	5.4	5.1	4.8	4.5	4.2
632.58	Vanadium metal, unwrought, waste and scrap (duty on waste and scrap suspended to June 30, 1981)	4.5	4.4	4.2	4.0	3.9	3.7
632.68	Vanadium alloys, unwrought	5.8	5.3	4.7	4.1	3.6	3.0
633.00	Vanadium metal, wrought	7.7	7.3	6.8	6.4	5.9	5.5
422.58	Vanadium carbide	5.3	5.1	4.9	4.7	4.4	4.2

Sources: The Customs Tariff and Commodities Index, January 1982, Revenue Canada; Tariff Schedules of the United States Annotated (1982), USITC Publication 1200; U.S. Federal Register, Vol. 44, No. 241.

Zirconium

M.A. BOUCHER

Canada imports all of its zirconium needs. In terms of tonnage, zircon sand and flour are the most important. Some 20 000 to 25 000 tpy of these two products are imported, mainly from Australia (90 per cent) and the United States. However, only 3 000 to 4 000 tpy are consumed in Canada; most of the product is exported to the United States.

In terms of value, zirconium metal and alloys represent the major imports, valued at $16 to $20 million a year. Most of these products come from the United States and the remaining are imported from France.

Canada also imports small quantities (less than 1 000 tpy each) of zirconium oxide, zirconium silicate, ferrozirconium, and zirconia-alumina-silica bricks.

Zircon sand consisting of the mineral baddeleyite, which is used in the manufacture of zirconia-alumina abrasives, is the only zirconium product processed in Canada. Baddeleyite sand is imported from South Africa.

CANADIAN DEVELOPMENTS

The Iron Ore Company of Canada (IOC) continued an evaluation of its "Strange Lake" rare and strategic minerals deposit that is located along the Quebec-Labrador boundary near Lac Brisson, some 300 km northeast of Schefferville, Quebec.

The deposit occurs in a granite complex of pre-cambrian age and can be mined by open pit. This is reported to be one of the world's largest high-grade deposits of yttrium and zirconium. The deposit also contains significant values of beryllium, niobium and rare earths. Measured reserves are large and these could be increased when required.

Preliminary flow sheet and metallurgical work indicates that a concentrate of zirconia grading +98 per cent ZrO_2 and/or 99.3 per cent ZrO_2 + HfO_2 could be produced by a solvent extraction process.

The demand for electric generating capacity in Canada has declined in recent years due to a slowdown in economic activity. Consequently, the construction of several nuclear reactors that use zirconium in the form of calandria and pressure tubes has been delayed, and earlier forecasts of CANDU generating capacity have been adjusted downward.

WORLD PRODUCTION AND DEVELOPMENTS

Australia accounts for about 70 per cent of western world zircon production. In 1982, Australia produced an estimated 451 553 t compared with 424 000 t in 1981 and 491 000 t in 1980.

The Republic of South Africa is the second largest producer of zircon in the western world. Production in 1982 was 80 000 t, compared with 100 000 t in 1981.

Due to the economic recession in general, western world consumption of zirconium ingot was about 9 000 t in 1982 although production capacity was 18 200 t.

A decline in projected demand for electricity continued to slow the growth of nuclear reactor generating plants in several countries during the year. Reactor projects were postponed in Mexico, Taiwan, South Korea, Spain and Romania.

Manufacturers in several countries, including the United States (Cummins Engine, NKG Insulators) Japan, (NKG Insulators), West Germany (Volkswagen) and Sweden (SAAB) continued their research on zirconia ceramics as a partial substitute for steel in diesel engines, particularly in applications such as cylinder liners, piston tops, and valve guides. The major advantage of ceramics in diesel engines is increased thermal efficiency, (i.e. 50 per

TABLE 1. AUSTRALIA, ZIRCON PRODUCTION, 1970, 1975 AND 1978-82

	Zircon concentrate	Zircon (ZrO_2 SiO_2 content)
	(tonnes)	
1970	395 351	390 294
1975	382 217	375 548
1978	391 606	386 724
1979	446 980	440 119
1980	491 547	413 603
1981	424 688	332 524
1982p	451 553	..

Sources: Australian Mineral Industry Quarterly, Volume 35 (1982), Number 2. Australian Mineral Industry Review Preliminary Summary, 1982.
P Preliminary; .. Not available.

cent compared with 30 per cent for a conventional diesel engine), which reduces fuel consumption. The major obstacles to commercial application are the high cost of raw materials and problems in bonding ceramics to the metal structure of the engine.

USES

Approximately 60 per cent of the world's consumption of zircon is used in refractories and foundry sand moulds. Table 8 shows world consumption by major use in 1980.

PRICES

Australian producers, which are the largest producers and exporters of zircon in the world, increased the price of zircon concentrate in response to strong demand for refractories which remained firm most of the year.

Inflationary factors continued to escalate the cost of raw materials (chemicals, magnesium, energy) necessary to produce zirconium. However, zirconium mill product prices were not increased because of the surplus capacity in the industry.

TABLE 2. WORLD PRODUCTION OF ZIRCON CONCENTRATES, 1980-82

	1980	1981p	1982e
		(tonnes)	
Australia	491 546	425 063	451 553
Republic of South Africa	79 832	99 790	79 832
U.S.S.R.e	72 575	72 575	..
India	14 787	14 968	11 793
Chinae	12 700	13 608	..
Brazil	3 933	3 992	..
Sri Lanka	3 031	3 202	..
Malaysia	454	599	..
Thailand	61	50	..
Other countries[1]	-	-	6 532
Total	678 919	633 847	549 710

Sources: United States Bureau of Mines Minerals Yearbook Preprint, Zirconium and Hafnium, 1981; Australian Mineral Industry Annual Review Preliminary Summary 1982.
[1] Excludes United States production which is withheld.
P Preliminary; e Estimated; .. Not available; - Nil.

OUTLOOK

Although the demand for zircon is expected to decline in 1983, zircon production in Australia is likely to remain at about the same level as 1982. This situation is due to the fact that zircon production is dependent on the joint production of ilmenite, whose demand is expected to improve slightly in 1983.

The excessive production capacity for zirconium metal that developed in 1981 and 1982 is expected to continue for several years, unless there is a dramatic increase in the demand growth of electricity from nuclear powered stations.

TABLE 3. CANADA, ZIRCONIUM IMPORTS BY COUNTRY, 1980-82

	1980		1981		1982	
	tonnes	$000	tonnes	$000	tonnes	$000
Zircon sand and flour						
Australia	25 574	2,404	21 017	2,556	14 781	2,021
United States	1 955	537	1 599	478	660	249
Total	27 529	2,941	22 616	3,034	15 441	2,270
Zirconium oxides						
United States	64	101	13	76	18	137
France	-	-	-	-	3	21
Total	64	101	13	76	21	158
Zirconium silicate						
United States	921	558	1 270	669	866	569
Australia	35	17	31	26	10	8
Total	956	575	1 301	695	876	577
Ferrozirconium alloys						
France	54	92	89	176	282	551
United States	179	348	232	515	191	412
Total	233	440	321	691	473	963
	kg		kg		kg	
Zirconium, primary forms and fabricated material						
United States	48 096	2,794	50 402	2,423	49 106	2,814
West Germany	-	-	-	-	9 230	1,389
Belgium-Luxembourg	-	-	-	-	998	20
South Africa	-	-	20 000	35	-	-
France	581	33	3 000	26	-	-
Total	48 677	2,827	73 402	2,484	59 334	4,223
Zirconium alloys						
United States	190 661	11,305	221 060	12,637	190 271	15,755
West Germany	-	-	-	-	8 757	1,478
France	38 792	1,977	67 614	3,491	24 046	1,198
United Kingdom	-	-	-	-	19 449	95
Sweden	-	-	-	-	44	3
Total	229 453	13,282	288 674	16,128	242 567	18,529

Source: Statistics Canada.
- Nil.

TABLE 4. FORECAST CANDU PHW NUCLEAR ELECTRIC GENERATING STATIONS IN CANADA (1980 AND 1982)

Name	Location	Power MW Net	Forecasted year of start-up	
			1980	1982
Gentilly 2	Quebec	638	1982	1983
Pt. Lepreau	New Brunswick	633	1982	1983
Pickering B 5	Ontario	516	1983	1983
Pickering B 6	Ontario	516	1983	1984
Pickering B 7	Ontario	516	1984	1984
Pickering B 8	Ontario	516	1984	1985
Bruce B 5	Ontario	780	1984	1985
Bruce B 6	Ontario	756	1983	1984
Bruce B 7	Ontario	756	1986	1986
Bruce B 8	Ontario	756	1985	1987
Darlington 1	Ontario	881	1988	1988
Darlington 2	Ontario	881	1989	1989
Darlington 3	Ontario	881	1989	1991
Darlington 4	Ontario	881	1990	1992

Source: Atomic Energy of Canada Limited; Ontario Hydro.

TABLE 5. WORLD PRODUCERS OF ZIRCONIUM SPONGE

Company	Plant Location	Annual Production Capacity		
		1978	1980	1982
			(tonnes)	
Teledyne Wah Chang (TWCA)	Albany, Oregon, U.S.A.	3 500	3 500	3 600
Cezus (a subsidiary of Pechiney Ugine Kuhlmann)	Jarrie, France	1 000	1 600	1 600
Western Zirconium Inc.	Ogden, Utah, U.S.A.	-	1 400	1 350
Nippon Mining Co. Ltd.	Toda, Japan	50	300	150
Zirconium Industry Inc.	Hiratsuka, Japan	250	300	-
Total		4 800	7 100	6 700

Source: Teledyne Wah Chang.
- Nil.

TABLE 6. CHEMICAL AND SIZE ANALYSIS OF ZIRCON CONCENTRATES OF TYPICAL PRODUCERS

	Australia (East Coast)		United States (Florida)		South Africa		
					Zircon		Baddeleyite
	Standard	Premium	Standard	Premium	Standard	Premium	
Chemical Guarantee							
% ZrO_2 Mn	65.5	66.0	65.0	66.0	65.0	66.0	95-97
% Fe_2O_3 Mx	0.05	0.05	0.1	0.04	0.3	0.05	0.4-1.0
% TiO_2 Mx	0.3	0.1	0.35	0.2	0.3	0.1	0.5-1.0
% Al_2O_3 Mx	0.4	0.3	2.0	0.5	0.25	0.08	0.1
Typical Screen Sizings microns (% cumulative)							
250	0	1	-	-	0.5	0.5	
180	1	6	5	-	0.7	0.7	
125	12	45	41	Traces	29.8	29.8	
90	67	95	84	56	80.0	80.0	
63	99	100	100	93	100.0	100.0	
53	100	-	-	100	-	-	

Source: Producers' Published Specifications.
Mn Minimum; Mx Maximum; - Nil.

TABLE 7. MAJOR CONSUMERS OF ZIRCONIUM PRODUCTS IN CANADA

Product	Major Consumers
Zircon sand and flour	Dofasco Inc. Haley Industries Limited Abex Industries Ltd. Sidbec Foseco Canada Inc.
Zirconium oxide	Norton Company
Ferrozirconium	Dofasco Inc. Atlas Steels Division of Rio Algom Limited Esco Limited
Zirconia-alumina-silica bricks	Consumers Glass Company Limited Domglas Inc.
Zirconium metal and alloys	Ontario Hydro Haley Industries Limited

TABLE 8. ESTIMATED WORLD CONSUMPTION OF ZIRCON BY USE - 1980

	Tonnes	%
Refractory	205 000	36
Foundries	134 000	23
Ceramics	124 000	22
Zirconia	35 000	6
Metal	10 000	2
Others	65 000	11
Total	573 000	100

Source: "Industrial Minerals", April 1983, Refractories Supplement.

PRICES

Zircon prices quoted in Metals Week and American Metal Market at the end of 1982.

	Price per kg ($US)
Zirconium ore	
Australia	0.193
United States	0.182
Sponge	26.456 - 37.479
Sheet, strip, bar	39.683 - 88.185

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
34720-1	Sponge and sponge briquettes, ingots, blooms, slabs, billets and castings in the rough, of zirconium or zirconium alloys for use in Canadian manufacture (expires June 30, 1983)	free	free	25	free
34730-1	Bars, rods, plate, sheet, strip, wire, forgings, castings, foils and tubes, seamless or welded, of zirconium or zirconium alloys for use in the manufacture of nuclear power reactors, including fuels components (expires June 30, 1983)	free	free	25	free
33508-1	Zirconium oxide	free	4.6	15	free
92845-4	Zirconium silicate	free	free	free	free

MFN Reductions under GATT (effective January 1 of year given)	1982	1983	1984	1985	1986	1987
			(%)			
33508-1	4.6	4.5	4.4	4.3	4.1	4.0

UNITED STATES

601.63 Zirconium ore, (including zirconium sand) — free

		1982	1983	1984	1985	1986	1987
				(%)			
629.60	Zirconium metal, unwrought, waste other than alloys	5.3	5.1	4.9	4.7	4.4	4.2
629.62	Zirconium, unwrought alloys	6.5	6.2	5.9	5.6	5.2	4.9
629.65	Zirconium metal, wrought	7.7	7.3	6.8	6.4	5.9	5.5
422.80	Zirconium oxide	4.5	4.4	4.2	4.0	3.9	3.7
422.82	Other zirconium compounds	4.5	4.4	4.2	4.0	3.9	3.7

EUROPEAN ECONOMIC COMMUNITY

		1982	Base Rate	Concession Rate
			(%)	
26.01	Zirconium and hafnium ores	free		
28.28	Zirconium oxide	7.6	8.0	7.0
28.45	Zirconium silicates	7.6	8.8	5.7
73.02	Ferrozirconium	6.7	7.0	4.9
81.04	Zirconium metal			
	Unwrought; waste and scrap	5.6	6.0	5.0
	Wrought	9.6	10.0	9.0

Sources: The Customs Tariff and Commodities Index, January 1982, Revenue Canada; Tariff Schedules of the United States Annotated 1982, USITC Publication 1200; U.S. Federal Register, Vol. 44, No. 241; Official Journal of the European Communities, Vol. 24, No. 335, 1981.

Zinc

M.J. GAUVIN

SUMMARY

The weakened state of the world economy continued to affect industrial use of zinc in 1982. Both consumption and price declined in extremely competitive markets. Producers in Canada and worldwide are caught in the vise of rising costs and low prices. The result is that the industry faces financial problems and its future capability to invest in new facilities, to replace obsolete plant and ensure adequate supplies when a recovery occurs, will be impaired.

CANADIAN SCENE

Mining

Zinc mine production in 1982 was 1 189 129 t, an increase of 8.5 per cent from 1 096 257 t in 1981.

The Buchans mine in Newfoundland, operated by ASARCO Incorporated, closed its concentrator in December 1981 because of lack of developed ore reserves. Development of recently discovered ore zones below and at the extremity of existing mine workings is continuing. Ore reserves are reported as 355 000 t averaging 10.25 per cent zinc, 5.93 per cent lead, 1.39 per cent copper and 98 g/t silver.

New Brunswick producers, like those elsewhere, were forced to constrain expenditures. Brunswick Mining and Smelting Corporation Limited instituted salary and hiring freezes and deferred capital expenditures as much as possible. The company completed an expansion program at its No. 12 mine near Bathurst in 1981 and higher production rates in 1982 reflected higher efficiency as well as the increased capacity. Also near Bathurst, Anaconda Canada Exploration Ltd. continued metallurgical test work and feasibility studies on reopening its Caribou zinc-lead-copper mine. In early 1982, the Little River Joint Venture owned 75 per cent by Heath Steele Mines Limited and 25 per cent by ASARCO Incorporated, implemented a cost cutting program at its property near Newcastle, New Brunswick. However, serious cash losses because of low metal prices resulted in a decision to suspend operations until price improves. The decision was deferred until April 1983 at the request of the New Brunswick government.

Late in the year, the Matagami division of Noranda Mines Limited ceased operation at its Orchan mine at Matagami, Quebec because of ore exhaustion. In the Noranda area, the zinc and precious metals open-pit operation of Les Mines Gallen Limitée, owned 51 per cent by Noranda Mines and 49 per cent by Macdonald Mines, Ltd., closed for an indefinite period at the beginning of July until there is an improvement in markets.

Kidd Creek Mines Ltd., 100 per cent owned by Canada Development Corporation, again increased its ore and concentrate production. In 1981, Kidd Creek completed the expansion of its mine and concentrator which raised annual ore production capacity to 4.5 million t and concentrator capacity to 12 250 tpd. The company increased zinc ore and concentrate production during 1982 over the record level of 1981. However general market conditions forced the company to cease all operations for 12 days at the end of the year. Among other cutbacks was Noranda's shutdown of its Lyon Lake mine and its 60 per cent owned Mattabi mine in the Sturgeon Lake area of Ontario for a two-month period during the summer of 1982. Together about 2 000 tpd are milled from the two mines.

In northern Manitoba, Hudson Bay Mining and Smelting Co., Limited deferred all possible capital expenditures and mine development for at least a year. In addition, it scheduled an eight-week summer shutdown of all mining and smelting operations because of depressed metal prices. Sherritt Gordon Mines Limited was forced to close operations for a fifteen-week period at its Ruttan and Fox mines near Lynn Lake, in northern Manitoba.

TABLE 1. CANADA, ZINC PRODUCTION AND TRADE, 1981 AND 1982 AND CONSUMPTION 1980 AND 1981

	1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)
Production				
All forms[1]				
Ontario	246 027	294,200	256 483	275,204
New Brunswick	228 608	273,369	247 360	265,416
Northwest Territories	133 604	159,764	277 635	297,900
Yukon	78 806	94,237	58 961	63,264
British Columbia	79 215	94,725	63 955	68,623
Quebec	53 200	63,616	65 407	70,842
Newfoundland	39 971	47,797	26 239	28,154
Manitoba	39 540	47,282	32 288	34,644
Saskatchewan	6 732	8,050	4 325	4,640
Nova Scotia	5 475	6,547	–	–
Total	911 178	1,089,587	1 032 653	1,108,687
Mine output[2]	1 096 257	..	1 189 129	..
Refined[3]	618 650	..	511 870	..
Exports				
Zinc blocks, pigs and slabs				
United States	304 438	336,082	263 593	266,028
United Kingdom	31 741	31,211	44 693	42,708
India	10 774	9,722	15 121	13,990
Venezuela	10 039	9,299	9 239	8,665
Brazil	9 121	7,426	702	624
Italy	7 149	6,689	5 926	5,210
Singapore	6 699	6,026	7 572	7,049
West Germany	6 069	5,784	12 022	11,588
Nigeria	6 707	5,707	8 304	7,473
Belgium-Luxembourg	6 404	5,452	6 782	6,283
Thailand	5 280	5,165	4 263	4,088
Other countries	49 105	43,403	92 180	86,014
Total	453 526	471,966	470 397	459,720
Zinc contained in ores and concentrates				
Belgium-Luxembourg	191 414	102,712	214 060	98,249
Japan	118 468	51,702	83 750	32,352
France	33 396	19,185	12 305	4,230
United States	35 895	17,996	4 953	2,553
United Kingdom	25 634	14,716	34 602	20,271
West Germany	28 003	13,257	30 563	12,975
Algeria	16 746	11,735	9 776	6,108
Italy	22 026	10,664	9 859	5,336
Netherlands	19 292	9,470	27 569	15,502
Other countries	25 336	13,210	30 322	19,632
Total	516 210	264,647	457 759	217,208
Zinc alloy scrap, dross and ash[4]				
United States	18 888	8,774	10 155	4,714
Belgium-Luxembourg	3 520	2,024	22 997	13,831
United Kingdom	2 173	641	7 992	4,699
West Germany	3 287	494	7 049	2,889
Taiwan	681	236	163	79
Other countries	413	107	25 234	15,250
Total	28 962	12,276	73 590	41,462

TABLE 1. (cont'd.)

	1981		1982P	
	(tonnes)	($000)	(tonnes)	($000)
Zinc dust and granules				
United States	5 393	7,424	2 296	3,061
United Arab Emirates	106	193	-	-
Venezuela	60	116	-	-
Other countries	97	109	15	24
Total	5 656	7,842	2 311	3,085
Zinc fabricated material, nes				
United States	2 238	5,000	1 020	2,925
Venezuela	150	146	-	-
New Zealand	72	59	-	-
Israel	7	57	-	-
West Germany	19	56	-	-
Other countries	136	222	76	202
Total	2 622	5,540	1 096	3,127
Imports				
In ores, concentrates and scrap	59 958	29,645	40 214	22,617
Dust and granules	380	578	615	875
Slabs, blocks, pigs and anodes	8 093	9,741	689	753
Bars, rods, plates, strip and sheet	527	1,059	298	786
Slugs, discs and shells	272	181	211	128
Zinc oxide	1 303	1,765	1 366	1,604
Zinc sulphate	1 660	710	1 966	827
Zinc fabricated materials, nes	930	2,489	840	2,142
Total	73 123	46,168	46 199	29,732

	1980			1981		
	Primary	Secondary	Total	Primary	Secondary	Total
	(tonnes)					
Consumption[5]						
Zinc used for, or in the manufacture of:						
Copper alloys (brass, bronze, etc.)	7 494)			9 019)		
Galvanizing: electro	1 138)	365	73 372	1 565)	1 336	74 966
hot dip	64 375)			63 046)		
Zinc die-cast alloy	12 738	X	X	12 553	X	X
Other products (including rolled and ribbon zinc, zinc oxide)	24 668	X	X	21 286	X	X
Total	110 413	6 205	116 618	107 469	5 592	113 061
Consumer stocks, year-end	20 967	1 151	22 118	12 058	370	12 428

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] Gross weight. [5] Consumer survey does not represent 100 per cent of Canadian consumption and is therefore consistently less than apparent consumption.
P Preliminary; - Nil; .. Not available; nes Not elsewhere specified; X Confidential.

TABLE 2. CANADA, ZINC MINE OUTPUT, 1981 AND 1982

	1981	1982
	(tonnes)	
Newfoundland	43 717	33 157
Nova Scotia	4 528	-
New Brunswick	273 015	304 619
Quebec	62 614	76 050
Ontario	269 831	286 691
Manitoba-Saskatchewan	56 750	46 390
British Columbia	82 540	88 577
Yukon Territory	99 988	60 210
Northwest Territories	203 274	293 435
Total	1 096 257	1 189 129

Westmin Resources Limited continued with development and pilot milling of the H-W orebody near its Lynx and Myra mines on Vancouver Island. The new shaft for the H-W is scheduled for completion in January 1983. The company has completed its Metal Mine Guidelines Stage II Report as required under provincial environmental procedures and is in the process of final evaluation of an expansion of the operations. Noranda now expects to bring its $60 million Goldstream project in British Columbia into production in 1983. Located in the Goldstream Valley about 90 km north of Revelstoke, the copper-zinc facility is expected to process 1 350 tpd, five days a week, and produce 5 000 tpy of zinc in concentrates. The small precious metal-zinc-lead operation of Northair Mines Ltd. in the Brandywine area of British Columbia suspended production in July. The mine is being kept on a care and maintenance basis.

Cadillac Explorations Limited did not start production in 1982 as originally planned at its Prairie Creek mine in the Nahanni area of the Northwest Territories. Pine Point Mines Limited's zinc production was only slightly lower than in 1981. Because of depressed markets, the company announced at the end of November a temporary shut-down of its Pine Point operations starting on January 2, 1983.

Cyprus Anvil Mining Corporation postponed development of its major lead-zinc-silver Cirque deposit in the Akie River district north of Williston Lake in north-central British Columbia. The company has spent some $17 million on exploration in the area. Ore reserves are estimated at 30 million t averaging 2.2 per cent lead, 7.8 per cent zinc and 48 g/t silver. When in production the project is expected to produce about 30 000 tpy of lead and 140 000 tpy of zinc in concentrates and employ upwards of 600 people. Because of the acquisition of its parent, Hudson's Bay Oil and Gas Company Limited, by Dome Petroleum Limited, Cyprus Anvil is now a wholly-owned subsidiary of Dome Petroleum. At its Faro operation in the Yukon, the company experienced heavy cash losses early in the year and suspended production starting June 4. Also in the Yukon, Hudson

TABLE 3. CANADA, ZINC PRODUCTION, EXPORTS AND DOMESTIC SHIPMENTS, 1970, 1975, 1978-82

	Production		Exports			Producers' Domestic Shipments
	All Forms[1]	Refined[2]	In Ores and Concentrates	Refined	Total	
			(tonnes)			
1970	1 135 714	417 906	809 248	318 834	1 128 082	106 405
1975	1 055 151	426 902	705 088	247 474	952 562	149 214
1978	1 066 902	495 243	688 186r	439 261	1 127 447	144 740
1979	1 099 926	580 449	598 279	429 353	1 027 632	153 744
1980	883 697	591 565	434 178	471 949	906 127	132 543
1981	911 178	618 650	516 210	453 526	969 736	131 859
1982P	1 032 653	511 870	457 759	470 397	928 156	119 714

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] Refined zinc produced from domestic and imported ores.
P Preliminary; r Revised.

TABLE 4. CANADA, PRODUCERS' DOMESTIC SHIPMENTS OF REFINED ZINC, 1980-82

	1980	1981	1982P
		(tonnes)	
1st Quarter	37 858	35 044	39 767
2nd Quarter	30 295	39 151	30 429
3rd Quarter	30 510	27 910	21 580
4th Quarter	33 880	29 754	27 938
Total	132 543	131 859	119 714

P Preliminary.

Bay Mining and Smelting Co., Limited stopped development work in March on its large Tom lead-zinc deposit in the Macmillan Pass area.

One of the few bright spots on the Canadian mining scene was the bringing into production of Cominco Ltd.'s Polaris mine on Little Cornwallis Island, some 130 km south of the magnetic North Pole. The project was brought into production about 10 weeks ahead of schedule at a cost of $160 million. The first ore was test-milled in November 1981 and sustained production commenced in February 1982. At full design capacity, the Polaris concentrator will produce 130 000 tpy of zinc and 30 000 tpy of lead in concentrates. Mining and milling operations will continue on a year round basis. Concentrates are stored in a large warehouse until the "Arctic Window" shipping season commences in late June or early July. Nanisivik Mines Ltd. has the same shipping problem at its mine on the northern tip of Baffin Island. In 1982, the MV Arctic, a prototype northern merchant ship built in Canada to Canadian Arctic Class 2 standards, arrived at Nanisivik at a record early date to pick up a load of lead and zinc concentrates. It subsequently spent the summer and early fall hauling concentrates from both Polaris and Nanisivik.

SMELTING AND REFINING

Metal production at 511 870 t in 1982 was down substantially from the 619 000 t produced in 1981, owing to shutdowns, production cutbacks and a strike. Cominco Ltd. reduced its production rate early in the year and closed the Trail plant and the Sullivan mine at Kimberley for five weeks during the summer. Cominco continued the modernization and expansion program at its Trail zinc plant. The program includes replacement and additions to the zinc electrolytic and melting plant and construction of the world's first zinc pressure leaching plant. Zinc pressure leaching was developed jointly by Cominco and Sherritt Gordon Mines to remove the sulphur from sulphide concentrates without producing sulphur dioxide gas while dissolving almost all the zinc. The capacity of the Trail plant has been expanded by 27 000 t to 272 000 tpy. A similar pressure leaching unit is being installed at the Hoyle, Ontario facilities of Kidd Creek Mines Ltd. When completed in 1983 it will expand capacity by 19 000 t to 127 000 tpy. The Kidd Creek zinc plant, which went into operation in April 1972, produced its 1 millionth t of zinc metal during the year. Canadian Electrolytic Zinc Limited's zinc refinery at Valleyfield, Quebec, is expanding its roaster-acid plant and will increase its annual capacity by 9 000 t in 1983.

In November 1981, Brunswick Mining and Smelting Corporation Limited announced a joint venture with Heath Steele Mines Limited to build a 100 000 tpy zinc reduction plant at Belledune, New Brunswick, at a cost of $367 million. Construction was to start in May 1982 but has been deferred. The plant would process zinc concentrates from the Brunswick and Heath Steele mines located some 60 km and 90 km respectively by rail from the smelter site.

CONSUMPTION

Canadian consumption of primary zinc, as measured by producers' shipments to domestic consumers, was 119 714 t in 1982, down 9.2 per cent from 1981. Consumption was lower in all the main classifications of consumption.

WORLD SCENE

Mining

Non-socialist world mine production in 1982, at 4.83 million t, rose substantially from the 4.46 million t produced in 1981. The increase is principally accounted for by new mine production in Australia and increased production in Canada and also Ireland where production in 1981 had been affected by industrial disputes.

Mine production in Australia rose from 485 000 t in 1981 to 636 000 t in 1982. New production in Australia is accounted for by

TABLE 5. PRINCIPAL ZINC MINES IN CANADA, 1982 AND (1981)

Company and Location	Daily Mill Capacity	Zinc	Lead	Copper	Silver	Ore Produced	Zinc Concentrates Produced	Zinc Concentrates Zinc Grade	Zinc Content of all Concentrates	Destination of Zinc Concentrates
	(tonnes ore)	(%)	(%)	(%)	(grams/ tonne)	(tonnes)	(tonnes)	(%)	(tonnes)	
Newfoundland										
ASARCO Incorporated	1 100	-	-	-	-	-	-	-	-	-
Buchans	(1 100)	(8.95)	(5.31)	(0.80)	(92.9)	(68 946)	(9 123)	(52.68)	(5 727)	(6)
Newfoundland Zinc Mines	1 500	7.60	-	-	-	507 248			32 428	6,8
Limited,	(1 500)	(7.53)	(-)	(-)	(-)	(549 652)	(63 421)	(61.53)	(39 023)	(6,8)
Daniel's Harbour										
New Brunswick										
Brunswick Mining and Smelting Corporation Limited	10 000	9.03	3.63	0.31	101.8	3 633 500	458 400	51.60	260 724	3,7,8,9,10 11,12
Bathurst	(10 000)	(8.74)	(3.50)	(0.35)	(97.9)	(3 422 690)	(488 064)	(48.37)	(249 998)	(3,7,8,9, 10,11,12)
Heath Steele Mines Limited Newcastle	3 800	3.97	1.45	0.99	57.6	1 399 078	86 928	49.06	46 612	3,8,10,11, 12
	(3 600)	(3.94)	(1.45)	(0.91)	(51.4)	(1 249 928)	(76 017)	(48.58)	(40 600)	(3,8,9,11, 12)
Quebec										
Corporation Falconbridge	1 400	0.70	-	2.90	13.4	324 129	2 259	50.99	1 409	3
Copper	(1 400)	(1.19)	(-)	(2.79)	(19.5)	(452 953)	(6 944)	(50.58)	(4 169)	(3)
Lake Dufault Division										
Noranda										
Lemoine Mines Limited	300	5.93	-	2.34	42.5	111 117	9 897	52.50	6 078	12
Chibougamau	(300)	(8.47)	(-)	(3.70)	(69.6)	(85 002)	(10 718)	(52.55)	(6 566)	(12)
Louvem Mining Company Inc.	900	-	-	-	-	-	-	-	-	-
Val d'Or	(900)	(4.03)	(0.19)	(0.19)	(29.5)	(32 276)	(2 109)	(53.30)	(1 124)	(2)
Noranda Mines Limited	4 000	6.10	-	0.99	20.9	1 178 041	123 888	51.70	65 037	3
Matagami Division	(4 000)	(4.85)	(-)	(0.75)	(19.6)	(1 203 444)	(99 567)	(51.57)	(51 614)	(3)
Mattagami										
Les Mines Gallen	1 300	4.43	-	0.10	31.9	161 916	10 156	49.70	5 325	3
Noranda	(1 300)	(3.14)	(-)	(0.12)	(33.9)	(34 548)	(1 124)	(42.91)	(524)	(3)

Ontario										
Kidd Creek Mines Ltd.	13 400	5.60	0.19	2.05	77.2	4 320 446	372 425	53.79	200 342	5,6,7,12
Hoyle	(13 400)	(5.35)	(0.16)	(1.90)	(64.9)	(4 076 359)	(331 993)	(53.08)	(192 792)	(3,5,6,12)
Mattabi Mines Limited and	2 700	7.42	0.74	0.64	105.9	752 931	94 958	52.36	52 204	1,2,3,12
Noranda Mines Limited,	(2 700)	(6.50)	(0.57)	(0.56)	(86.4)	(896 197)	(96 562)	(52.49)	(53 462)	(1,2,3,12)
Lyon Lake Division and										
"F" Group Mine										
Sturgeon Lake										
Noranda Mines Limited	4 550	3.51	0.13	1.59	45.6	1 350 734	76 576	53.59	43 974	3
Geco Division	(4 550)	(3.16)	(0.10)	(1.83)	(46.6)	(1 329 489)	(67 985)	(52.41)	(39 243)	(1)
Manitouwadge										
Selco Inc.	-	-	-	-	-	-	-	-	-	-
South Bay Division	(450)	(8.81)	(-)	(1.42)	(79.5)	(38 698)	(5 842)	(53.08)	(3 187)	(6)
Uchi Lake										
Manitoba and Saskatchewan										
Hudson Bay Mining and										
Smelting Co., Limited,										
Flin Flon	7 250	2.71	-	1.90	20.7	1 034 449	41 066	46.75	23 853	2
	(7 250)	(2.10)	(0.14)	(1.58)	(20.0)	(983 990)	(23 052)	(46.38)	(15 738)	(2)
Snow Lake	3 450	2.84	0.19	2.48	14.2	687 574	31 221	51.44	16 881	2
	(3 450)	(2.65)	(0.14)	(2.56)	(12.4)	(771 427)	(31 420)	(52.30)	(17 454)	(2)
Sherritt Gordon Mines Limited,										
Fox mine	2 700	1.77	-	1.76	14.1	427 695	10 231	50.73	6 130	2
Lynn Lake	(2 700)	(1.73)	(-)	(1.42)	(7.6)	(733 538)	(17 315)	(50.68)	(10 274)	(2)
Ruttan mine	9 050	0.14	-	2.16	8.2	784 363	-	-	263	-
Ruttan Lake	(9 050)	(1.25)	(-)	(1.30)	(7.3)	(1 702 809)	(29 011)	(51.11)	(17 019)	(2)
British Columbia										
Cominco Ltd.	9 050	3.23	4.98	-	65.5	2 219 198	118 865	49.42	66 282	1
Sullivan mine	(9 050)	(3.23)	(4.43)	(-)	(62.1)	(2 209 669)	(119 049)	(49.54)	(65 127)	(1)
Kimberley										
Dickenson Mines Limited	100	2.83	3.54	-	403.9	26 189	841	50.83	624	1,6
Silmonac mine	(100)	(3.49)	(4.18)	(-)	(430.3)	(26 764)	(1 145)	(50.53)	(829)	(1,6)
Sandon										
Northair Mines Ltd.	250	2.32	1.32	0.19	35.9	33 104	1 219	48.69	694	1
Brandywine area	(250)	(2.09)	(1.15)	(0.15)	(28.6)	(62 548)	(2 087)	(48.13)	(1 146)	(1)

TABLE 5. (cont'd)

Company and Location	Daily Mill Capacity	Zinc	Lead	Copper	Silver	Ore Produced	Zinc Concentrates Produced	Zinc Concentrates Zinc Grade	Zinc Content of all Concentrates	Destination of Zinc Concentrates
	(tonnes ore)	(%)	(%)	(%)	(grams/tonne)	(tonnes)	(tonnes)	(%)	(tonnes)	
British Columbia (cont'd.)										
Teck Corporation	100	0.62	0.29	-	386.6	36 380	262	40.22	138	1
Beaverdell mine	(100)	(0.82)	(0.35)	(-)	(353.1)	(35 774)	(433)	(37.53)	(202)	(1)
Beaverdell										
Westmin Resources Limited	900	7.28	1.11	1.06	127.9	287 579	32 944	52.84	19 363	1,7
Lynx and Myra mines	(900)	(7.37)	(1.22)	(1.13)	(124.1)	(246 150)	(28 695)	(53.43)	(17 245)	(1)
Myra Falls										
Yukon Territory										
Cyprus Anvil Mining	9 050	4.70	2.80	-	33.8	1 643 983	121 162	49.10	63 202	7
Corporation	(9 050)	(4.80)	(2.90)	(-)	(42.0)	(2 751 789)	(201 200)	(49.50)	(107 185)	(7,8,12)
Faro										
United Keno Hill Mines	450	-	-	-	-	-	-	-	-	-
Limited	(450)	(0.64)	(3.59)	(-)	(750.2)	(60 712)	(-)	(-)	(125)	(-)
Elsa										
Northwest Territories										
Cominco Ltd.	2 050	17.00	7.00	-	-	469 922	129 183	57.30	81 308	12
Polaris Mine	(2 050)	(15.34)	(4.75)	(-)	(-)	(23 277)	(5 425)	(57.40)	(3 364)	(-)
Little Cornwallis Island										
Nanisivik Mines Ltd.	2 200	11.30	1.50	-	58.2	633 621	122 846	56.67	69 712	5,8,9
Baffin Island	(2 200)	(11.31)	(1.46)	(-)	(62.4)	(624 275)	(119 591)	(56.84)	(68 040)	(9)
Pine Point Mines Limited	10 000	7.27	2.97	-	-	2 218 299	260 746	57.30	151 332	1,2
Pine Point	(10 000)	(4.78)	(2.02)	(-)	(-)	(3 298 655)	(248 964)	(58.45)	(147 261)	(1,2,8)

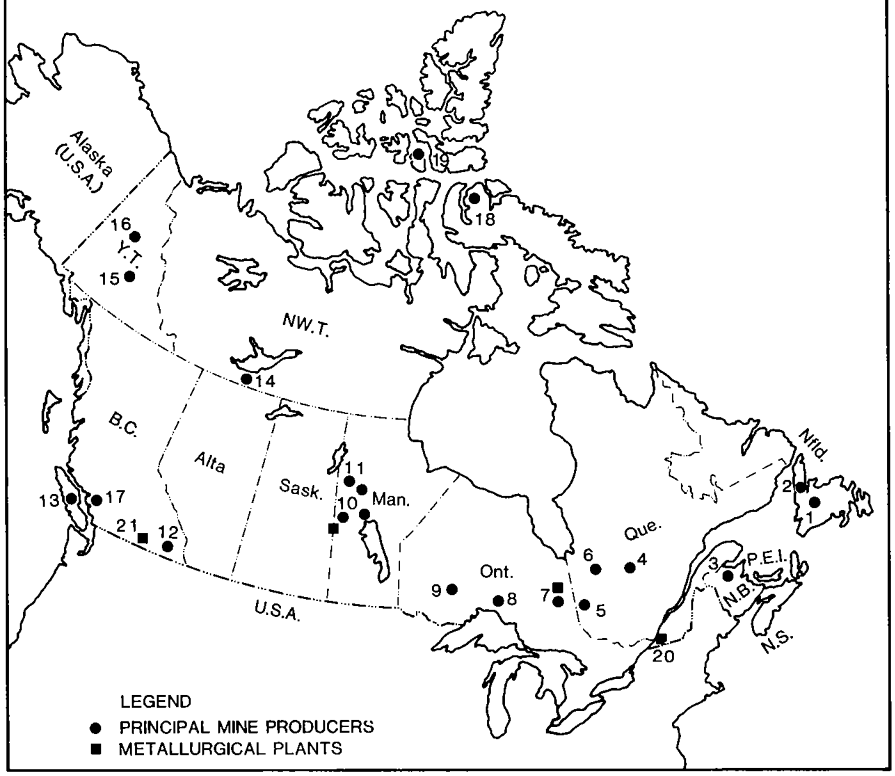
Sources: Company reports in response to survey by Energy, Mines and Resources Canada.
Destination of concentrates: (1) Trail; (2) Flin Flon; (3) Valleyfield; (4) Belledune; (5) Timmins; (6) United States; (7) Japan; (8) Germany; (9) Belgium; (10) France; (11) Britain; (12) Unspecified, and other countries.
- Nil.

TABLE 6. CANADA, ZINC-BEARING DEPOSITS CONSIDERED MOST PROMISING FOR FUTURE PRODUCTION

Company and Province	Deposit Name	Indicated Tonnage	Per Cent Zinc	Zinc Content
		(000 tonnes)		(000 tonnes)
New Brunswick				
Billiton Canada Ltd. and Gowganda Resources Inc.	Restigouche	2 900	6.00	174.0
Caribou-Chaleur Bay Mines Ltd.	Caribou	44 800	4.48	2 007.0
Cominco Ltd.	Stratmat 61	2 040	6.29	128.3
Key Anacon Mines Limited	Middle Landing	1 690	7.43	125.6
Kidd Creek Mines Ltd. and Bay Copper Mines Limited	Halfmile Lake	10 160	7.51	763.0
		61 590	5.19	3 197.9
Quebec				
Les Mines d'Argent Abcourt Inc. and Antiquois Mining Corporation	Barraute	3 270	2.50	81.8
Noranda Mines Limited	Magusi	2 130	3.55	75.6
Les Mines Selbaie	A-2 Zone	5 000	1.33	66.5
		10 400	2.15	223.9
Ontario				
Corporation Falconbridge Copper	Winston Lake	3 000	13.5	405.0
British Columbia				
Cyprus Anvil Mining Corporation	Cirque	39 920	7.80	3 113.8
Yukon Territory				
Cyprus Anvil Mining Corporation	DY zone	14 700	7.10	1 043.7
	Swim Lake	4 540	5.50	249.7
Hudson Bay Mining and Smelting Co., Limited	Tom	7 840	8.40	658.6
Aberford Resources Ltd. and Ogilvie Joint Venture	Jason	11 790	7.00[e]	825.3
Placer Development Limited and United States Steel Corporation	Howard's Pass	272 160[e]	6.40[e]	17 418.2
Sulpetro Minerals Limited and Sovereign Metals Corporation	MEL	4 780	5.10	243.8
		315 810	6.47	20 439.3
Northwest Territories				
Cominco Ltd. and Bathurst Norsemines Ltd.	Seven deposits	19 050	4.98	948.7
Kidd Creek Mines Ltd.	Izok Lake	11 020	13.77	1 517.5
Westmin Resources Limited,	X-25	3 450	9.10	314.0
Du Pont Canada Inc. and Philipp Brothers (Canada) Ltd.	R-190	1 270	11.90	151.1
		34 790	8.43	2 931.3
Canada		465 510	6.51	30 311.2

Source: MR 191 Canadian Reserves of Copper, Nickel, Lead, Zinc, Molybdenum, Silver and Gold, as of January 1, 1981; Energy, Mines and Resources Canada, 1981.
[e] Estimated.

ZINC PRODUCERS IN CANADA, 1982



Principal Producers
(numbers refer to numbers on map above)

1. ASARCO Incorporated (Buchans Unit)
2. Newfoundland Zinc Mines Limited
3. Brunswick Mining and Smelting Corporation Limited
   Heath Steele Mines Limited
4. Lemoine Mines Limited
5. Corporation Falconbridge Copper Lake Dufault Division
   Louvem Mining Company Inc.
6. Mattagami Lake Mines Limited
   Noranda Mines Limited (Orchan mine)
7. Kidd Creek Mines Ltd.
8. Noranda Mines Limited (Geco Division)
9. Mattabi Mines Limited
   Noranda Mines Limited (Lyon Lake)
10. Hudson Bay Mining and Smelting Co., Limited (Chisel Lake, Osborne Lake, Stall Lake, Ghost Lake, Anderson Lake, Westarm, Flin Flon, White Lake, Centennial, Trout Lake, Spruce Point)
11. Sherritt Gordon Mines Limited (Fox Lake mine and Ruttan mine)
12. Cominco Ltd. (Sullivan mine)
    Teck Corporation (Beaverdell mine)
    Dickenson Mines Limited (Silmonac mine)
13. Westmin Resources Limited
14. Pine Point Mines Limited
15. Cyprus Anvil Mining Corporation
16. United Keno Hill Mines Limited
17. Northair Mines Ltd.
18. Nanisivik Mines Ltd.
19. Cominco Ltd. (Polaris mine)

Metallurgical Plants

7. Kidd Creek Mines Ltd., Hoyle
10. Hudson Bay Mining and Smelting Co., Limited, Flin Flon
20. Canadian Electrolytic Zinc Limited, Valleyfield
21. Cominco Ltd., Trail

TABLE 7. CANADA, PRIMARY ZINC METAL CAPACITY, 1982

Company and Location	Annual Rated Capacity
	(tonnes of slab zinc)
Canadian Electrolytic Zinc Limited (CEZ) Valleyfield, Quebec	218 000
Kidd Creek Mines Ltd. Hoyle, Ontario	108 000
Hudson Bay Mining and Smelting Co., Limited Flin Flon, Manitoba	77 000
Cominco Ltd. Trail, British Columbia	272 000
Canada total	675 000

three new mines. During 1981, the Que River project of Aberfoyle Limited, 47 per cent owned by Cominco Ltd., started production with a capacity of 20 000 t of zinc in concentrates; the Teutonic Bore mine in Western Australia of Seltrust Mining Corp. Pty. Ltd. and M.I.M. Holdings Limited came on-stream with a capacity of 25 000 t of zinc, and in 1982, M.I.M. Holdings completed the expansion of its Mount Isa Mines Ltd. mine, increasing its zinc production by 30 000 t. EZ Industries Ltd. expects to start production in 1983 at its new Elura mine in New South Wales. The mine will add 70 000 t to Australian zinc mine capacity.

In the United States, Gulf & Western Industries, Inc. closed indefinitely its Jefferson City, Tennessee mine in July and in December announced that it would suspend operations indefinitely at its Beaver Creek, Tennessee mine. Hecla Mining Company has also closed its Star Mine in Idaho until metal prices improve. St. Joe Resources Company began production of zinc from its new Pierrepont mine in New York State. The mine, with ore reserves of 2.3 million t averaging 16 per cent zinc, has a capacity to produce 16 000 tpy of zinc in concentrates. Jersey Minière Zinc Co. completed the expansion of its Tennessee mines which adds 31 000 tpy to its zinc capacity. The Red Dog deposit in north-

TABLE 8. WESTERN WORLD PRIMARY ZINC STATISTICS, 1980-83

	1980	1981	1982P	1983e
	(000 tonnes)			
Mine production (Zn content)	4 515r	4 456r	4 833	4 700
Metal production	4 468r	4 560r	4 326	4 500
Metal consumption	4 482r	4 416	4 124	4 400

Source: International Lead and Zinc Study Group.

e Estimated by Energy, Mines and Resources Canada.
P Preliminary; r Revised.

western Alaska, discovered by Cominco Ltd., promises to be a large, rich producer of zinc, lead and silver. Cominco American Incorporated and Nana Regional Corp., a company owned by about 4,600 Inuit shareholders, have agreed to complete a two- to three-year feasibility study on the deposit. The deposit is estimated to contain over 85 million t grading 17.1 per cent zinc, 5 per cent lead and 75 g/t silver.

Zinc mine production in Ireland during 1981 suffered from the prolonged strike at Tara Mines Ltd.'s Navan mine which ended in mid-February 1982. During 1982, the Silvermines mine of Mogul of Ireland Ltd. closed because of ore depletion. The large Prieska mine in South Africa, with a capacity of 65 000 tpy zinc, is expected to cease production in 1985 because of depletion of developed ore reserves. In Mexico, Industrial Minera Mexico S.A. started production during the year at five new silver-zinc-lead mines, thereby adding 37 000 t to Mexico's zinc mine capacity, and Comision de Fomento Minero opened its Minera Real de Angeles, S.A. de C.V. project with a capacity of 26 000 t of zinc.

SMELTING AND REFINING

Zinc metal production in 1982, at 4.32 million t, was 5 per cent below that in 1981. Large production drops in Canada and the United States more than offset the small increases recorded in a few other countries.

The on-going difficulties in the European zinc industry caused by overcapacity in smelting facilities led to a proposal by a group of smelters in the EEC to reduce capacity by 150 000 to 200 000 t. The plan calls for the creation of a fund based on contributions from all participating companies according to their actual capacity. Those companies which decided to permanently close smelting capacity would receive compensation for each tonne of capacity closed. The scheme, which must be in conformity with EEC anti-trust regulations, has received preliminary approval by the relevant authorities in Brussels. Belgium's Regional Authority of Wallonia in December agreed in principle to provide capital to reopen Société de Prayon's electrolytic zinc plant at Ehein next year at a rate of 55 000 tpy. M.I.M. Holdings Limited of Australia and Metallgesellschaft AG have reached an agreement whereby M.I.M. will acquire a 50 per cent interest in Ruhr-Zink GmbH which operates a 125 000 t electrolytic zinc plant at Datteln, West Germany and a one-third interest in a zinc product plant also at Datteln. An important part of the deal involves a 10-year zinc concentrate supply contract between the two companies which gives Ruhr-Zink an assured concentrate supply and M.I.M. a long-term contract for its Mount Isa production. Preussag AG closed part of its vertical retort plant at Harz, West Germany, which reduced its capacity by 30 000 t. SAMIN S.p.A. is building a new 100 000 t electrolytic refinery in Sardinia, Italy, which will replace two plants it closed in the past two years.

Zinc metal production in the United States fell 27 per cent in 1982 to 287 000 t. This was due to the closing of The Bunker Hill Co. plant at the end of 1981, reduced operating rates at several plants and suspending of operations at another. However secondary production was expanded, helped by output from four new secondary distillation plants in California, Michigan and Tennessee with total new capacity of some 60 000 t. Gulf Resources & Chemical Corporation has sold its Bunker Hill facilities, including the Bunker Hill and Crescent mines, to a private company. ASARCO Incorporated, after operating its Corpus Christi refinery at 50 per cent of capacity most of the year, indefinitely suspended operations at the plant on October 30.

The Cominco Binani Zinc Limited smelter in Kerala, southern India, is being expanded in two stages from its present 14 000 t capacity to 20 000 t in 1986. A decision is expected in 1983 on construction in Rajasthan by the state-owned Hindustan Zinc Ltd. of a 70 000 t zinc smelter. Minero Peru's new 100 000 t zinc refinery at Cajamarquilla, east of Lima, which started production in 1981 operated at near capacity throughout 1982. Late in the year, Grupo Industrial Minera Mexico SA de CV started production at its new 113 000 t electrolytic zinc plant at San Luis Potosi.

CONSUMPTION

For 1982, non-socialist world metal consumption at 4.12 million t, was down 298 000 t or 6.8 per cent from 1981. Most of the decline in consumption was in the United States where a reduction of 163 000 t or 17.4 per cent occurred. Part of the excess world production of both metal and concentrates was absorbed by a much higher level of exports to socialist countries. Of particular interest are exports of refined zinc to China, which increased from 10 000 t in 1981 to an estimated 80 000 t in 1982.

PRICES

At the beginning of 1982 the producer price of high grade zinc was 52 cents a pound in Canada and 44 cents US in the United States. The European producer price at that time was $US 950 a t. A general weakening of prices during the first quarter of the year brought the price in early April down to 43¢/lb in Canada and 37¢ in the United States. The producer price for zinc metal outside North America was lowered to $US 860 a t in April and to $US 800 in June. Price increases in July and September raised the price to 51¢ in Canada and 42¢ in the United States. During September an attempt was made by North American and Australian producers to raise the European price to $US 850 but this lead was not followed by European producers and a split price of $US 800-850 prevailed in Europe for the balance of the year. Prices softened again in November and at year-end most producers were quoting; for high grade, 49¢/lb in Canada and 40¢ in the United States; for special high grade, prime western and continuous line zinc with controlled lead, 49.5¢ in Canada and 40.5¢ in the United States; and for continuous line zinc with aluminum added, 49.75¢ in Canada and 40.75¢ in the United States. The average settlement price for zinc on the LME in 1981 was £425 a t compared with £327 in 1980. During 1982 it rose from £434 in January to £446 in February. It then declined slowly to an average of £394 during

TABLE 9. WESTERN WORLD ZINC INDUSTRY, PRODUCTION AND CONSUMPTION, 1982

	Mine Production	Metal Production	Metal Consumption
	(000 metric tonnes)		
Europe			
Austria	19	23	25
Belgium	-	228	126
Denmark[1]	77	-	10
Finland	55	144	27
France	37	244	264
Germany F.R.	106	335	370
Greece	21	-	15
Ireland	167	-	2
Italy	39	158	202
Netherlands	-	186	59
Norway	32	79	16
Portugal	-	4	13
Spain	167	190	97
Sweden	185	-	35
Switzerland	-	-	17
United Kingdom	10	79	182
Yugoslavia	84	101	90
Total	999	1 772	1 549
Africa			
Algeria	12	31	16
Egypt	-	-	12
Morocco	12	-	7
Nigeria	-	-	18
South Africa[2]	123	80	91
Tunisia	8	-	1
Zaire	82	64	-
Zambia	52	39	1
Others	-	-	23
Total	289	214	169
Americas			
Argentina	37	29	24
Bolivia	46	-	-
Brazil	71	95	105
Canada	1 189	512	120
Colombia	1	-	12
Honduras	25	-	-
Mexico	245	128	87
Peru	541	161	11
United States	334	287	772
Venezuela	-	-	18
Others	4	-	25
Total	2 493	1 212	1 174
Asia			
Burma	4	-	-
Hong Kong	-	-	25
India	32	53	104
Indonesia	-	-	50
Iran	36	-	-
Japan	250	662	703
Korea, Rep.	58	96	80
Philippines	6	-	20
Taiwan	-	-	34
Thailand	4	-	32
Turkey	30	18	22
Others	-	-	57
Total	420	829	1 127
Oceania			
Australia	636	296	81
New Zealand	-	-	18
Total	636	296	99
Total Non-Socialist World	4 837	4 323	4 118

Source: International Lead and Zinc Study Group.

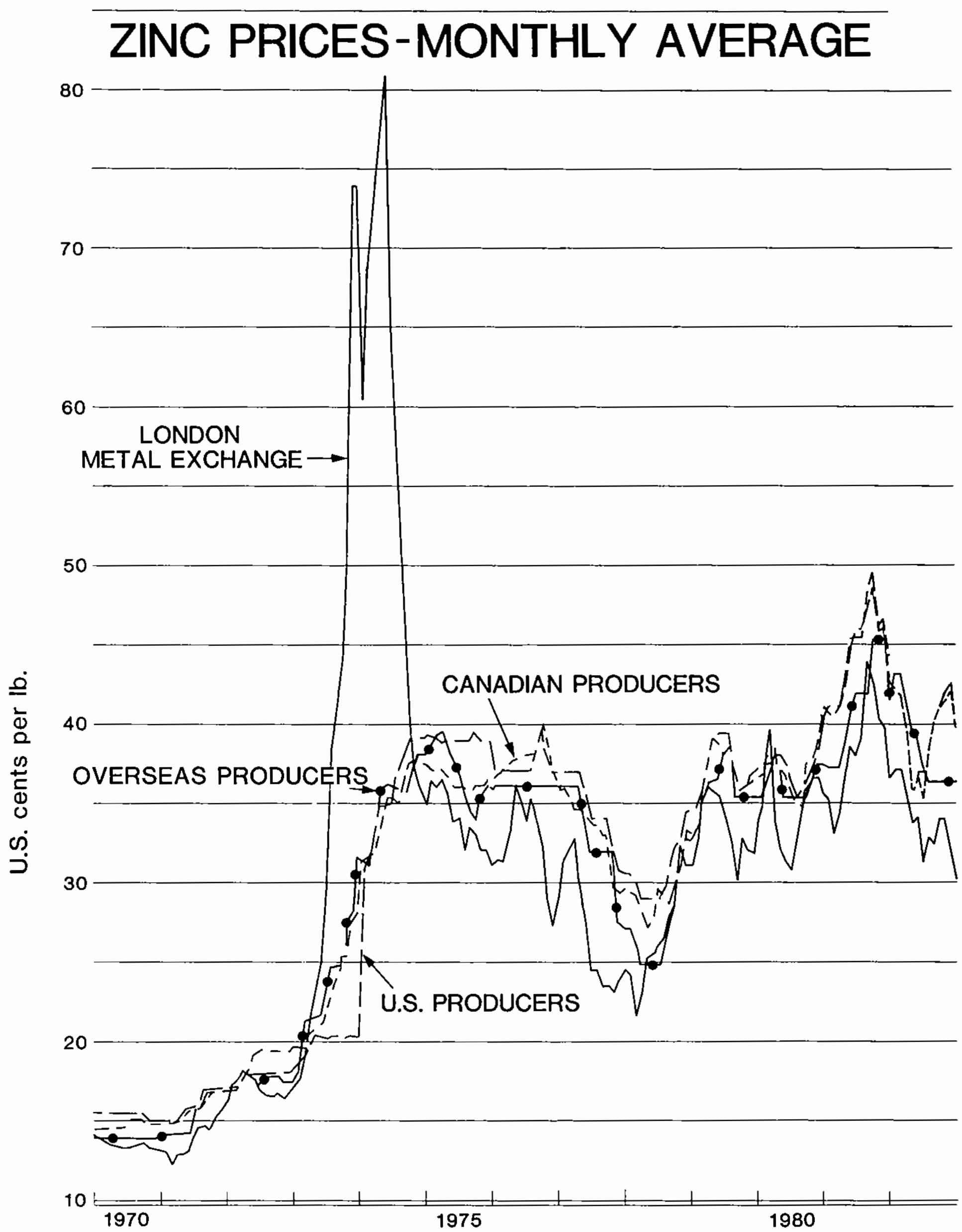
[1] Includes Greenland. [2] Includes Namibia.
- Nil.
Totals may not add due to rounding.

June when it reversed its trend and rose to an average of £443 in October and then dropped to £414 at year-end.

DEVELOPMENTS

Galfan, a new and improved galvanizing alloy developed by The International Lead Zinc Research Organization, Inc. (ILZRO), is expected to be used commercially early in 1983. The alloy contains about 95 per cent zinc, 5 per cent aluminum and a small but significant amount of rare earth metals. While many companies have been licensed to use Galfan, Yodugawa Steel Works Ltd. of Japan will be the first to begin applying the alloy.

The first copper-plated zinc penny was struck November 23, 1981 and placed in circulation by the United States Bureau of the Mint in January 1982. The penny blanks are made of an alloy containing 99.2 per cent SHG zinc and 0.8 per cent copper; the total penny including plating is 97.6 per cent zinc and 2.4 per cent copper. Some 3.6 billion such pennies were in circulation by the end of 1982. During the year the Mint bought some 20 000 t of zinc and expects that it will eventually be using some 40 000 t/y in this program. The Mint bought its zinc by public tenders at intervals during the year.


ZINC PRICES-MONTHLY AVERAGE
80
70
60
50
40
30
20
10
U.S. cents per lb.
LONDON
METAL EXCHANGE
CANADIAN PRODUCERS
OVERSEAS PRODUCERS
U.S. PRODUCERS
1970
1975
1980

OUTLOOK

Lower interest rates may improve demand for products containing zinc. In the United States and Canada, housing starts in 1983 could improve substantially over the low levels recorded in 1982. The OECD countries overall are likely to experience little or no economic growth in the near future and appear to be headed toward a slow recovery. This does not bode well for a quick return to higher levels of demand for zinc and it will take some time to resolve the problem of overcapacity within the industry. Any sustained metal price recovery is unlikely. Producers have been reducing operating rates and some have closed plants completely. The industry capacity in place or irrevocably committed is more than adequate to meet anything other than a massive rise in consumption. New market development for zinc products is necessary to diversify away from over-dependence on galvanizing and diecasting. Such research to develop new markets could be viewed as a long term strategy to promote vital consumption growth.

TABLE 10. INTERNATIONAL ZINC METAL PRICES, 1982

	Average Monthly Prices			
Month	Canada	U.S.	Producers Outside North America	London Metal Exchange Prompt
	(¢/lb)	(¢/lb)	($US/tonne)	(£/tonne)
January	51.2	42.2	950.0	434.0
February	51.2	42.7	950.0	445.6
March	49.3	39.2	908.7	437.4
April	44.0	35.5	878.0	419.0
May	45.5	34.7	860.0	414.4
June	45.5	34.6	827.3	393.8
July	49.7	35.7	800.0	417.0
August	50.5	37.8	800.0	414.7
September	51.2	39.6	800.0	437.8
October	51.5	40.8	800.0	442.9
November	50.7	40.4	800.0	435.0
December	49.5	38.5	800.0	413.6
1982 Average	49.2	38.5	846.6	425.5
1981 Average	52.2	44.6	915.4	425.0

Source: International Lead and Zinc Study Group Bulletin, **Northern Miner** quotes as compiled by Energy, Mines and Resources Canada.

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
		(% unless otherwise specified)			
32900-1	Zinc in ores and concentrates	free	free	free	free
34500-1	Zinc dross and zinc scrap for remelting, or for processing into zinc dust	free	free	10	free
34505-1	Zinc spelter, zinc and zinc alloys containing not more than 10% by weight of other metal or metals, in the form of pigs, slabs, blocks, dust or granules	free	free	2¢/lb	free
35800-1	Zinc anodes	free	free	10	free

UNITED STATES (MFN)

626.04	Zinc, unwrought, alloyed	19.0%

		1982	1983	1984	1985	1986	1987
		(% unless otherwise specified)					
602.20	Zinc in ores and concentrates	0.53¢/lb	0.48¢/lb	0.44¢/lb	0.39¢/lb	0.35¢/lb	0.30¢/lb
626.02	Zinc, unwrought, unalloyed	1.8	1.8	1.7	1.6	1.6	1.5
626.10	Zinc, waste and scrap (suspended until June 30, 1984)	4.0	3.7	3.3	2.9	2.5	2.1

EUROPEAN ECONOMIC COMMUNITY (MFN)

		1982	Base Rate	Concession Rate
		(% unless otherwise specified)		
26.01	Zinc, ores and concentrates	free	free	free
79.01	Zinc, unwrought	3.5	3.5	3.5
	Zinc, waste and scrap	free	free	free

JAPAN (MFN)

		1982	Base Rate	Concession Rate
		(% unless otherwise specified)		
26.01	Zinc, ores and concentrates	free	free	free
79.01	Zinc, unwrought, unalloyed	2.4	2.5	2.1
	Zinc, unwrought, alloyed	7.5 yen/kg	10 yen/kg	7 yen/kg
	Zinc, waste and scrap	1.9	2.5	1.9

Sources: The Customs Tariff and Commodities Index, January 1982, Revenue Canada; Tariff Schedules of the United States Annotated 1982, USITC Publication 1200; U.S. Federal Register Vol. 44, No. 241; Official Journal of the European Communities, Vol. 24, No. L 335, 1981; Customs Tariff Schedules of Japan, 1982.

Statistical Summary
of the Mineral Industry in Canada

In January 1979, the responsibility for Canadian mineral statistics was transferred from Statistics Canada to the Department of Energy, Mines and Resources. The first annual statistical report of this nature on the Canadian mineral industry was published by the Geological and Natural History Survey of Canada in 1886 and later by the Mines Branch of the Department of Mines until 1920. In 1921, the Dominion Bureau of Statistics, later Statistics Canada, assumed the responsibility and continued to publish the reports until 1978.

The statistical material contained in this summary was principally derived from surveys conducted by the Information Systems Division of the Mineral Policy Sector of Energy, Mines and Resources Canada.

The statistical survey program of Energy, Mines and Resources Canada is conducted jointly with the provincial governments and Statistics Canada. This joint program is intended to minimize the reporting burden on the mineral companies. The cooperation of the companies that provide information is greatly appreciated. Without this cooperation, a statistical report of this nature would not be possible. International mineral statistics contained in this summary are derived from the U.S. Bureau of Mines, The American Bureau of Metal Statistics, The World Bureau of Metal Statistics, **Metals Week, Engineering and Mining Journal,** The United Nations and the Organization for Economic Co-operation and Development (OECD).

This statistical summary of the mineral industry in Canada for the year 1981 was prepared by J.T. Brennan and staff, Statistics Section, Mineral Policy Sector, Energy, Mines and Resources Canada, Ottawa. Telephone (613) 995-9466.

STATISTICAL TABLES

SECTION 2: TRADE

SECTION 3: CONSUMPTION

SECTION 4: PRICES

SECTION 5: PRINCIPAL STATISTICS

SECTION 6: EMPLOYMENT, SALARIES AND WAGES

TABLE 1. MINERAL PRODUCTION[1] OF CANADA, 1981 AND 1982, AND AVERAGE 1987-82

	Unit of Measure	1981		1982P		Average 1978-82	
		(Quantity)	($000)	(Quantity)	($000)	(Quantity)	($000)
Metals							
Antimony	t	..	3,121	..	4,172	2 100	6,171
Bismuth	t	168	1,121	126	762	145	1,006
Cadmium	t	834	4,121	739	2,235	993	5,928
Cobalt	t	2 080	108,383	1 458	45,379	1 706	86,121
Columbium (Cb_2O_5)	t	2 741	18,612	3 126	20,944	2 663	16,874
Copper	000 t	691	1,529,770	606	1,179,767	662	1,432,924
Gold	kg	52 034	922,089	62 456	929,378	54 044	798,015
Iron ore	000 t	49 551	1,748,112	34 496	1,211,657	47 133	1,537,936
Iron remelt	000 t	..	113,125	..	105,872	..	97,004
Lead	000 t	269	263,588	290	210,203	288	283,540
Molybdenum	t	12 850	288,473	15 232	327,077	13 018	285,193
Nickel	000 t	160	1,238,148	89	581,074	138	956,142
Platinum group	kg	11 902	136,186	8 590	98,889	10 039	103,158
Selenium	t	255	8,665	198	3,752	214	6,604
Silver	kg	1 129	458,134	1 204	378,761	1 163	479,092
Tantalum (Ta_2O_5)	t	104	23,165	60	7,947	119	14,923
Tellurium	t	31	1,089	19	723	28	1,268
Tin	t	239	3,767	153	2,750	266	4,454
Tungsten (WO_3)	t	2 515	..	3 053	..	3 143	..
Uranium (U)	t	7 507	794,212	8 189	815,185	7 435	709,026
Zinc	000 t	911	1,089,587	1 033	1,108,687	999	986,818
Total metals			8,753,468		7,035,214		7,812,197
Nonmetals							
Asbestos	000 t	1 122	548,406	822	402,995	1 236	541,952
Barite	000 t	..	5,124	..	2,359	75	3,295
Gemstone	t	..	194	..	186	365	982
Gypsum	000 t	7 025	46,855	5 726	42,577	7 252	41,744
Magnesitic dolomite and brucite	000 t	..	11,472	..	13,556	51	10,082
Nepheline syenite	000 t	588	16,770	518	17,338	582	15,881
Peat	000 t	462	51,574	447	54,399	458	45,368
Potash (K_2O)	000 t	6 549	990,418	5 196	625,658	6 473	775,312
Pyrite, pyrrhotite	000 t	10	110	20	220	20	204
Quartz	000 t	2 238	34,693	1 610	32,880	2 032	28,784
Salt	000 t	7 240	131,565	8 076	161,452	7 214	124,793

Soapstone, talc & pyrophyllite	000 t	83	4,462	72	5,456	80	3,882
Sodium sulphate	000 t	535	39,404	549	47,592	477	32,395
Sulphur in smelter gas	000 t	783	47,392	579	41,027	720	28,699
Sulphur, elemental	000 t	8 018	647,652	7 108	600,302	6 970	390,617
Titanium dioxide	000 t	..	131,669	..	106,006	613	103,712
Total nonmetals	000 t		2,707,760		2,154,003		2,147,703
Fuels							
Coal	000 t	40 088	1,072,500	43 200	1,297,800	36 731	988,345
Natural gas	000 m^3	73 824 000	6,420,631	73 783 000	7,081,678	83 550 000	5,686,089
Natural gas by-products	000 m^3	18 883	2,098,376	17 965	2,154,702	18 934	1,718,182
Petroleum, crude	000 m^3	74 553	9,454,124	71 095	11,627,923	78 477	8,676,558
Total fuels			19,045,631		22,162,103		17,069,174
Structural materials							
Clay products	000 $	..	119,116	..	94,656	..	110,677
Cement	000 t	10 145	665,936	8 418	610,387	10 232	616,832
Lime	000 t	2 555	153,874	2 191	148,861	2 239	118,192
Sand and gravel	000 t	259 661	517,002	207 227	464,221	260 225	472,946
Stone	000 t	85 091	312,060	61 929	254,948	96 450	314,323
Total structural materials			1,767,988		1,573,073		1,632,971
Other minerals[2]		..	135,634	..	157,515	..	112,390
Total, all minerals			32,410,481		33,081,908		28,774,435

Notes: [1] Production statistics for the following are not available for publication: diatomite, helium, nitrogen and yttrium. [2] Other minerals include calcium, magnesium, indium, arseneous trioxide, diatomite, mica, strontium, rhenium, cesium, for which the value of production is confidential.
P Preliminary; .. Not available or not applicable.

TABLE 2. CANADA, VALUE OF MINERAL PRODUCTION, PER CAPITA VALUE OF MINERAL PRODUCTION, AND POPULATION, 1953-82

	Metallics	Industrial Minerals	Fuels	Other Minerals[1]	Total	Per Capita Value of Mineral Production	Population of Canada
		($ million)				($)	(000)
1953	710	312	314		1,336	90.02	14,845
1954	802	333	353		1,488	97.36	15,287
1955	1,008	373	414		1,795	114.37	15,698
1956	1,146	420	519		2,085	129.65	16,081
1957	1,159	466	565		2,190	131.87	16,610
1958	1,130	460	511		2,101	122.99	17,080
1959	1,371	503	535		2,409	137.79	17,483
1960	1,407	520	566		2,493	139.48	17,870
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	690	973		3,365	174.45	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	214.99	20,378
1968	2,493	886	1,343		4,722	228.10	20,701
1969	2,378	891	1,465		4,734	225.42	21,001
1970	3,073	931	1,718		5,722	268.68	21,297
1971	2,940	1,008	2,015		5,963	276.46	21,568
1972	2,956	1,085	2,367		6,408	293.92	21,802
1973	3,850	1,293	3,227		8,370	379.69	22,043
1974	4,821	1,731	5,202		11,754	525.55	22,364
1975	4,796	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	794.26	23,258
1978r	5,682	2,986	11,578	73	20,319	865.51	23,476
1979r	7,924	3,514	14,617	81	26,135	1,104.11	23,671
1980r	9,666	4,201	17,944	115	31,926	1,333.79	23,936
1981r	8,753	4,476	19,012	136	32,410	1,331.46	24,342
1982P	7,035	3,727	22,162	158	33,082	1,344.63	24,603

[1] Other minerals include calcium, magnesium, indium, arseneous trioxide, diatomite, mica, strontium, rhenium, cesium, for which the value of production is confidential.
P Preliminary; r Revised.

TABLE 3. CANADA' VALUE OF MINERAL PRODUCTION BY PROVINCES, TERRITORIES AND MINERAL CLASSES, 1982P

	Metals		Industrial minerals		Fuels		Other minerals[1]		Total	
	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)	($000)	(% of total
Alberta	161	0.0	861,763	23.1	19,293,522	87.1	-	-	20,155,446	60.9
Ontario	2,307,710	32.8	781,510	21.0	51,959	0.2	31,887	20.2	3,173,065	9.6
British Columbia	1,248,344	17.7	264,001	7.1	1,324,320	6.0	5,004	3.2	2,841,709	8.6
Saskatchewan	283,519	4.0	725,074	19.4	1,182,397	5.3	-	-	2,190,990	6.6
Quebec	1,193,851	17.0	799,397	21.4	-	-	12,803	8.1	2,006,051	6.1
Newfoundland	593,713	8.4	32,200	0.9	-	-	-	-	625,913	1.9
Northwest Territories	461,607	6.6	-	-	29,414	0.1	107,613	68.3	598,634	1.8
New Brunswick	432,629	6.1	59,376	1.6	24,571	0.1	168	0.1	516,744	1.6
Manitoba	345,818	4.9	74,616	2.1	85,920	0.4	-	-	511,355	1.5
Nova Scotia	-	-	122,086	3.3	170,000	0.8	-	-	292,086	0.9
Yukon	167,862	2.4	-	-	-	-	-	-	167,862	0.5
Prince Edward Island	-	-	2,054	0.1	-	-	-	-	2,054	0.0
Total, Canada	7,035,214	100.0	3,727,076	100.0	22,162,103	100.0	157,515	100.0	33,081,908	100.0

[1] Other minerals include calcium, magnesium, indium, arseneous trioxide, diatomite, mica, strontium, rhenium, cesium, for which the value of production is confidential.
P Preliminary; - Nil.

TABLE 4. PRODUCTION OF LEADING MINERALS,

	Unit of measure	Nfld.	P.E.I.	Nova Scotia	New Brunswick	Quebec	Ontario
Oil, crude	000 m^3	-	-	-	1	-	89
	$000	-	-	-	29	-	13,764
Natural gas	000 m^3	-	-	-	2	-	407
	$000	-	-	-	42	-	38,195
Natural gas	000 m^3	-	-	-	-	-	-
byproducts	$000	-	-	-	-	-	-
Coal	000 t	-	-	3,100	500	-	-
	$000	-	-	170,000	24,500	-	-
Iron ore	000 t	17,853	-	-	-	12,122	3,748
	$000	558,498	-	-	-	446,252	187,309
Copper	000 t	2	-	-	13	91	173
	$000	4,813	-	-	25,000	176,660	336,307
Zinc	000 t	26	-	-	247	65	256
	$000	28,154	-	-	265,416	70,842	275,204
Gold	kg	x	-	-	x	23	20
	$000	1,158	-	-	2,989	346,943	293,856
Uranium (U)	t	-	-	-	-	-	5
	$000	-	-	-	-	-	550,586
Potash (K_2O)	000 t	-	-	-	-	-	-
	$000	-	-	-	-	-	-
Cement	000 t	..	-	..	..	2,307	2,800
	$000	4,304	-	27,670	13,066	129,987	215,208
Sulphur, elemental	000 t	-	-	-	-	-	22
	$000	-	-	-	-	-	1,870
Nickel	000 t	-	-	-	-	-	63
	$000	-	-	-	-	-	412,930
Sand and gravel	000 t	2,775	400	9,550	6,100	34,209	75,000
	$000	9,380	2,054	24,206	9,635	46,479	148,208
Asbestos	000 t	13	-	-	-	731	-
	$000	9,572	-	-	-	324,992	-
Silver	000 t	1	-	-	243	54	345
	$000	225	-	-	76,310	16,967	108,448
Molybdenum	000 t	-	-	-	-	x	-
	$000	-	-	-	-	6,219	-
Stone	000 t	490	-	800	2,500	23,301	30,200
	$000	2,058	-	4,320	10,425	94,823	120,752
Lead	000 t	1	-	-	82	-	6
	$000	833	-	-	59,261	-	4,527
Salt	000 t	-	-	1,142	..	150	5,479
	$000	-	-	30,974	..	2,300	97,701
Lime	000 t	-	-	-	x	329	1,463
	$000	-	-	-	3,944	22,444	99,484
Titanium dioxide	$000	-	-	-	-	106,006	-
Iron, remelt	$000	-	-	-	-	105,872	-
Platinum group	t	-	-	-	-	-	9
	$000	-	-	-	-	-	98,889
Clay products	$000	821	-	4,500	2,200	13,720	50,946
Total leading minerals	$000	619,816	2,054	261,675	492,817	1,910,506	3 054,184
Total all minerals	$000	625,913	2,054	292,086	516,744	2,006,051	3 173,065
Leading minerals as % of all minerals		99.0	100.0	89.6	95.4	95.2	96.3

P Preliminary; - Nil; .. Not available; x less than 1 unit.

BY PROVINCES AND TERRITORIES, 1982P

Manitoba	Saskat-chewan	Alberta	British Columbia	Yukon	N.W.T.	Total Canada
561	7,360	60,878	2,050	–	158	71,095
85,920	1,066,813	10,123,968	324,466	–	12,963	11,627,923
–	1,294	65,292	6,641	–	146	73,783
–	30,858	6,659,091	337,041	–	16,451	7,081,678
–	84	17,650	231	–	–	17,965
–	9,226	2,117,663	27,813	–	–	2,154,702
–	7,700	20,100	11,800	–	–	43,200
–	75,500	392,800	635,000	–	–	1,297,800
–	–	–	772	–	–	34,496
–	–	–	19,598	–	–	1,211,657
48	4	–	268	7	x	606
93,325	8,677	–	520,419	14,077	489	1,179,767
32	4	–	64	59	278	1,033
34,644	4,640	–	68,623	63,264	297,900	1,108,687
2	x	x	7	3	7	62
23,922	4,051	161	110,708	42,430	103,160	929,378
–	3	–	–	–	–	8
–	264,599	–	–	–	–	815,185
–	5,196	–	–	–	–	5,196
–	625,658	–	–	–	–	625,658
275	206	1,468	776	–	–	8,418
21,137	15,833	112,830	70,352	–	–	610,387
–	–	6,827	259	–	–	7,108
–	–	580,295	18,137	–	–	600,302
26	–	–	–	–	–	89
168,144	–	–	–	–	–	581,074
12,800	8,200	29,000	29,193	–	–	207,227
27,900	20,037	111,978	64,345	–	–	464,221
–	–	–	78	–	–	822
–	–	–	68,431	–	–	402,995
25	4	–	458	70	4	1,204
7,973	1,405	–	144,111	22,141	1,181	378,761
–	–	–	15	–	–	15
–	–	–	320,158	–	–	327,077
1,800	–	325	2,513	–	–	61,929
10,098	–	2,542	9,930	–	–	254,948
1	–	–	83	36	81	290
567	–	–	60,188	25,950	58,877	210,203
–	402	903	–	–	–	8,076
–	14,363	16,109	–	–	–	161,452
x	–	159	107	–	–	2,191
5,100	–	10,812	7,077	–	–	148,861
–	–	–	–	–	–	106,006
–	–	–	–	–	–	105,872
–	–	–	–	–	–	9
–	–	–	–	–	–	98,889
1,776	3,477	12,251	4,965	–	–	94,656
480,506	2,145,137	20,140,500	2,812,062	167,862	491,021	32,578,139
511,355	2,190,990	20,155,446	2,841,709	167,862	598,634	33,081,908
94.0	97.9	99.9	99.0	100.0	82.0	98.5

TABLE 5. CANADA, PERCENTAGE CONTRIBUTION OF LEADING MINERALS TO TOTAL VALUE OF MINERAL PRODUCTION, 1976-82

	1976	1977	1978	1979	1980	1981	1982P
Oil, crude	25.8	26.4	28.7	28.6	28.4	29.2	35.1
Natural gas	16.9	18.5	19.4	18.6	19.3	19.8	21.4
Natural gas byproducts	5.1	5.3	5.3	5.5	5.7	6.5	6.5
Coal	3.9	3.3	3.8	3.3	2.9	3.3	3.9
Iron ore	7.8	7.5	6.0	6.9	5.3	5.4	3.7
Copper	7.0	6.3	5.4	5.8	5.8	4.7	3.6
Zinc	5.2	4.5	4.0	4.1	2.7	3.4	3.4
Gold	1.3	1.5	1.9	2.3	3.7	2.8	2.8
Uranium (U)	1.5	1.9	3.1	2.4	2.2	2.5	2.5
Potash (K_2O)	2.3	2.2	2.5	2.8	3.2	3.1	1.9
Cement	2.4	2.3	2.8	2.5	1.8	2.1	1.8
Sulphur, elemental	0.5	0.4	0.5	0.6	1.4	2.0	1.8
Nickel	7.3	6.6	3.1	3.2	4.7	3.8	1.8
Sand and gravel	2.1	2.0	2.1	1.8	1.6	1.6	1.4
Asbestos	2.9	3.1	2.6	2.3	1.9	1.7	1.2
Silver	1.1	1.1	1.2	1.8	2.6	1.4	1.1
Molybdenum	0.6	0.8	0.9	1.3	0.9	0.9	1.0
Stone	1.5	1.6	1.6	1.3	1.1	1.0	0.8
Lead	0.8	1.1	1.3	1.6	0.9	0.8	0.6
Salt	0.5	0.5	0.5	0.4	0.4	0.4	0.5
Lime	0.4	0.4	0.4	0.3	0.4	0.5	0.5
Titanium dioxide	0.5	0.4	0.4	0.3	0.4	0.4	0.3
Iron, remelt	0.4	0.4	0.4	0.2	0.4	0.4	0.3
Platinum group	0.3	0.3	0.3	0.2	0.5	0.4	0.3
Clay products	0.6	0.6	0.5	0.5	0.3	0.4	0.3
Other minerals	1.3	1.0	1.3	1.4	1.5	1.5	1.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

P Preliminary.

TABLE 6. CANADA, VALUE OF MINERAL PRODUCTION BY PROVINCES AND TERRITORIES, 1976-82

	1976	1977	1978	1979	1980	1981	1982P
				($ million)			
Alberta	6,934	8,576	10,087	12,899	16,379	17,559	20,155
Ontario	2,712	2,980	2,698	3,265	4,640	4,160	3,173
British Columbia	1,606	1,687	1,883	2,677	2,795	2,822	2,842
Saskatchewan	974	1,208	1,582	1,874	2,315	2,293	2,191
Quebec	1,493	1,675	1,796	2,165	2,467	2,420	2,006
Newfoundland	745	867	675	1,125	1,036	1,030	626
Northwest Territories	225	256	310	435	425	447	599
New Brunswick	239	289	339	480	373	531	517
Manitoba	511	564	459	653	803	642	511
Nova Scotia	127	159	211	210	247	269	292
Yukon	125	210	219	299	361	236	168
Prince Edward Island	2	2	2	2	2	2	2
Total	15,693	18,473	20,261	26,084	31,842	32,410	33,082

P Preliminary.

TABLE 7. CANADA, PERCENTAGE CONTRIBUTION OF PROVINCES AND TERRITORIES TO TOTAL VALUE OF MINERAL PRODUCTION, 1976-1982

	1976	1977	1978	1979	1980	1981	1982P
Alberta	44.2	46.4	49.8	49.5	51.4	54.2	60.9
Ontario	17.3	16.1	13.3	12.5	14.6	12.8	9.6
British Columbia	10.2	9.1	9.3	10.3	8.8	8.7	8.6
Saskatchewan	6.2	6.5	7.8	7.2	7.2	7.0	6.6
Quebec	9.5	9.1	8.9	8.3	7.7	7.5	6.1
Newfoundland	4.7	4.7	3.3	4.3	3.3	3.2	1.9
Northwest Territories	1.5	1.4	1.5	1.7	1.3	1.4	1.8
New Brunswick	1.5	1.6	1.7	1.8	1.2	1.6	1.6
Manitoba	3.3	3.1	2.3	2.5	2.5	2.0	1.5
Nova Scotia	0.8	0.9	1.0	0.8	0.8	0.8	0.9
Yukon	0.8	1.1	1.1	1.1	1.1	0.7	0.5
Prince Edward Island	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

P Preliminary.

TABLE 8. CANADA'S WORLD ROLE AS A PRODUCER OF

		World
Nickel (mine production)	t	716 100
	% of world total	
Zinc (mine production)	000 t	6 122
	% of world total	
Asbestos	000 t	4 480
	% of world total	
Potash (K_2O equivalent)	000 t	27 227
	% of world total	
Sulphur, elemental	000 t	33 482
	% of world total	
Uranium (U concentrates)	t	43 969
	% of world total	
Titanium concentrates (ilmenite)	000 t	4 742
	% of world total	
Gypsum	000 t	77 094
	% of world total	
Molybdenum (Mo content)	t	107 000
	% of world total	
Aluminum (primary metal)	000 t	15 694
	% of world total	
Platinum group metals (mine production)	kg	211 917
	% of world total	
Gold (mine production)	t	1 280
	% of world total	
Lead (mine production)	t	3 462 600
	% of world total	
Copper (mine production)	000 t	8 333
	% of world total	
Cadmium (smelter production)	t	17 466
	% of world total	
Silver	t	11 275
	% of world total	
Iron ore	000 t	859 795
	% of world total	

[p] Preliminary; [e] Estimated.

CERTAIN IMPORTANT MINERALS, 1981P

Rank of Six Leading Countries					
1	2	3	4	5	6
Canada	U.S.S.R.	New Caledonia	Australia	Indonesia	Cuba
159 700	145 000[e]	78 200	74 500	45 500	40 300[e]
22.3	20.2	10.9	10.4	6.4	5.6
Canada	U.S.S.R.	Australia	Peru	U.S.A.	Japan
1 096	1 010[e]	518	497	343	242
17.9	16.5	8.5	8.1	5.6	4.0
U.S.S.R.	**Canada**	China	Zimbabwe	South Africa	Brazil
2 105[e]	1 122	250[e]	248	236	138
47.0	25.0	5.6	5.5	5.3	3.1
U.S.S.R.	**Canada**	East Germany	West Germany	U.S.A.	France
8 449	6 549	3 490	2 591	2 156	1 831
31.0	24.1	12.8	9.5	7.9	6.7
U.S.A.	**Canada**	Poland	U.S.S.R.	Mexico	France
10 607	5 925	4 773	3 710	2 052	1 970
31.7	17.7	14.3	11.1	6.1	5.9
U.S.A.	**Canada**	South Africa	Niger	Namibia	France
14 801	7 801	6 123	4 355	3 969	2 708
33.7	17.7	13.9	9.9	9.0	6.2
Australia	**Canada**	Norway	U.S.A.	U.S.S.R.	South Africa
1 337	762	657	462	435[e]	370
28.1	16.1	13.9	9.7	9.2	7.8
U.S.A.	**Canada**	France	Iran	U.S.S.R.	Spain
10 430	7 025	6 304	5 987	5 450[e]	5 198
13.5	9.1	8.2	7.7	7.1	6.7
U.S.A.	Chile	**Canada**	U.S.S.R.	Peru	China
62 300	15 400	12 850	10 400[e]	2 600	2 000[e]
58.2	14.4	12.0	9.7	2.4	1.9
U.S.A.	U.S.S.R.	**Canada**	Japan	West Germany	Norway
4 489	2 400[e]	1 118	771	729	633
28.6	15.3	7.1	4.9	4.6	4.0
U.S.S.R.	South Africa	**Canada**	Colombia	Australia	U.S.A.
104 198	93 312	11 902	467	297	191
49.2	44.0	5.6	0.2	0.1	0.1
South Africa	U.S.S.R.	**Canada**	China	Brazil	U.S.A.
658	262[e]	53	47[e]	35	30
51.4	20.5	4.1	3.7	2.7	2,3
U.S.S.R.	U.S.A.	Australia	**Canada**	Peru	China
570 000[e]	454 600	388 100	332 045	186 700	160 000
16.5	13.1	11.2	9.6	5.4	4.6
U.S.A.	U.S.S.R.	Chile	**Canada**	Zambia	Zaire
1 538	1 140	1 081	691	587	505
18.5	13.7	13.0	8.3	7.0	6.1
U.S.S.R.	Japan	U.S.A.	**Canada**	Belgium	Germany
2 800	1 977	1 871	1 293	1 176	1 074
16.0	11.3	10.7	7.4	6.7	6.1
Mexico	U.S.S.R.	Peru	U.S.A.	**Canada**	Australia
1 655	1 580[e]	1 318	1 266	1 203	723
14.7	14.0	11.7	11.2	10.7	6.5
U.S.S.R.	Brazil	Australia	U.S.A.	China	**Canada**
242 022	99 979	85 960	74 375	70 000[e]	49 551
28.1	10.9	10.9	8.1	8.6	5.8

TABLE 9. CANADA, GROSS DOMESTIC PRODUCT BY INDUSTRY IN CONSTANT 1971 DOLLARS, 1976-1982

	1976	1977	1978	1979	1980	1981	1982P
				($ million)			
Goods producing industries							
Agriculture	2,947.5	3,069.7	2,996.5	2,698.5	2,908.6	3,260.5	3,348.0
Forestry	705.6	741.9	794.9	795.9	816.2	788.7	643.2
Fishing and trapping	144.4	162.3	179.5	183.7	174.1r	160.8	184.8
Mining[1]	3,243.6	3,337.3	3,015.1	3,282.9	3,401.1	3,222.8	2,829.4
Manufacturing	23,413.9	23,901.6	25,139.9	36,631.8	25,846.3	26,378.5	23,131.3
Construction	6,992.0	6,856.2	6,706.0	6,887.8	6,859.2	7,344.2	6,740.7
Electrical power, gas and water utilities	3,116.0	3,311.3	3,521.6	3,685.3	3,783.7	3,977.9	3,989.7
Total	40,581.0	41,380.3	42,353.6	44,165.9	43,789.2r	45,133.4	40,867.1
Service producing industries							
Transportation, storage and communication	10,419.5	10,972.8	11,462.3	12,393.9	12,756.3	13,167.2	12,634.1
Trade	13,531.4	13,710.4	14,206.5	14,686.2	14,721.2	14,763.1	13,482.3
Finance, insurance and real estate	12,683.3	13,444.8	14,119.9	14,555.0	15,041.1	15,623.9	15,629.9
Community, business and personnel services	20,469.5	21,096.3	21,888.1	22,459.9	22,771.2	23,718.0	23,552.6
Public administration and defense	7,564.7	7,736.2	7,927.5	7,884.5	7,985.6	8,145.1	8,405.3
Total	64,668.4	66,960.5	69,604.3	71,979.5	73,275.4	75,417.3	73,704.2
Grand total	105,249.4	108,340.8	111,957.9	116,145.4	117,064.6r	120,550.7	114,571.3

[1] Cement, lime, clay and clay products (domestic clays) industries are included under "Manufacturing".
P Preliminary; r Revised.

TABLE 10. CANADA, CENSUS VALUE ADDED, TOTAL ACTIVITY, MINING AND MINERAL MANUFACTURING INDUSTRIES, 1975-81

	1975	1976	1977	1978	1979	1980	1981
				($ million)			
Mining							
Metallic minerals							
Gold-quartz	149.9	113.7	152.0	207.6	322.8	588.8	519.0
Silver-lead-zinc	320.8	233.7	279.8	372.7	671.9	513.6	380.3
Nickel-copper-gold-silver	1,325.1	1,488.8	1,244.3	1,288.5	2,469.7	2,992.2	2,007.9
Iron	556.7	732.1	807.3	717.0	1,022.2	1,005.0	1,036.0
Uranium	157.8	195.8	300.1	501.7	525.4	559.3	865.8
Miscellaneous metal mines	53.7	74.2	118.0	138.6	179.7	243.3	150.2
Total	2,563.9	2,838.4	2,901.4	3,226.1	5,191.6	5,902.2	4,959.3
Industrial minerals							
Asbestos	230.6	373.2	474.8	401.6	456.8	473.4	431.5
Gypsum	14.9	15.8	21.0	25.9	27.5	26.9	31.3
Peat	20.6	23.7	27.4	33.7	38.8	42.7	47.8
Potash	298.5	262.1	301.4	360.2	613.5	900.4	889.7
Salt	45.9	70.7	70.9	77.9	86.4	93.7	98.2
Sand and gravel	102.3	99.0	91.3	85.8	91.5	92.0	98.3
Stone	111.0	111.0	106.1	110.2	121.7	123.4	122.5
Miscellaneous nonmetals	40.4	42.4	45.6	44.7	53.7	59.0	72.8
Total	864.1	997.8	1,138.4	1,139.9	1,489.8	1,811.5	1,791.9
Fuels							
Coal	483.5	474.3	508.5	566.8	658.6	621.6	671.1
Petroleum and natural gas	5,838.5	7,052.0r	8,698.3	10,078.6r	12,554.1r	14,917.3	15,924.6
Total	6,322.0	7,526.3r	9,206.9	10,645.4r	13,212.7r	15,538.9	16,595.7
Total mining industry	9,750.0	11,362.5	13,246.7	15,011.4r	19,894.1r	23,252.6	23,347.0
Mineral manufacturing							
Primary metal industries							
Iron and steel mills	1,364.0	1,498.8	1,677.6	1,924.9	2,424.3	2,537.9	2,750.9
Steel pipe & tube mills	170.3	148.8	160.3	225.1	280.4	297.6	378.3
Iron foundries	238.1	241.9	257.7	273.8	298.2	266.9	266.0
Smelting and refining	886.4	812.7	1,176.1	1,387.2	1,401.0	1,976.9	1,808.9
Aluminum rolling, casting and extruding	132.6	149.4	193.7	154.3	249.0	273.5	292.8
Copper and alloy rolling, casting and extruding	68.3	71.4	78.5	93.1	131.5	103.7	129.3
Metal rolling, casting and extruding, nes	88.4	113.3	110.2	136.2	198.9	203.6	210.4
Total	948.2	3,036.3	3,654.0	4,194.7	4,983.3	5,660.1	5,836.6

(continued on following page)

TABLE 10. (cont'd)

	1975	1976	1977	1978	1979	1980	1981
				($ million)			
Mineral manufacturing (cont'd)							
Nonmetallic mineral products industries							
Cement manufacturers	210.3	249.1	275.0	319.9	388.8	357.3	421.4
Lime manufacturers	24.9	30.0	36.6	44.6	49.3	59.5	62.8
Concrete products manufacturers	282.1	282.1	273.5	309.3	328.7	324.6	378.5
Ready-mix concrete manufacturers	282.6	282.6	292.8	317.3	341.6	352.4	430.1
Clay products (domestic clay)	59.7	65.9	69.6	73.6	87.5	84.6	82.0
Clay products (imported clay)	41.7	39.1	39.8	43.1	44.9	51.6	50.9
Refractories manufacturers	45.8	44.4	32.5	45.3	66.6	73.6	54.5
Stone products manufacturers	14.0	16.3	19.6	22.4	28.2	33.2	40.9
Glass manufacturers	185.6	205.1	199.2	266.8	294.9	308.1	364.6
Glass products manufacturers	74.3	87.4	96.6	122.9	141.0	143.6	141.0
Abrasive manufacturers	43.9	55.1	64.1	70.6	79.4	92.1	95.9
Other nonmetallic mineral products industries	237.4	270.2	253.6	341.0	375.2	370.7	388.0
Total	1,502.4	1,627.3	1,652.9	1,976.8	2,226.2	2,251.3	2,510.5
Petroleum and coal products industries							
Petroleum refining	789.7	945.8	1,206.7	1,180.4	1,390.9	1,750.1	2,641.5
Manufacturers of lubricating oil and greases	32.6	32.6	36.8	36.9	38.3	26.7	35.0
Other petroleum and coal products industries	43.6	45.7	44.4	33.1	30.5	36.0	39.3
Total	866.0	1,024.2	1,287.9	1,250.4	1,459.8	1,812.8	2,715.8
Total mineral manufacturing	5,316.5	5,687.8	6,594.8	7,421.9	8,669.2	9,724.2	11,062.9
Total mining and mineral manufacturing	15,066.6	17,050.3 r	19,841.5	22,433.3 r	28,563.3 r	32,976.9	34,409.9

nes Not elsewhere specified; r Revised.

TABLE 11. CANADA, INDEXES OF GROSS DOMESTIC PRODUCT OF INDUSTRIAL PRODUCTION, MINING AND MINERAL MANUFACTURING, 1968-82 (1971=100)

	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978r	1979r	1980r	1981	1982p
Total industrial production	87.6	93.6	94.9	100.0	107.6	119.0	122.8	115.5	122.2	125.3	129.9	137.8	135.5	137.7	122.8
Total mining	86.2	86.9	98.7	100.0	104.4	117.8	114.0	100.9	103.1	106.1	95.8	104.3	108.1	102.4	89.9
Metals															
All metals	95.5	88.4	105.4	100.0	94.3	105.7	101.8	91.2	96.7	99.5	73.8	76.4	82.1	78.7	59.5
Placer gold and gold quartz mines	121.7	118.2	105.3	100.0	90.1	80.0	68.4	67.4	69.1	68.2	65.5	60.0	54.3	55.2	75.3
Iron mines	104.8	91.9	116.1	100.0	78.7	97.4	80.4	71.4	104.6	94.7	41.5	69.0	60.0	54.7	36.9
Other metal mines	92.0	85.3	103.0	100.0	98.6r	109.3r	109.3r	97.7r	96.0r	102.4r	82.8	79.2	89.4	86.3	63.7
Fuels															
All fuels	73.4	80.8	92.6	100.0	114.7	130.1	124.7	112.4	107.5	108.6	109.5	122.7	120.9	113.8	113.0
Coal	68.7	68.4	87.5	100.0	105.4	115.5	116.8	137.5	128.5	125.2	138.9	156.0	171.5	184.1	193.6
Crude oil and natural gas	73.7	81.7	93.0	100.0	115.4	131.2	125.3	110.5	105.9	107.3	107.3	120.2	117.1	108.5	106.8
Nonmetals															
All metals	83.7	92.8	95.0	100.0	99.7	107.8	119.7	88.9	103.6	109.4	103.2	110.7	113.7	108.8	84.3
Asbestos	82.6	89.8	95.2	100.0	101.0	102.1	102.0	63.7	85.5	85.5	64.6	66.2	61.6	52.2	36.7
Mineral manufacturing															
Primary metals	92.9	94.9	100.9	100.0	101.3	112.2	118.7	107.0	105.6	113.2	119.5	123.4	126.4	126.9	101.7
Nonmetallic mineral products	87.1	90.5	86.6	100.0	109.1	119.5	125.2	117.7	120.5	119.4	127.3	134.4	124.6	126.2	100.5
Petroleum and coal products	88.7	92.1	94.4	100.0	115.3	136.1	136.8	130.9	120.0	112.1	110.8	105.5	104.4	97.6	85.3

p Preliminary; r Revised.

TABLE 12. CANADA, INDEXES OF GROSS DOMESTIC PRODUCT BY INDUSTRIES, 1968-1982 (1971=100)

	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978r	1979r	1980r	1981	1982P
Gross domestic product, all industries	86.9	92.2	94.4	100.0	105.9	114.1	119.3	120.4	126.4	130.1	134.5	139.5	140.6	144.8	137.6
Agriculture	85.2	90.6	89.0	100.0	88.7	96.9	89.5	103.0	109.3	113.9	111.2	100.1	107.9	121.0	124.5
Forestry	94.4	102.4	103.3	100.0	105.7	113.7	112.1	97.8	105.4	110.8	118.7	118.9	121.9	117.8	95.6
Fishing and trapping	115.6	102.6	105.4	100.0	95.7	101.6	90.2	85.8	98.0	110.1	121.8	124.6	118.1	109.1	125.4
Mines (incl. milling), quarries and oil wells	86.2	86.9	98.7	100.0	104.4	117.8	114.0	100.9	103.1	106.1	95.8	104.3	108.1	102.4	89.5
Electric power, gas and water utilities	78.2	85.4	93.3	100.0	111.1	120.3	130.1	130.5	142.0	150.9	160.5	168.0	172.5	181.3	181.3
Manufacturing	89.1	95.8	94.5	100.0	107.7	119.1	123.4	116.2	123.1	125.5	132.0	139.9	135.7	138.5	121.6
Construction	90.1	92.5	90.9	100.0	103.0	106.1	110.3	116.0	119.6	117.3	114.7	117.8	117.3	125.6	115.7
Transportation, storage and communications	82.8	89.0	94.2	100.0	108.5	117.9	125.0	126.5	134.2	141.6	148.6	159.4	164.0	170.0	164.7
Trade	87.1	91.7	93.2	100.0	109.9	119.8	129.5	132.5	138.0	139.8	144.9	149.8	150.1	150.6	137.6
Community, business and personal service	85.7	91.6	95.5	100.0	104.8	109.5	115.8	121.1	127.3	131.2	136.1	139.7	141.6	147.5	146.4
Finance, insurance and real estate	86.7	92.4	94.6	100.0	105.3	114.0	120.9	125.9	132.3	140.2	147.3	151.8	156.9	162.9	163.0
Public administration and defence	89.1	91.6	95.2	100.0	104.2	109.7	113.9	119.4	123.0	125.7	128.9	128.2	129.8	132.4	136.6

P Preliminary; r Revised.

TABLE 13. CANADA, GROSS DOMESTIC PRODUCT FOR SELECTED INDUSTRIES BY PROVINCE, 1980

	Newfoundland	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Yukon and Northwest Territories	Canada
					($ million)							
Agriculture	18.9	99.6	108.7	97.3	1,124.9	2,280.9	589.0	2,098.5	2,000.6	455.5	..	8,873.6
Forestry	x	x	27.0	107.9	327.3	327.3	15.3	19.6	37.5	1,193.3	-	2,099.1
Fishing, Hunting and Trapping	110.9	18.2	157.8	34.0	37.4	30.4	17.5	8.1	9.9	125.3	5.6	555.7
Mining[1]	410.3	-	120.0	88.6	1,123.6	2,806.1	522.6	1,333.0	9,641.6	1,464.3	368.0	17,851.2
Manufacturing	418.0	65.9	1,015.2	889.2	15,364.1	27,266.5	1,526.8	655.0	2,781.3	5,714.5	7.6	55,706.5
Construction	274.7	52.4	399.6	312.3	2,856.1	4,102.1	441.8	708.2	3,667.1	2,258.4	259.5	15,332.2
Electric power, gas and water utilities	202.4	11.7	178.6	203.3	2,390.9	3,095.8	400.1	226.2	693.0	881.3	40.6	8,323.9
Goods-producing industries	1,479.4	248.2	2,006.9	1,732.6	23,224.2	39,909.1	3,513.1	5,048.6	18,831.0	12,092.6	681.3	108,742.2

[1] Industry, coverage same as in Table 9.
x confidential; .. not available; - nil.

TABLE 14. CANADA, GROSS DOMESTIC PRODUCT FOR MINING BY PROVINCE[1], 1974-1980

	Newfoundland	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Yukon and Northwest Territories	Canada
						($ million)						
1974	151.0	0.1	65.1	74.6	581.1	1,453.8	246.7	404.7	2,817.8	631.0	153.3	6,567.4
1975	212.3	-	63.5	66.9	503.2	1,128.9	170.3	445.3	3,474.6	613.2	104.8	6,771.7
1976	309.6	-	80.5	59.2	677.7	1,261.1	207.5	504.5	3,860.6	849.1	68.0	7,865.9
1977	346.6	-	113.4	65.6	737.1	1,203.1	125.4	660.5	4,804.2	866.9	155.2	9,064.6
1978	230.7	-	103.9	113.2	708.3	1,217.0	184.9	861.4	5,245.9	924.5	215.2	9,794.3
1979	459.2	-	111.1	206.4	1,175.2	1,519.9	426.4	1,045.3	7,120.6	1,507.3	262.2	13,921.7
1980	410.3	-	120.0	88.6	1,123.6	2,806.1	522.6	1,333.0	9,641.6	1,464.3	368.0	17,851.2

[1] Industry coverage same as in Table 9.

TABLE 15. CANADA, VALUE OF EXPORTS OF CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS, 1976-1982

	1976	1977	1978	1979	1980	1981	1982P
				($ million)			
Ferrous							
Crude material	984.4	1,114.9	854.5	1,469.5	1,342.9	1,540.0	1,098.6
Fabricated material	1,007.4	1,242.9	1,696.0	1,947.6	2,358.0	2,664.9	2,299.2
Total	1,991.8	2,357.9	2,550.6	3,417.1	3,701.1	4,205.0	3,397.8
Nonferrous							
Crude material	1,528.0	1,614.9	1,549.2	2,425.1	2,866.6	2,544.0	2,088.8
Fabricated material	2,231.3	2,578.4	3,360.9	3,807.1	6,273.8	5,615.6	4,987.5
Total	3,759.3	4,193.4	4,910.1	6,232.1	9,140.4	8,159.6	7,076.3
Nonmetals							
Crude material	1,103.4	1,276.1	1,369.7	1,715.3	2,305.0	2,618.7	2,168.7
Fabricated material	194.7	253.6	377.2	455.9	412.5	439.7	409.6
Total	1,298.1	1,529.6	1,746.8	2,171.2	2,717.5	3,058.3	2,578.3
Mineral fuels							
Crude material	4,464.0	4,428.9	4,514.9	6,128.9	7,816.8	8,022.0	8,752.4
Fabricated material	562.0	649.1	1,022.7	1,885.3	2,324.2	2,642.0	1,989.0
Total	5,026.0	5,078.0	5,537.6	8,014.2	10,141.0	10,664.0	10,741.4
Total minerals and products							
Crude material	8,079.8	8,434.9	8,288.2	11,738.8	14,331.4	14,724.6	14,108.5
Fabricated material	3,995.5	4,724.1	6,456.8	8,095.8	11,368.7	11,362.3	9,685.2
Total	12,075.3	13,158.9	14,745.0	19,834.7	25,700.1	26,086.9	23,793.8

P Preliminary.

TABLE 16. CANADA, VALUE OF IMPORTS OF CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS, 1976-1982

	1976	1977	1978	1979	1980	1981	1982P
				($ million)			
Ferrous							
Crude material	129.8	106.0	223.8	322.1	354.2	373.2	227.5
Fabricated material	1,274.0	1,501.0	1,838.3	2,533.9	2,329.0	3,303.2	2,115.1
Total	1,403.8	1,607.0	2,062.1	2,856.0	2,683.2	3,676.4	2,342.6
Nonferrous							
Crude material	294.6	409.0	480.9	808.1	1,778.3	1,509.4	1,263.1
Fabricated material	600.4	662.1	949.1	2,122.7	2,784.6	2,433.4	1,862.4
Total	895.0	1,071.1	1,430.0	2,930.8	4,562.9	3,942.8	3,125.5
Nonmetals							
Crude material	157.9	170.6	231.0	284.5	329.3	339.3	282.2
Fabricated material	413.5	472.0	526.8	644.7	724.2	805.3	671.9
Total	571.4	642.6	757.8	929.2	1,053.5	1,144.6	954.1
Mineral fuels							
Crude material	3,834.1	3,876.4	4,092.8	5,364.3	7,732.3	8 696.9	5,906.3
Fabricated material	219.7	299.7	344.8	394.0	687.7	881.3	863.6
Total	4,053.8	4,176.1	4,437.6	5,758.3	8,420.0	9,578.2	6,769.9
Total minerals and products							
Crude material	4,416.4	4,562.0	5,028.6	6,779.0	10,194.1	10,918.7	7,679.0
Fabricated material	2,507.6	2,934.8	3,659.0	5,695.3	6,525.4	7,423.3	5,513.1
Total	6,924.0	7,496.8	8,687.6	12,474.3	16,719.5	18,342.0	13,192.1

P Preliminary.

TABLE 17. CANADA, VALUE OF EXPORTS OF CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS IN RELATION TO TOTAL EXPORT TRADE, 1972, 1977, 1982

	1972		1977		1982P	
	$ million	%	$ million	%	$ million	%
Crude material	3,282.3	16.7	8,434.9	19.3	14,108.5	16.7
Fabricated material	2,217.5	11.3	4,724.1	10.8	9,685.2	11.5
Total	5,499.8	28.0	13,158.9	30.1	23,793.7	28.2
Total exports, all products	19,670.8	100.0	43,683.9	100.0	84,402.8	100.0

P Preliminary.

TABLE 18. CANADA, VALUE OF IMPORTS OF CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS IN RELATION TO TOTAL EXPORT TRADE, 1972, 1977, 1982

	1972		1977		1982P	
	$ million	%	$ million	%	$ million	%
Crude material	1,178.1	6.3	4,562.0	10.8	7,679.0	11.4
Fabricated material	1,602.0	8.6	2,934.8	6.9	5,513.1	8.2
Total	2,780.1	14.9	7,496.8	17.7	13,192.1	19.5
Total imports, all products	18,669.4	100.0	42,332.3	100.0	67,629.7	100.0

P Preliminary.

TABLE 19. CANADA, VALUE OF EXPORTS OF CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS, BY MAIN GROUPS AND DESTINATION, 1982P

	U.S.A.	United Kingdom	E.F.T.A.[1]	E.E.C.[2]	Japan	Other countries	Total
				($ million)			
Ferrous materials and products	2,047.6	204.0	27.4	488.6	109.0	521.3	3,397.8
Nonferrous materials and products	4,125.8	457.1	256.4	704.0	696.8	836.2	7,076.3
Nonmetallic mineral materials and products	1,081.0	46.7	27.9	249.8	128.4	1,044.7	2,578.3
Mineral fuels, materials and products	9,442.9	35.3	51.5	94.1	845.9	271.6	10,741.4
Total	16,697.3	743.2	363.1	1,536.4	1,780.0	2,673.8	23,793.8
Percentage of total mineral exports	70.2	3.1	1.5	6.5	7.5	11.2	100.0

[1] European Free Trade Association includes Austria, Norway, Portugal, Sweden, Switzerland, Finland and Iceland. [2] European Economic Community includes Belgium-Luxembourg, France, Italy, Netherlands, West Germany, Greece, Denmark and Ireland.
P Preliminary.

TABLE 20. CANADA, VALUE OF IMPORTS OF CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS, BY MAIN GROUPS AND DESTINATION, 1982P

	U.S.A.	United Kingdom	E.F.T.A.[1]	E.E.C.[2]	Japan	Other countries	Total
				($ million)			
Ferrous materials and products	1,500.1	127.5	55.9	227.2	258.0	173.9	2,342.6
Nonferrous materials and products	2,087.8	86.1	137.0	131.7	62.5	620.5	3,125.5
Nonmetallic mineral materials and products	666.8	14.4	9.4	136.7	46.0	80.8	954.1
Mineral fuels, materials and products	2,499.4	344.0	-	55.1	0.1	3,871.2	6,769.9
Total	6,754.1	572.1	202.2	550.6	366.6	4,746.4	13,192.1
Percentage of total mineral imports	51.2	4.3	1.5	4.2	2.8	36.0	100.0

[1] European Free Trade Association includes Austria, Norway, Portugal, Sweden, Switzerland, Finland and Iceland. [2] European Economic Community includes Belgium-Luxembourg, France, Italy, Netherlands, West Germany, Greece, Denmark and Ireland.
P Preliminary.

TABLE 21. CANADA, VALUE OF EXPORTS OF CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS, BY COMMODITY AND DESTINATION, 1982P

	United States	United Kingdom	E.F.T.A.[1]	E.E.C.[2]	Japan	Other Countries	Total
				($ 000)			
Aluminum	851,241	6,539	12,826	25,215	216,347	394,297	1,506,465
Asbestos	99,804	29,062	11,992	115,129	44,039	218,441	518,467
Copper	303,923	136,110	42,537	148,053	242,716	61,916	935,255
Fuels	9,442,910	35,306	51,510	94,131	845,915	271,609	10,741,381
Iron Ore	470,072	160,968	4,627	345,237	76,268	41,436	1,098,608
Lead	45,279	23,827	2,651	38,332	11,445	17,377	138,911
Molybdenum	31,341	21,215	1,678	115,491	53,492	14,901	238,118
Nickel	380,698	76,895	160,777	104,437	32,918	57,697	813,422
Primary ferrous metals	107,644	854	1	52,497	25,820	41,246	228,062
Uranium	346,891	11,690	-	-	-	-	358,581
Zinc	279,281	67,716	8,720	190,945	33,231	144,709	724,602
All other minerals	4,338,205	172,976	65,798	306,949	197,822	1,410,144	6,491,894
Total	16,697,289	743,158	363,117	1,536,416	1,780,013	2,673,773	23,793,766

[1] European Free Trade Association includes Austria, Norway, Portugal, Sweden, Switzerland, Finland and Iceland. [2] European Economic Community includes Belgium-Luxembourg, France, Italy, Netherlands, West Germany, Greece, Denmark and Ireland.
P Preliminary; - Nil.

TABLE 22. CANADA, PHYSICAL VOLUME OF IMPORT TRADE FOR SELECTED COMMODITIES, 1976-1982

	Units of Weight	1976	1977	1978	1979	1980	1981	1982P
Crude materials								
Metals								
Alumina	tonnes	908 055	821 596	1 056 190	952 584	983 972	1 020 550	939 282
Bauxite ore	tonnes	1 230 052	2 764 286	2 434 435	2 149 636	3 504 368	2 702 282	2 574 762
Iron ore	tonnes	3 020 130	2 505 203	4 685 868	5 912 581	5 875 292	5 794 634	3 356 580
Manganese ore	tonnes	118 972	57 644	136 446	45 150	95 161	119 746	71 658
Nonmetals								
Bentonite	tonnes	274 095	358 724	353 790	638 307	471 684	311 459	238 081
Clay, ground & unground	tonnes	355 760	334 431	381 486	445 231	403 282	413 040	345 389
Fluorspar	tonnes	137 310	124 494	170 237	167 904	223 940	173 599	126 954
Limestone, crushed	tonnes	3 513 824	2 922 684	2 873 601	3 215 717	2 418 330	2 526 808	1 485 420
Phosphate rock	tonnes	2 241 086	2 439 021	3 043 899	3 341 039	3 816 514	3 245 446	2 511 708
Salt & Brine	tonnes	1 523 407	1 126 225	1 330 474	1 275 627	1 151 203	1 254 992	1 526 852
Sand & Gravel	tonnes	2 085 922	1 645 663	1 810 989	1 201 915	1 209 582	1 446 872	1 179 279
Silica sand	tonnes	1 337 139	1 101 186	1 242 444	1 651 890	1 200 237	1 142 880	788 764
Fuels								
Coal	tonnes	14 371 622	15 026 358	13 000 320	17 381 794	15 719 025	14 687 279	15 488 032
Petroleum, crude	$metres^3$	44 027 841	38 042 718	36 754 037	35 330 535	32 710 030	30 154 730	19 621 900
Fabricated materials								
Metals								
Aluminum & Aluminum alloy	tonnes	115 870	118 216	119 154	168 125	128 061	139 377	134 962
Ferroalloys	tonnes	95 272	93 672	101 160	167 232	118 516	117 907	64 635
Steel:								
bars & rods	tonnes	307 057	301 502	318 336	300 069	189 853	341 532	219 231
castings & forgings	tonnes	123 609	113 365	116 473	139 095	129 363	118 475	70 159
pipes & tubes	tonnes	169 916	203 238	317 031	285 144	322 121	364 803	249 672
sheets & strips	tonnes	466 172	552 606	704 502	1 039 054	582 233	1 717 433	542 110
structural shapes	tonnes	231 619	225 869	151 502	273 111	207 657	363 406	105 539
Non-metals								
Cement	tonnes	329 045	263 528	256 721	248 422	223 247	721 205	232 834
Fire bricks	tonnes	189 599	242 720	156 002	227 156	236 205	187 017	132 603
Phosphate fertilizers	tonnes	168 482	200 445	286 744	381 887	248 328	306 502	249 833
Fuels								
Coke	tonnes	876 943	1 267 895	1 527 342	1 366 182	1 311 698	1 436 037	1 064 531
Fuel oil	thousand litres	1 137 041	1 260 034	1 277 077	871 425	1 617 606	1 256 795	1 571 003

P Preliminary.

TABLE 23. CANADA, PHYSICAL VOLUME OF EXPORT TRADE FOR SELECTED COMMODITIES, 1976-82

	Unit of Weight	1976	1977	1978	1979	1980	1981	1982P
Crude material								
Metals								
Copper, ores & concentrates	tonnes	294 823	279 582	282 159	315 211	286 076	276 810	252 756
Iron, ores	tonnes	44 684 868	45 060 391	31 929 094	48 849 270	39 020 922	41 452 044	27 281 254
Lead, ores & concentrates	tonnes	140 933	137 820	142 693	151 485	147 008	146 090	106 743
Zinc, ores & concentrates	tonnes	653 737	598 451	688 186	598 279	435 831	516 210	457 759
Nonmetals								
Asbestos, crude & fibers	tonnes	1 502 435	1 415 482	1 398 081	1 461 042	1 217 737	1 062 189	875 505
Crude refractory materials	tonnes	820 645	747 938	1 081 684	1 023 734	803 892	629 770	40 840
Gypsum	tonnes	3 798 243	4 994 323	5 178 631	5 474 764	4 960 240	5 094 873	4 775 755
Limestone, crushed	tonnes	1 287 976	1 502 492	1 710 348	2 296 295	2 214 489	1 758 299	1 517 490
Nepheline syenite	tonnes	418 975	443 763	420 961	471 056	448 468	476 281	414 785
Salt and Brine	tonnes	1 423 847	1 163 163	1 608 582	1 822 120	1 655 768	1 507 710	1 718 102
Sand and Gravel	tonnes	377 677	273 745	269 216	323 639	383 533	318 635	168 690
Sulphur, crude	tonnes	3 719 992	4 291 032	4 984 545	5 154 831	6 850 143	7 309 216	6 111 411
Fuels								
Coal	tonnes	11 761 930	12 068 905	13 657 514	13 852 848	14 310 782	16 285 102	15 528 461
Natural gas	thousand metres[3]	27 015 710	28 141 415	24 992 242	28 047 648	22 963 134	21 687 359	22 074 591
Fabricated materials								
Metals								
Aluminum, pig ingots	tonnes	510 751	655 353	863 320	551 957	784 720	725 441	896 378
Copper, refinery shapes	tonnes	322 991	294 490	247 727	191 211	335 200	262 642	232 623
Iron, pig ingots	tonnes	281 577	505 277	544 716	255 523	562 351	466 360	485 616
Lead, pig ingots	tonnes	114 421	130 819	131 950	117 992	126 538	119 815	146 132
Zinc, pig ingots	tonnes	352 071	295 358	439 260	429 352	471 949	453 526	470 397
Nonmetals								
Cement	tonnes	921 031	1 274 652	1 634 582	2 288 822	1 550 562	1 578 659	1 752 141
Lime, quick & hydrated	tonnes	309 355	359 540	478 551	490 863	403 166	432 845	281 137
Peat	tonnes	296 258	303 414	312 903	358 267	390 457	326 826	356 030
Fuels								
Butane gas, liquified	thousand litres	2 712 650	2 432 188	2 208 682	2 926 459	2 563 406	3 137 545	3 572 545
Coke	tonnes	321 636	355 919	352 358	354 016	470 496	391 027	234 690
Fuel Oil	thousand litres	439 222	388 080	972 282	913 271	706 539	600 969	498 154
Gasoline	thousand litres	2 092 266	1 456 991	4 232 409	4 654 162	4 273 510	3 846 907	2 665 774
Propane gas, liquified	thousand litres	4 048 280	5 019 524	3 543 782	4 858 175	3 879 915	3 867 950	4 513 307

P Preliminary.

TABLE 24. CANADA, APPARENT CONSUMPTION[1] OF SOME MINERALS, AND RELATION TO PRODUCTION[2], 1980-82

		1980			1981			1982P		
	Unit of Measure	Apparent Consumption	Production	Consumption as % of production	Apparent Consumption	Production	Consumption as % of production	Apparent Consumption	Production	Consumption as % of production
Asbestos	t	106 472	1 323 053	8.0	60 590	1 121 845	5.4	53 600	822 000	6.5
Cement	t	9 884 463	11 211 778	88.2	9 294 745	10 152 199	91.6	6 560 000	8 080 000	81.2
Gypsum	t	2 530 695	7 336 218	34.5	2 074 045	7 025 418	29.5	1 044 000	5 726 000	18.2
Iron ore	t	15 922 485	49 068 115	32.4	13 893 389	49 550 799	28.0	10 574 000	34 496 000	30.7
Lime		1 678 379	2 040 644	82.2	2 145 087	2 554 788	84.0	1 936 000	2 201 000	88.0
Quartz silica	t	3 003 599	2 251 831	133.4	3 262 119	2 238 333	145.7	2 334 000	1 610 000	145.0
Salt	t	6 918 289	7 422 854	93.2	6 986 743	7 239 461	96.5	7 885 000	8 076 000	97.6

[1] "Apparent consumption" is production, plus imports, less exports. [2] "Production" refers to producers' shipments.
P Preliminary.

TABLE 25. CANADA, REPORTED CONSUMPTION OF MINERALS AND RELATION TO PRODUCTION, 1979-81

	Unit of Measure	1979 Consumption	1979 Production	1979 Consumption as % of production	1980 Consumption	1980 Production	1980 Consumption as % of production	1981p Consumption	1981p Production	1981p Consumption as % of production
Metals										
Aluminum	t	398 834r	860 287	46.4	329 400	1 068 197	30.8	336 989	1 115 691	30.2
Antimony	kg	463 423	..	..	336 105	..	..	209 829	..	..
Bismuth	kg	25 117	136 733	18.4	10 271	149 566	6.9	10 094	167 885	6.0
Cadmium	kg	48 746	209 459	4.0	61 011	1 033 097	5.9	34 092	833 788	4.1
Chromium (chromite)	t	27 205	-	..	27 900	-	..	24 771	-	..
Cobalt	kg	114 606	1 639 624	7.0	105 225	2 118 154	5.0	101 334	2 080 395	4.9
Copper[1]	t	210 689	636 383	33.1	195 124	716 363	27.2	216 759	691 327	31.4
Lead[2]	t	126 464	310 745	40.7	130 988	251 627	52.1	137 245	268 556	51.1
Magnesium	t	4 450	9 015	49.4	5 412	9 252	58.5	6 094	..	..
Manganese ore	t	61 643	-	..	157 680	-	..	288 908	-	..
Mercury	kg	26 249	-	..	36 326	-	..	35 635	-	..
Molybdenum (Mo content)	t	1 250	11 175	11.2	1 055	11 889	8.9	1 315	12 850	10.2
Nickel	t	8 336	126 482	6.6	9 676	184 802	5.2	9 440	160 247	5.9
Selenium	kg	15 773	217 759	7.2	10 795	279 626	3.9	9 414	255 369	3.7
Silver	kg	251 985	1 146 908	22.0	265 938	1 069 635	24.9	292 130	1 129 394	25.9
Tellurium	kg	..	42 433	..	..	15 011	..	..	31 145	..
Tin	t	4 675	338	1 383.1	4 517	243	1 858.8	3 766	239	1 575.7
Tungsten (W content)	kg	380 229	3 254 067	11.7	290 479	4 006 647	7.2	293 910	2 515 165	11.7
Zinc	t	131 317	1 099 926	11.9	116 618	883 697	13.2	113 061	911 178	12.4
Nonmetals										
Barite	t	96 315r	73 512	131.0	138 829	94 317	147.2	94 027	78 154	120.3
Feldspar	t	4 588	-	..	4 051	-	..	4 606	-	..
Fluorspar	t	107 004	-	..	65 492	-	..	135 378	-	..
Mica	kg	2 208	-	..	2 576	-	..	2 259	-	..
Nepheline syenite	t	86 788	605 699	14.3	84 873	599 699	14.2	97 734	587 565	16.6
Phosphate rock	t	2 139 420r	-	..	3 546 636	-	..	3 582 686	-	..
Potash (K_2O)	t	..	7 074 388	..	..	7 201 217	..	..	6 548 701	..
Sodium sulphate	t	255 059	443 279	57.5	223 222	480 666	46.4	216 913	535 214	40.5
Sulphur	t	976 730	6 314 144	15.5	808 618	7 655 723	10.6	1 001 991	8 017 885	12.5
Talc, etc.	t	46 940	90 330	52.0	42 217	91 848	46.0	38 984	82 715	47.1
Fuels										
Coal	000t	34 764	33 200	104.7	37 333	36 688	101.8	38 367	40 088	95.7
Natural gas[3]	million m^3	43 506	94 426	46.0	43 255	87 108	49.7	42 886	73 824	58.1
Crude oil[4]	000 m^3	112 659	86 910	129.6	109 802	83 477	131.5	100 777	74 553	135.2

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.

[1] Consumption defined as producers domestic shipments of refined metal. [2] Consumption includes primary and secondary refined metal. [3] Consumption defined as domestic sales. [4] Consumption defined as refinery receipts.

p Preliminary; - Nil; .. Not available or not applicable; r Revised.

TABLE 26. CANADA, DOMESTIC CONSUMPTION OF PRINCIPAL REFINED METALS IN RELATION TO REFINERY PRODUCTION[1], 1975-81

	Unit of measure	1975	1976	1977	1978	1979	1980	1981P
Copper								
Domestic consumption[2]	tonnes	185 194	206 205	200 372	228 694	210 689	195 124	216 759
Production	tonnes	529 199	510 469	508 767	446 278	397 263	505 238	476 655
Consumption of production	%	35.0	40.4	39.4	51.2	53.0	38.6	45.5
Zinc								
Domestic consumption[3]	tonnes	98 280	98 897	105 412	121 375	131 317	116 618	113 061
Production	tonnes	426 902	472 316	494 938	495 243	580 449	591 565	618 650
Consumption of production	%	23.0	20.9	21.3	24.5	22.6	19.7	18.3
Lead								
Domestic consumption[3]	tonnes	89 192	107 654	106 962	100 762	126 464	130 988	137 245
Production	tonnes	171 517	175 720	187 457	194 054	183 769	162 463	168 450
Consumption of production	%	52.0	61.3	57.1	51.9	68.8	80.6	81.5
Aluminum								
Domestic consumption[4]	tonnes	293 280	332 206	322 393	380 291	398 834	329 400	336 989
Production	tonnes	878 056	628 049	973 524	1 048 469	860 287	1 068 197	1 115 691
Consumption of production	%	33.4	51.3	34.1	36.3	46.4	30.8	30.2

[1] Production of refined metal from all sources, including metal derived from secondary materials at primary refineries. [2] Producers' domestic shipments of refined metal. [3] Consumption of primary and secondary refined metal, reported by consumers. [4] Consumption of primary refined metal, reported by consumers.
P Preliminary.

TABLE 27A. AVERAGE ANNUAL PRICES[1] OF SELECTED MINERALS, 1976-1982[2]

	Unit of measure	1976	1977	1978	1979	1980	1981	1982
Aluminum, major U.S. producer[3]	cents/lb	44.341	51.339	53.075	59.395	69.566	57.274	44.966
Antimony, New York dealer	Cdn $/st	1.561	1.237	1.145	1.407	1.508	1.355	1.072
Asbestos, No. 4 cement fibre	$/lb	492.000	551.000	642.000	687.000	769.000	850.000	876.000
Bismuth, U.S. producer	$/lb	7.500	6.010	3.378	3.011	2.637	2.044	2.300
Cadmium, U.S. producer	$/lb	2.662	2.962	2.450	2.760	2.843	1.927	1.113
Calcium, metal crowns	$/lb	1.335	1.482	1.680	1.868	2.502	2.831	3.050
Chrome, U.S. metal, 9% carbon	$/lb	2.640	2.900	3.080	3.375	4.017	4.450	4.450
Cobalt metal, shot/cathode/250 kg	$/lb	4.508	5.633	12.246	24.583	25.000	21.429[7]	12.500
Columbium, pyrochlore	$/lb	n	n	2.550	2.550	2.550	3.250	3.250
Copper, electrolytic cathode	Cdn $/lb	0.684	0.695	0.746	1.076	1.178	1.004	0.885
Gold, London[4]	Cdn $/troy oz	123.107	157.089	220.407	359.289	716.087	551.178	465.102
Iridium, major producer	Cdn cents/lb	316.667	300.000	300.000	258.333	505.833	600.000	600.000
Iron ore, taconite pellets	cents/ltu	51.012	55.300	57.108	63.966	69.562	80.073	80.500
Lead, producer	Cdn cents/lb	22.650	31.420	36.820	59.920	49.350	44.520	32.887
Maganese, U.S. metal, regular	cents/lb	55.333	58.000	58.000	58.333	65.267	70.000	86.274
Magnesium, U.S. primary ingot	cents/lb	89.537	97.487	100.500	105.758	116.667	130.250	134.000
Mercury, New York	$/flask (76 lb)	121.302	135.710	153.322	281.096	389.447	413.885	370.934
Molybdenum, climax concentrate	$/lb	2.999	3.730	4.644	7.762	9.768	8.493	9.740
Nickel, major producer cathode	$/lb	2.256	2.360	2.091	2.707	3.415	3.429	3.200
Osmium, major producer	$/troy oz	200.000	170.000	150.000	150.000	150.000	150.000	139.167
Palladium, major producer	$/troy oz	50.928	59.702	70.873	113.143	213.975	129.500	110.000
Platinum, major producer	$/troy oz	161.729	162.544	237.250	351.649	439.425	475.000	475.000
Potash, K_2O, coarse major producer	cents/lb	74.667	76.000	80.583	100.417	112.667	120.750	119.615
Rhodium, major producer	$/troy oz	350.000	441.667	516.667	737.500	764.583	639.583	600.000
Ruthenium, major producer	$/troy oz	60.000	60.000	60.000	45.000	45.000	45.000	45.000
Selenium, major producer commercial	$/lb	18.000	17.000	15.000	12.250	9.654	..	..
Silver, fob Toronto	Cdn $/troy oz	4.298	4.920	6.171	12.974	24.099	12.617	9.831
Sulphur, elemental, major producer[5]	Cdn $/lt	17.204	15.678	17.913	25.665	30.740	59.323	66.923
Tantalum, Tanco	$/lb	16.000	17.750	26.479	60.014	97.604	100.830	48.958
Tellurium, major producer, slab	$/lb	10.500	17.416	20.000	20.000	19.500	..	..
Tin	Cdn $/lb	3.822	5.779	7.265	8.898	10.008	8.893	8.144
Titanium, ilmenite ore	$/lt	55.000	55.000	53.229	51.083	55.000	68.021	70.000
Tungsten, U.S. hydrogen red	$/lb	10.087	14.065	13.900	13.900	13.900	13.900	13.350
Uranium, U_3O_8[6]	Cdn $/lb	40.388	42.311	48.081	50.004	51.927	42.311	44.234
Vanadium, pentoxide metal	$/lb	2.600	2.750	2.900	3.050	3.050	3.250	3.350
Zinc, special high grade	Cdn cents/lb	37.620	35.530	34.757	43.717	44.050	54.240	48.667

[1] Prices except for noted, are in United States currency. [2] Sources for prices include: Alberta Energy Resource Industries Monthly Statistics, Asbestos, Engineering and Mining Journal, Metals Week and Northern Miner. [3] Starting 1981, London Metal Exchange. [4] Average afternoon fixings of London bullion dealers, converted to Canadian dollar. [5] Starting 1980, North American deliveries. [6] From EMR publications on assessment of Canada's uranium supply and demand series EP 76-3 to EP 82-3. [7] Seven month average.

.. Not available; n Nominal.

TABLE 27B. CANADIAN AVERAGE ANNUAL PRICES OF SELECTED MINERALS, 1976-1982[1]

	Unit of measure	1976	1977	1978	1979	1980	1981	1982
Aluminum, major U.S. producer[2]	$/kg	0.964	1.204	1.334	1.534	1.793	1.514	1.223
Antimony, New York dealer	$/kg	3.394	2.900	2.879	3.634	3.887	3.582	2.917
Asbestos, No. 4 cement fibre	$/mt	542.337	607.373	707.684	757.288	847.677	936.964	965.625
Bismuth, U.S. producer	$/kg	16.305	14.091	8.495	7.777	6.796	5.403	6.258
Cadmium, U.S. producer	$/kg	5.787	6.945	6.161	7.128	7.327	5.094	3.028
Calcium, metal crowns	$/kg	2.902	3.475	4.225	4.825	6.448	7.483	8.298
Chrome, U.S. metal, 9% carbon	$/kg	5.739	6.799	7.745	8.717	10.353	11.763	12.107
Cobalt metal, shot/cathode/250 kg	$/kg	9.800	13.207	30.795	63.492	64.430	56.610[6]	34.009
Columbium, pyrochlore	$/kg	n	n	6.413	6.586	6.572	8.591	8.842
Copper, electrolytic cathode	$/kg	1.508	1.532	1.645	2.372	2.597	2.213	1.951
Gold, London[3]	$/gm	3.958	5.051	7.086	11.551	23.023	17.721	14.953
Iridium, major producer	$/gm	10.040	10.258	11.002	9.730	19.011	23.129	23.806
Iron Ore, taconite pellets	$/kg	49.508	57.883	64.086	73.754	80.034	94.490	97.776
Lead, producer	¢/kg	49.935	69.269	81.174	132.101	108.798	98.150	72.503
Manganese, U.S. metal, regular	$/kg	1.203	1.360	1.459	1.507	1.682	1.850	2.347
Magnesium, U.S. primary ingot	$/kg	1.947	2.286	2.527	2.731	3.007	3.443	3.646
Mercury, New York	$/kg	3.470	3.316	5.073	9.553	13.206	14.395	13.279
Molybdenum, climax concentrate	$/kg	6.520	8.745	11.678	20.047	25.174	22.450	26.500
Nickel, major producer cathode	$/kg	4.905	5.533	5.258	6.992	8.801	9.064	8.706
Osmium, major producer	$/gm	6.341	5.813	5.501	5.650	5.638	5.782	5.522
Palladium, major producer	$/gm	1.615	2.041	2.599	4.262	8.042	4.992	4.364
Platinum, major producer	$/gm	5.127	5.558	8.701	13.245	16.515	18.310	18.847
Potash, K_2O, coarse major producer	$/kg	1.623	1.782	2.026	2.594	2.904	3.192	3.254
Rhodium, major producer	$/gm	11.096	15.102	18.948	27.778	28.736	24.655	23.806
Ruthenium, major producer	$/gm	1.902	2.052	2.200	1.695	1.691	1.735	1.765
Selenium, major producer commercial	$/kg	39.132	39.858	37.721	31.639	24.880	..	..
Silver, fob Toronto	$/kg	138.184	158.182	198.402	417.124	774.801	405.646	316.074
Sulphur, elemental, major producer[4]	$/mt	16.932	15.430	17.630	25.260	30.255	58.386	65.866
Tantalum, Tanco	$/kg	34.784	41.617	66.587	155.002	251.545	266.524	133.201
Tellurium, major producer, slab	$/kg	22.827	40.834	50.294	51.655	50.255	..	..
Tin	$/kg	8.426	12.740	16.017	19.617	22.064	19.606	17.954
Titanium, ilmenite ore	$/mt	55.106	59.431	61.691	60.805	65.327	82.865	87.773
Uranium, U[5]	$/kg	105.000	110.000	125.000	130.000	135.000	110.000	115.000
Vanadium, pentoxide metal	$/kg	5.652	6.448	7.293	7.877	7.861	8.591	9.114
Zinc, special high grade	$/kg	0.829	0.783	0.766	0.964	0.971	1.196	1.073

[1] Sources for prices include: Alberta Energy Resource Industries Monthly Statistics, Asbestos, Engineering and Mining Journal, Metals Week and Northern Miner. [2] Starting 1981, London Metal Exchange. [3] Average afternoon fixings of London bullion dealers, converted to Canadian dollar. [4] Starting 1980, North American deliveries. [5] From EMR publications on assessment of Canada's uranium supply and demand series EP 76-3 to EP 82-3. [6] Seven month average.

.. Not available; n Nominal.

TABLE 28. CANADA, MINERAL PRODUCTS INDUSTRIES, SELLING PRICE INDEXES, 1976-82 (1971 = 100)

	1976	1977	1978	1979	1980	1981	1982P
Iron and steel products industries							
Agricultural implements industry	165.7	177.6	188.7	206.0	224.9	260.2	293.1
Hardware, tool and cutlery manufacturers	147.3	162.6	179.1	207.3	238.4	268.2	296.0
Heating equipment manufacturers	146.9	156.5	169.8	188.0	213.2	236.5	267.7
Primary metal industries	169.9	190.5	207.7	258.8	308.3	312.6	310.7
Iron and steel mills	177.2	187.9	203.9	233.7	261.7	290.3	314.2
Steel pipe and tube mills	179.1	197.8	218.0	248.1	276.9	322.1	362.6
Iron foundries	181.0	189.6	200.1	223.3	243.2	261.8	268.9
Wire and wire products manufacturers	171.0	175.4	185.8	206.4	226.9	242.4	249.6
Nonferrous metal products industries							
Aluminum rolling, casting and extruding	155.8	173.6	191.5	234.0	271.0	292.6	290.9
Copper and alloy, rolling, casting and extruding	138.4	144.5	153.0	201.8	219.7	205.8	193.0
Jewellery and silverware manufacturers	235.2	277.8	337.6	507.3	871.3	676.1	609.5
Metal rolling, casting and extruding, nes	181.0	216.3	239.8	310.4	327.3	325.7	314.0
Nonmetallic mineral products industries							
Abrasives manufacturers	167.5	194.7	223.6	255.3	290.6	325.1	361.8
Cement manufacturers	171.1	186.7	207.5	233.2	265.7	308.0	359.7
Clay products and manufacturers from imported clay	161.7	164.7	173.7	190.1	215.2	251.9	278.0
Glass and glass products manufacturers	138.6	150.4	162.1	173.4	197.0	223.2	250.2
Lime manufacturers	204.3	228.7	252.9	292.7	338.3	396.1	453.2
Concrete products manufacturers	161.5	173.7	187.7	200.1	222.5	259.4	296.7
Clay products from domestic clay	169.6	182.8	196.4	214.3	226.9	243.0	269.9
Petroleum and coal products industries	210.2	244.5	275.4	321.3	404.6	551.7	634.4
Petroleum refineries	211.5	246.7	278.7	325.8	410.6	559.8	643.7
Mixed fertilizers	176.9	180.2	191.0	229.0	280.3	289.5	294.5

P Preliminary; nes Not elsewhere specified.

TABLE 29. CANADA, PRINCIPAL STATISTICS OF THE MINING INDUSTRY[1], 1981

	Mining Activity								Total Activity[2]		
		Production and Related Workers			Costs						
	Establishments (number)	Employees (number)	Man-hours paid (000)	Wages ($000)	Fuel and Electricity ($000)	Materials and Supplies ($000)	Value of Production ($000)	Value Added ($000)	Employees (number)	Salaries and Wages ($000)	Value Added ($000)
Metals											
Gold quartz	33	5,600	11,510	136,782	27,168	146,172	693,404	520,064	6,809	169,138	518,994
Silver-lead-zinc	25	5,506	11,489	148,251	57,264	578,140	1,015,523	380,119	7,740	218,931	380,286
Nickel-copper-gold-silver	41	24,604	48,999	589,157	174,941	1,658,519	3,811,812	1,978,352	33,246	847,020	2,077,927
Iron	14	7,865	16,297	226,619	189,606	567,279	1,832,266	1,075,381	12,397	374,429	1,036,019
Uranium	8	4,764	9,825	133,822	40,687	191,540	1,092,068	859,841	6,869	197,737	865,847
Misc. metal mines	7	1,247	2,511	30,916	13,629	50,180	212,799	148,990	1,651	43,412	150,181
Total	128	49,586	100,631	1,265,547	503,295	3,191,830	8,657,872	4,962,747	68,712	1,850,667	4,959,254
Nonmetals											
Asbestos	9	5,395	11,112	132,795	57,203	108,361	597,711	432,147	6,829	172,879	431,493
Gypsum	10	594	1,336	10,000	3,726	14,151	49,483	31,606	711	12,577	31,316
Peat	57	1,188	2,380	17,379	3,332	14,761	65,012	46,920	1,441	22,187	47,511
Potash	10	3,378	6,826	84,590	72,734	92,931	1,054,560	888,894	4,661	123,816	889,746
Salt	9	946	2,031	21,123	12,340	22,538	133,525	98,647	1,439	33,125	98,237
Sand and gravel	106	1,215	2,636	23,577	11,701	26,730	134,332	95,902	1,765	36,147	98,329
Stone	113	1,894	4,181	40,659	18,406	56,785	194,750	119,559	2,418	52,353	122,515
Misc. nonmetals	30	1,056	2,318	22,180	19,023	23,476	115,101	72,602	1,310	28,070	72,790
Total	344	15,666	32,820	352,302	198,466	359,730	2,344,474	1,786,275	20,574	481,154	1,791,937
Fuels											
Coal	27	9,188	19,348	237,161	68,024	302,664	1,044,462	673,774	11,182	300,261	671,148
Oil, crude and natural gas	862	6,696	14,509	198,750	118,769	412,410	16,413,222	15,881,979	28,783	807,863	15,924,652
Total	889	15,884	33,857	435,911	186,793	715,074	17,457,684	16,555,753	39,965	1,108,124	16,595,800
Total mining industry	1,361	81,136	167,308	2,053,761	888,554	4,266,634	28,460,030	23,304,775	129,251	3,439,945	23,346,991

[1] Cement manufacturing, lime manufacturers, clay and clay products (domestic clays) are included in the mineral manufacturing industry. Industry coverage is the same as in Tables 31, 33, 35 and 37. [2] Total activity includes sales and head offices.

TABLE 30. CANADA, PRINCIPAL STATISTICS OF THE MINERAL MANUFACTURING INDUSTRIES[1], 1981

	Mineral Manufacturing Activity									Total Activity[2]		
		Production and related workers			Costs							
	Establishments	Employees	Man-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)
Primary metal industries												
Iron and steel mills	53	42,819	89,321	1,004,543	426,522	3,888,624	6,996,870	2,736,895		56,543	1,407,299	2,750,934
Steel pipe and tube mills	33	6,346	13,211	141,370	25,046	952,723	1,322,940	374,825		7,531	174,560	378,256
Iron foundries	110	6,830	14,123	128,131	27,242	241,252	517,671	265,418		8,358	166,705	265,969
Smelting and refining	33	25,093	51,469	629,311	365,045	1,419,410	3,287,270	1,738,567		38,011	1,002,650	1 808,939
Aluminum rolling, casting and extruding	75	4,699	10,123	95,882	24,539	831,529	1,148,123	293,204		6,512	144,624	292,835
Copper and alloy rolling, casting and extruding	41	2,472	5,112	50,528	11,099	448,470	595,726	131,998		3,031	64,748	129,260
Metal rolling, casting and extruding, nes	94	4,078	8,292	70,254	15,867	357,074	580,881	205,674		5,182	98,223	210,370
Total	439	92,337	191,651	2,120,019	895,360	8,139,082	14,449,481	5,746,581		125,168	3,058,809	5,836,563
Nonmetallic mineral products industries												
Cement manufacturers	27	2,997	6,428	80,143	154,346	140,340	695,872	410,680		4,726	126,677	421,404
Lime manufacturers	15	728	1,581	16,748	48,557	20,654	131,274	62,824		968	22,818	62,793
Concrete products manufacturers	475	6,791	13,889	134,439	20,819	259,839	643,135	371,247		9,121	191,281	378,461
Ready-mix concrete manufacturers	527	7,698	16,031	173,640	41,845	639,566	1,085,326	402,313		10,053	226,960	430,145
Clay products manufacturers (domestic)	84	1,725	3,634	30,935	21,045	26,466	123,526	81,879		2,238	44,048	82,022
Clay products manufacturers (imported)	47	1,554	3,081	24,660	4,735	29,721	85,124	49,288		1,907	31,990	50,897
Refractories manufacturers	17	865	1,694	15,953	5,462	73,680	132,088	51,374		1,489	32,627	54,497
Stone products manufacturers	133	1,224	2,284	18,743	1,410	26,115	68,089	41,123		1,410	22,411	40,899
Glass manufacturers	14	6,412	13,775	130,125	58,370	170,617	587,644	368,519		8,476	179,415	364,562
Glass products manufacturers	111	2,925	5,976	51,416	7,265	127,693	269,107	138,335		3,527	66,660	140,996
Abrasive manufacturers	26	1,897	3,833	35,194	25,489	108,527	277,655	93,445		2,571	51,595	95,905
Other nonmetallic mineral products industries	98	5,329	11,027	106,570	57,781	310,882	720,447	357,898		8,783	191,973	387,951
Total	1,574	40,145	83,233	818,566	447,124	1,934,100	4,769,287	2,428,925		55,269	1,188,455	2,510,532
Petroleum and coal products industries												4
Petroleum refining industry	40	7 566	17 101	231 701	212 303	17 801 168	19 957 989	2 621 924		21 325	657 519	2 6~~9~~1 497
Manufacture of lubricating oils & greases	20	444	923	8 578	1 750	155 020	185 738	30 324		705	15 263	35 041
Other petroleum & coal products industries	51	422	873	8 920	3 916	95 768	132 734	34 252		584	12 847	39 304
Total	111	8 432	18 897	249 199	217 969	18 051 956	20 276 461	2 686 500		22 614	685 629	2 715 842
Total, mineral manufacturing industries	2 124	140 914	293 781	3 187 784	1 560 453	28 125 138	39 495 229	10 862 006		203 051	4 932 893	11 062 937

1 Industry coverage is the same as in Tables 32, 34, 36 and 38. 2 Includes sales and head offices.
nes Not elsewhere specified.

TABLE 31. CANADA, PRINCIPAL STATISTICS OF THE MINERAL INDUSTRY[1] BY REGION, 1981

		Mines, Quarries and Oil Well Activity							Total Activity[2]		
		Production and Related Workers			Costs						
	Establish-ments (number)	Employees (number)	Man-hours paid (000)	Wages ($000)	Fuel and Electri-city ($000)	Materials and Supplies ($000)	Value of Production ($000)	Value Added ($000)	Employees (number)	Salaries and Wages ($000)	Value Added ($000)
Atlantic[3]	112	11,384	23,705	267,585	128,362	622,696	1,617,359	866,236	13,472	332,841	866,694
Quebec	190	15,230	32,499	382,295	175,403	596,415	2,019,829	1,248,010	22,295	582,745	1,235,458
Ontario	160	23,023	46,058	532,185	138,095	1,238,321	3,563,800	2,187,383	31,499	779,678	2,199,902
Prairies	622	17,690	35,707	449,608	260,679	822,446	18,236,161	17,153,035	42,897	1,149,845	17,197,853
British Columbia[4]	208	10,897	22,959	309,334	148,616	725,179	2,499,455	1,625,658	14,893	441,047	1,627,948
Yukon and Northwest Territories[5]	69	2,912	6,380	112,753	37,396	261,578	523,427	224,453	4,195	153,788	219,135
Canada	1,361	81,136	167,308	2,053,761	888,554	4,266,634	28,460,030	23,304,775	129,251	3,439,945	23,346,991

[1]Cement manufacturing, lime manufacturing, clay and clay products are included in the mineral manufacturing industry. Industry coverage is the same as in Tables 29, 33, 35 and 37. [2]Total activity includes sales and head offices. [3]Includes eastern Canada offshore. [4]Includes western Canada offshore. [5]Includes Arctic Islands and offshore.

TABLE 32. STATISTICS OF THE MINERAL MANUFACTURING INDUSTRY[1] BY REGION; 1981

	Mineral Manufacturing Activity								Total Activity[2]		
		Production and Related Workers			Costs						
	Establish-ments	Employees	Man-hours paid	Wages	Fuel and Electri-city	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	136	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Quebec	530	31,775	66,122	738,299	472,955	7,197,068	10,041,898	2,791,274	48,097	1,168,962	2,826,658
Ontario	842	72,911	160,972	1,691,904	754,008	11,618,427	17,800,348	5,700,945	110,612	2,661,846	5,733,343
Prairie Provinces	373	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
British Columbia	241	11,233	22,993	300,377	74,555	2,385,977	3,248,875	928,914	16,386	450,550	1,027,151
Yukon and Northwest Territories	2	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Canada	2,124	140,914	293,781	3,187,784	1,560,453	28,125,138	39,495,229	10,862,006	203,051	4,932,893	11,062,937

[1]Industry coverage same as in Tables 30, 34, 36 and 38. [2]Includes sales and head offices. [3]Confidential, included in Canadian total.

TABLE 33. CANADA, PRINCIPAL STATISTICS OF THE MINING INDUSTRY[1], 1975-1981

		Mineral Manufacturing Activity								Total Activity[2]		
		Production and Related Workers			Costs							
	Establishments	Employees	Man-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)
1975	1,345	77,091	159,431	1,030,009	319,496	2,214,191	12,240,016	9,706,329	115,715	1,655,278	9,750,032
1976	1,244	78,989	163,426	1,185,184	401,899	2,438,672	14,178,010	11,337,439	117,694	1,902,682	11,360,511
1977	1,232r	79,902	167,884	1,342,508	473,202	2,715,468	16,400,460	13,211,792	119,061r	2,137,523	13,246,689
1978	1,179	70,306	150,291	1,275,008	501,335	2,766,072	18,201,459	14,934,052	109,948	2,118,342	15,016,214
1979	1,150	72,580	152,560	1,493,773	600,448	3,252,991	23,546,742	19,693,303	115,245	2,492,715	19,899,635
1980	1,323	80,066	166,427	1,779,389	706,405	3,802,062	27,661,246	23,152,778	126,422	2,979,470	23,347,682
1981	1,361	81,136	167,308	2,053,761	888,554	4,266,634	28,460,030	23,304,775	129,251	3,439,945	23,346,991

[1] Cement manufacturing, lime manufacturers, clay and clay products (domestic clays) are included in the mineral manufacturing industries. Industry coverage is the same as in Tables 29, 31, 35 and 37. [2] Includes sales and head offices.
r Revised.

TABLE 34. CANADA, PRINCIPAL STATISTICS OF THE MINERAL MANUFACTURING INDUSTRIES[1], 1975-1981

	Mineral Manufacturing Activity								Total Activity[2]		
		Production and Related Workers			Costs						
	Establishments (number)	Employees (number)	Man-hours paid (000)	Wages ($000)	Fuel and electricity ($000)	Materials and supplies ($000)	Value of production ($000)	Value added ($000)	Employees (number)	Salaries and wages ($000)	Value added ($000)
1975	1,680	140,195	290,264	1,712,892	541,650	9,724,522	15,205,070	5,183,708	193,526	2,580,313	5,316,534
1976	1,662	137,310	284,392	1,898,753	655,828	10,798,653	16,793,147	5,548,868	188,751	2,820,873	5,687,750
1977	1,616	138,700	288,409	2,110,400	798,486	12,743,217	19,725,082	6,489,111	189,576	3,114,744	6,594,794
1978	2,022	143,917	297,554	2,365,782	981,506	15,700,614	24,036,539	7,272,298	198,085	3,494,336	7,421,897
1979	2,115	145,929	308,770	2,614,816	1,118,146	19,116,369	28,318,690	8,522,128	202,695	3,910,454	8,669,240
1980	2,143	146,606	308,312	2,927,363	1,272,902	22,045,572	32,177,335	9,417,966	204,872	4,386,065	9,599,868
1981	2,124	140,914	293,781	3,187,784	1,560,453	28,125,138	39,495,229	10,862,006	203,051	4,932,893	11,062,937

[1] Industry coverage is the same as in Tables 30, 32, 36 and 38. [2] Includes sales and head offices.

TABLE 35. CANADA, CONSUMPTION OF FUEL AND ELECTRICITY IN THE MINING INDUSTRY[1], 1981

	Unit	Metals	Nonmetals	Fuels	Total
Coal and coke	000 t	132	-	-	132
	$000	5,111	-	-	5,111
Gasoline	000 litres	27 332	21 814	9 157	58 303
	$000	8,962	7,050	2,816	18,828
Fuel oil, kerosene, diesel oil	000 litres	1 251 094	308 245	122 209	1 681 548
	$000	242,528	70,731	31,288	344,547
Liquefied petroleum gas	000 litres	98 884	6 721	4 217	109 822
	$000	16,696	1 431	806	18,933
Natural gas	000 m^3	175 817	802 579	157 000	1 135 396
	$000	18,994	62,957	12,081	94,032
Other fuels[2]	$000	1,686	-	-	1,686
Total value of fuels	$000	293,979	142,169	46,991	483,139
Electricity purchased	million kwh	10 494	2 100	3 740	16 334
	$000	209,316	56,297	139,802	405,415
Total value of fuels and electricity purchased, all reporting companies	$000	503,295	198,466	186,793	888,554

[1] Cement and lime manufacturing and manufacturers of clay products (domestic clays) are included under mineral manufacturing, Tables 36 and 38. Industry coverage is the same as in Tables 29, 31, 33 and 37. [2] Includes wood, manufactured gas, steam purchased and other miscellaneous fuels.
- Nil.
Note: Totals may not add due to rounding.

TABLE 36. CANADA, CONSUMPTION OF FUEL AND ELECTRICITY IN THE MINERAL MANUFACTURING INDUSTRIES[1], 1981

	Unit	Primary Metal Industries	Nonmetallic Mineral Products Industries	Petroleum and Coal Products Industries	Total
Coal and coke	000 t	335	576	-	911
	$000	37,266	30,449	-	67,715
Gasoline	000 litres	17 466	30 889	2 693	51 048
	$000	5,382	9,658	840	15,880
Fuel oil, kerosene, diesel oil	000 litres	1 207 588	539 645	11 140	1 758 373
	$000	195,911	99,267	2,417	297,595
Liquefied petroleum gas	000 litres	36 248	22 645	1 098	59 992
	$000	6,306	3,897	173	10,376
Natural gas	000 m^3	2 691 919	1 773 697	1 226 163	5 691 779
	$000	288,597	178,924	127,161	594,682
Other fuels	$000	4,714	10,866	6,873	22,453
Total value of fuels	$000	538,175	333,061	137,463	1,008,699
Electricity purchased	million kWh	20 429	4 573	3 669	28 671
	$000	357,186	114,062	80,517	551,765
Total value of fuels and electricity purchased, all reporting companies	$000	895,361	447,123	217,980	1,560,464

[1] Industry coverage is the same as in Tables 30, 32, 34 and 38.
- Nil.

TABLE 37. CANADA, COST OF FUEL AND ELECTRICITY USED IN THE MINING INDUSTRY[1], 1975-81

	Unit	1975	1976	1977	1978	1979	1980	1981
Metals								
Fuel	$000	107,808	128,637	148,578	153,608	193,828	220,052	293,979
Electricity purchased	million kWh	10 259	11 326	11 713	10 739	11 459	11 024	10 494
	$000	85,063	107,318	135,014	132,100	153,905	174,837	209,316
Total cost of fuel and electricity	$000	192,871	235,955	283,591	285,708	347,733	394,889	503,295
Nonmetals[2]								
Fuel	$000	46,561	62,453	72,946	79,090	92,499	112,672	142,169
Electricity purchased	million kWh	1 763	1 959	2 457	2 082	2 244	2 269	2 100
	$000	20,049	23,401	29,510	35,141	42,982	48,336	56,297
Total cost of fuel and electricity	$000	66,610	85,854	102,456	114,231	135,481	161,008	198,466
Fuels								
Fuels	$000	11,352	12,015	15,117	19,774	23,988	32,582	46,991
Electricity purchased	million kWh	2 539	2 770	2 791	2 699	3 238	3 504	3 740
	$000	48,663	68,075	72,035	81,624	98,783	117,927	139,802
Total cost of fuel and electricity	$000	60,015	80,090	87,152	101,398	122,771	150,509	186,793
Total mining industry								
Fuel	$000	165,721	203,105	236,642	252,470	310,315	365,306	483,139
Electricity purchased	million kWh	14 560	16 055	16 961	15 520	16 941	16 797	16 334
	$000	153,775	198,794	236,559	248,865	295,670	341,100	405,415
Total cost of fuel and electricity	$000	319,496	401,899	473,201	501,335	605,985	706,406	888,554

[1] Cement and lime manufacturing and manufacture of clay products (domestic clays) are included in mineral manufacturing, Tables 36 and 38. Industry coverage is the same as in Tables 29, 31, 33 and 35. [2] Includes structural materials.

TABLE 38. CANADA, COST OF FUEL AND ELECTRICITY USED IN THE MINERAL MANUFACTURING INDUSTRIES[1], 1975-81

	Unit	1975	1976	1977	1978	1979	1980	1981
Primary metals								
Fuel	$ 000	187,846	224,928	279,172	336,684	357,775	421,426	538,175
Electricity purchased	million kWh	16 544	16 497	15 352	17 257	18 451	20 535	20 429
	$ 000	129,750	151,011	183,574	226,313	260,317	316,884	357,186
Total cost of fuel and electricity	$ 000	317,596	375,939	462,746	562,997	618,092	738,317	895,361
Nonmetallic mineral products								
Fuel	$ 000	133,016	162,312	181,952	221,855	280,846	271,481	333,061
Electricity purchased	million kWh	3 723	4 137	4 190	4 782	5 163	4 633	4 573
	$ 000	41,258	52,113	65,553	79,606	98,296	102,765	114,062
Total cost of fuel and electricity	$ 000	174,274	214,425	247,507	301,461	379,142	374,248	447,123
Petroleum and coal products								
Fuel	$ 000	21,758	30,474	42,184	61,891	74,968	88,311	137,463
Electricity purchased	million kWh	2 904	3 010	3 205	3 505	3 555	3 705	3 669
	$ 000	28,028	34,988	46,050	55,303	63,395	72,186	80,517
Total cost of fuel and electricity	$ 000	49,786	65,462	88,233	117,194	138,363	160 498	217,980
Total mineral manufacturing industries								
Fuel	$ 000	342,620	417,714	503,308	620,430	713,589	781,218	1,008,699
Electricity purchased	million kWh	23 171	23 644	22 747	25 544	27 169	28 873	28 671
	$ 000	199,036	238,112	295,177	361,222	422,008	491,834	551,765
Total cost of fuel and electricity	$ 000	541,656	655,826	798,486	981,652	1,135,597	1,273,063	1,560,464

[1] Industry coverage is the same as in Tables 30, 32, 34 and 36.

TABLE 39. CANADA, EMPLOYMENT, SALARIES AND WAGES IN THE MINING INDUSTRY[1], 1975-81

	Unit	1975	1976	1977	1978	1979	1980	1981
Metals								
Production and related workers	Number	50,319	49,834	49,414	39,977	41,541	47,592	49,586
Salaries and wages	$000	685,562	759,499	849,345	757,258	879,383	1 091,848	1,265,547
Annual average salary and wage	$	13,624	15,241	17,188	18,942	21,169	22,942	25,522
Administrative and office workers	Number							
Salaries and wages	$000	18,842	18,435	17,831	16,470	17,419	18,526	19,126
Annual average salary and wage	$	320,873	352,847	377,714	358,680	428,639	504,316	585,120
		17,030	19,140	21,183	21,778	24,608	27,222	30,593
Total metals								
Employees	Number	69,161	68,269	67,245	56,447	58,960	66,118	68,712
Salaries and wages	$000	1,006,435	1,112,346	1,227,059	1 115,938	1,308,022	1,596,165	1,850,667
Annual average salary and wage	$	14,552	16,294	18,248	19,770	22,185	24,141	26,933
Nonmetals								
Production and related workers	Number	15,397	16,447	16,812	16,133	16,633	16,645	15,666
Salaries and wages	$000	188,956	237,982	266,294	274,037	321,303	343,004	352,302
Annual average salary and wage	$	12,272	14,470	15,840	16,986	19,317	20,607	22,488
Administrative and office workers	Number	4,688	4,887	4,986	4,749	4,829	4,795	4,908
Salaries and wages	$000	69,208	82,861	89,757	95,659	106,776	116,932	128,852
Annual average salary and wage	$	14,763	16,955	18,002	20,143	22,114	24,386	26,253
Total nonmetals								
Employees	Number	20,085	21,334	21,798	20,882	21,462	21,440	20,574
Salaries and wages	$000	258,164	320,843	356,051	369,696	428,079	459,936	481,154
Annual average salary and wage	$	12,854	15,039	16,334	17,704	19,946	21,452	23,387
Fuels								
Production and related workers	Number	11,375	12,708	13,679	14,196	14,406	15,829	15,884
Salaries and wages	$000	155,491	187,704	226,869	243,713	293,087	344,537	435,911
Annual average salary and wage	$	13,670	14,771	16,585	17,168	20,345	21,766	27,443
Administrative and office workers	Number							
Salaries and wages	$000	15,094	15,383	16,342	18,423	20,417	23,035	24,081
Annual average salary and wage	$	235,188	281,789	327,544	388,995	463,527	578,832	672,213
		15,582	18,318	20,043	21,115	22,703	25,128	27,915
Total fuels								
Employees	Number	26,469	28,091	30,021	32,619	34,823	38,864	39,965
Salaries and wages	$000	390,679	469,493	554,413	632,708	756,614	923,369	1,108,124
Average annual salary and wage	$	14,760	16,713	18,468	19,397	21,727	23,759	27,727
Total mining								
Production and related workers	Number	77,091	78,989	79,905	70,306	72,580	80,066	81,136
Salaries and wages	$000	1,030,009	1,185,184	1 342,508	1,275,008	1,493,773	1,779,389	2,053,761
Average annual salary and wage	$	13,361	15,004	16,801	18,135	20,581	22,224	25,313
Administrative and office workers	Number							
Salaries and wages	$000	38,624	38,705	39,159	39,642	42,665	46,356	48,115
Annual average salary and wage	$	625,269	717,498	795,015	843,335	998,942	1,200,081	1,386,184
		16,189	18,538	20,302	21,274	23,414	25,888	28,810
Total mining								
Employees	Number	115,715	117,694	119,064	109,948	115,245	126,422	129,251
Salaries and wages	$000	1,655,278	1,902,682	2,137,523	2,118,343	2,492,715	2,979,470	3,439,945
Annual average salary and wage	$	14,305	16,166	17,954	19,267	21,630	23,568	26,614

[1] Does not include cement and lime manufacturing and clay products (domestic clays) manufacturing. These industries are included in Table 38 under "Nonmetallic mineral products industries". See Table 29 for detail of industries.

TABLE 40. CANADA, EMPLOYMENT, SALARIES AND WAGES IN THE MINERAL MANUFACTURING INDUSTRIES, 1975-81

	Unit	1975	1976	1977	1978	1979	1980	1981
Primary metal industries								
Production and related workers	Number	90,169	88,939	91,683	93,798	95,942	97,530	92,337
Salaries and wages	$000	1,119,159	1,241,893	1,399,390	1,544,412	1,725,904	1,980,423	2,120,019
Annual average salary and wage	$	12,412	13,963	15,263	16,465	17,989	20,306	22,960
Administrative and office workers	Number	30,161	28,102	27,536	28,198	30,812	28,920	32 831
Salaries and wages	$000	493,764	511,236	545,957	597,544	713,279	787,022	938 790
Annual average salary and wage	$	16,371	18,192	19,827	21,191	23,149	27,214	28 595
Total primary metal industries								
Employees	Number	120,330	117,041	119,219	121,996	126,754	126,450	125,168
Salaries and wages	$000	1,612,923	1,753,128	1,945,347	2,140,956	2,432,183	2,767,445	3,058,809
Annual average salary and wage	$	13,404	14,979	16,317	17,549	19,188	21,886	24,438
Nonmetallic mineral products industries								
Production and related workers	Number	42,149	41,272	39,321	41,297	41,813	40,799	40,145
Salaries and wages	$000	471,466	529,264	564,444	638,152	710,622	743,254	818,566
Annual average salary and wage	$	11,186	12,824	14,355	15,452	16,995	18,217	20,390
Administrative and office workers	Number	13,783	13,749	13,187	14,439	14,935	15,287	15,124
Salaries and wages	$000	197,884	218,164	229,855	264,166	297,211	333,815	369,899
Annual average salary and wage	$	14,357	15,868	17,430	18,295	19,900	21,837	24,458
Total nonmetallic mineral products								
Employees	Number	55,932	55,021	52,508	55,736	56,748	56,086	55,269
Salaries and wages	$000	669,350	747,428	794,299	902,318	1,007,833	1,077,069	1,188,455
Annual average salary and wage	$	11,967	13,584	15,127	16,189	17,760	19,203	21,503
Petroleum and coal products industries								
Production and related workers	Number	7,877	7,099	7,696	8,822	8,174	8,277	8,432
Salaries and wages	$000	122,268	127,594	146,566	183,218	185,290	203,686	249,199
Annual average salary and wage	$	15,522	17,974	19,044	20,768	22,668	24,609	29,554
Administrative and office workers	Number	9,387	9,590	10,153	11,531	11,019	11,769	14,182
Salaries and wages	$000	175,772	192,722	228,532	267,844	285,148	337,865	436,430
Annual average salary and wage	$	18,725	20,096	22,509	23,228	25,887	28,708	30,773
Total petroleum and coal products								
Employees	Number	17,264	16,689	17,849	20,353	19,193	20,046	22,614
Salaries and wages	$000	298,040	320,316	375,098	451,062	470,438	541,551	685,629
Annual average salary and wage	$	17,264	19,193	21,015	22,162	24,511	27,015	30,319
Total mineral manufacturing								
Production and related workers	Number	140,195	137,310	138,700	143,917	145,929	146,606	140,914
Salaries and wages	$000	1,712,892	1,898,751	2,110,400	2,365,782	2,621,816	2,927,363	3,187,784
Annual average salary and wage	$	12,218	13,828	15,216	16,439	17,966	19,968	22,622
Administrative and office workers	Number	53,331	51,441	50,876	54,168	56,766	55,976	62,137
Salaries and wages	$000	867,421	922,122	1,004,344	1,129,554	1,295,638	1,458,702	1,745,109
Annual average salary and wage	$	16,269	17,926	19,741	20,853	22,824	26,059	28,085
Total mineral manufacturing industries								
Employees	Number	193,526	188,751	189,576	198,085	202,695	202,582	203,051
Salaries and wages	$000	2,580,313	2,820,872	3,114,744	3,494,336	3,910,454	4,386,065	4,932,893
Annual average salary and wage	$	13,333	14,945	16,430	17,641	19,292	21,651	24,294

Note: See footnote, Table 35. See Table 30 for detail of industries covered.

TABLE 41. CANADA, NUMBER OF WAGE EARNERS EMPLOYED IN THE MINING INDUSTRY, (SURFACE, UNDERGROUND AND MILL), 1975-81

	1975	1976	1977	1978	1979	1980	1981
Metals							
Surface	16,230	16,143	16,115	12,901	12,664	14,347	14,043
Underground	20,555	20,043	19,482	15,682	15,906	19,308	19,784
Mill	13,534	13,648	13,817	11,394	12,971	13,937	15,759
Total	50,319	49,834	49,414	39,977	41,541	47,592	49,586
Nonmetals							
Surface	7,180	7,264	7,166	6,660	6,877	6,510	6,015
Underground	1,870	2,180	2,245	2,275	2,370	2,550	2,606
Mill	6,347	7,003	7,401	7,198	7,386	7,585	7,045
Total	15,397	16,447	16,812	16,133	16,633	16,645	15,666
Fuels							
Surface	8,789	9,705	10,510	11,045	11,535	12,929	12,958
Underground	2,586	3,003	3,169	3,151	2,871	2,900	2,926
Total	11,375	12,708	13,679	14,196	14,406	15,829	15,884
Total mining industry							
Surface	32,200	33,112	33,791	30,606	31,076	33,786	33,016
Underground	25,010	25,226	24,896	21,108	21,147	24,758	25,316
Mill	19,881	20,651	21,218	18,592	20,357	21,522	22,804
Total	77,091	78,989	79,905	70,306	72,580	80,066	81,136

TABLE 42. CANADA, MINE AND MILL WORKERS BY SEX, 1981

	Mine Workers				Mill Workers		Total	
	Underground		Surface					
	Male	Female	Male	Female	Male	Female	Male	Female
Metallic minerals								
Gold-quartz	3,116	-	1,185	48	1,224	27	5,525	75
Silver-lead-zinc	2,285	1	1,487	59	1,614	60	5,386	120
Nickel-copper-gold-silver	11,524	10	6,712	152	5,927	279	24,163	441
Iron Ore	292	3	2,341	119	4,852	258	7,485	380
Uranium	2,341	9	1,399	47	861	107	4,601	163
Miscellaneous metal mines	203	-	469	25	502	48	1,174	73
Total	19,761	23	13,593	450	14,980	779	48,334	1,252
Industrial minerals								
Asbestos	408	-	1,683	6	3,193	105	5,284	111
Gypsum	116	-	429	-	49	-	594	-
Peat	-	-	670	20	488	10	1,158	30
Potash	1,656	20	80	1	1,583	38	3,319	59
Salt	356	-	153	-	414	23	923	23
Sand and gravel	-	-	1,161	12	41	1	1,202	13
Stone	6	-	1,586	9	291	2	1,883	11
Miscellaneous nonmetals	44	-	203	2	798	9	1,045	11
Total	2,586	20	5,965	50	6,857	188	15,408	258
Mining Total	22,347	43	19,558	500	21,837	967	63,742	1,510

TABLE 43. CANADA, LABOUR COSTS IN RELATION TO TONNES MINED, METAL MINES, 1979-81

Type of metal mine	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)		($)
1979						
Gold-quartz	4,155	75,979	18,286	5 478	1 318	13.87
Nickel-copper-gold-silver	18,135	369,494	20,375	109 437	6 035	3.38
Silver-lead-zinc	5,087	103,783	20,402	15 078	2 964	6.88
Iron ore	8,911	221,216	24,825	130 799	14 678	1.69
Uranium	4,320	87,902	20,348	6 141	1 422	14.31
Miscellaneous metals	933	21,009	22,518	7 822	8 384	2.50
Total	41,541	879,383	21,169	274 755	6 614	3.20
1980						
Gold-quartz	4,781	103,293	21,605	6 346	1 327	16.28
Nickel-copper-gold-silver	23,447	510,380	21,767	121 399	5 178	4.20
Silver-lead-zinc	5,275	122,248	23,175	16 219	3 075	7.54
Iron ore	8,264	216,280	26,171	123 107	14 897	1.76
Uranium	4,463	107,209	24,022	7 152	1 603	14.99
Miscellaneous metals	1,362	32,438	23,816	15 871	11 653	2.04
Total	47,592	1,091,848	22,942	290 095	6 095	3.76
1981						
Gold-quartz	5,600	136,782	24,425	6 810	1 216	20.09
Nickel-copper-gold-silver	24,604	589,157	23,946	137 710	5 597	4.28
Silver-lead-zinc	5,506	148,251	26,925	15 964	2 899	9.29
Iron ore	7,865	226,619	28,814	118 579	15 077	1.91
Uranium	4,764	133,822	28,090	7 454	1 565	17.95
Miscellaneous metals	1,247	30,916	24,792	15 014	12 040	2.06
Total	49,586	1,265,547	25,522	301 530	6 081	4.20

TABLE 44. CANADA, PERSON-HOURS PAID, PRODUCTION AND RELATED WORKERS, TONNES OF ORE MINED AND ROCK QUARRIED, METAL MINES AND NONMETALLIC MINERAL OPERATIONS, 1975-81

	Unit	1975	1976	1977	1978	1979	1980	1981
Metal mines[1]								
Ore mined	million tonnes	264.2	296.5	299.5	248.1	274.8	290.1	301.5
Person-hours paid[2]	million	102.4	100.6	101.2	84.9	85.1	97.5	100.6
Person-hours paid per tonne mine	number	0.39	0.34	0.34	0.34	0.31	0.34	0.33
Tonnes mined per person-hour paid	tonnes	2.58	2.95	2.96	2.92	3.23	2.98	3.00
Nonmetallic mineral operations[3]								
Ore mined and rock quarried	million tonnes	155.1	162.0	200.2	200.4	192.1	185.0	164.8
Person-hours paid[2]	million	23.4	26.9	27.7	26.3	27.8	26.5	23.5
Person-hours paid per tonne mine	number	0.15	0.17	0.14	0.13	0.14	0.14	0.14
Tonnes mined per person-hour paid	tonnes	6.63	6.02	7.23	7.62	6.91	6.98	7.01

[1] Excludes placer mining. [2] Man-hours paid for production and related workers only. [3] Includes asbestos, potash, gypsum and stone.

TABLE 45. CANADA, AVERAGE WEEKLY WAGES AND HOURS WORKED, HOURLY-RATED EMPLOYEES IN MINING, MANUFACTURING AND CONSTRUCTION INDUSTRIES, 1976-82

	1976	1977	1978	1979r	1980r	1981	1982p
Mining							
Average hours per week	40.3	40.6	40.5	41.1	40.8	40.4	39.6
Average weekly wage ($)	298.44	329.45	354.51	396.58	440.61	494.62	551.68
Metals							
Average hours per week	39.6	39.8	39.4	40.4	40.1	40.2	39.0
Average weekly wage ($)	296.21	325.75	344.94	387.14	425.08	485.03	535.92
Mineral fuels							
Average hours per week	40.6	41.3	41.0	40.8	41.2	41.3	42.1
Average weekly wage ($)	309.24	333.51	367.34	410.38	476.30	553.71	631.91
Nonmetals							
Average hours per week	40.5	40.3	40.5	40.3	39.5	38.7	37.2
Average weekly wage ($)	273.56	301.92	326.23	366.03	402.98	445.02	479.44
Manufacturing							
Average hours per week	38.7	38.7	38.8	38.8	38.5	38.5	37.7
Average weekly wage ($)	222.79	246.63	265.06	287.82	314.80	352.08	384.79
Construction							
Average hours per week	38.9	38.7	39.0	39.4	39.0	38.9	38.1
Average weekly wage ($)	330.95	378.50	400.58	433.51	470.45	531.54	564.33

Note: Wages reflect seasonally adjusted figures.
p Preliminary; r Revised.

TABLE 46. CANADA, AVERAGE WEEKLY WAGES OF HOURLY-RATED EMPLOYEES IN THE MINING INDUSTRY, IN CURRENT AND 1971 DOLLARS, 1976-82

	1976	1977	1978	1979	1980	1981	1982p
Current dollars							
All mining	298.44	329.45	354.51	396.58	440.61	494.62	551.68
Metals	296.21	325.75	344.94	387.14	425.08	485.03	535.92
Mineral fuels	309.24	333.51	367.34	414.96	476.30	553.11	631.91
Coal	274.00	303.53	323.49	362.20	430.16	485.03	562.12
Nonmetals except fuel	273.56	301.92	326.23	330.47	402.98	445.02	479.44
1971 dollars							
All mining	200.43	204.88	202.35	207.42	209.22	208.79	210.16
Metals	198.93	202.58	196.88	202.48	226.16	244.74	204.16
Mineral fuels	207.68	207.41	209.67	217.03	220.82	233.48	240.73
Coal	184.02	188.76	184.64	189.44	204.25	204.74	214.14
Industrial minerals	183.72	187.76	186.20	172.84	191.35	187.85	182.64

Note: Wages reflect seasonally adjusted figures.
p Preliminary.

TABLE 47. CANADA, INDUSTRIAL FATALITIES PER THOUSAND WORKERS, BY INDUSTRY GROUPS 1980-82[1]

	Fatalities (number)			Number of Workers (000)			Rate per 1,000 workers[2]		
	1980	1981	1982p	1980	1981	1982p	1980	1981	1982p
Agriculture	7	17	19	186.0	151.0	149.0	0.05	0.11	0.13
Forestry	76	60	65	68.2	65.6	54.3	1.11	0.91	1.20
Fishing	22	20	18	15.0	13.8	11.4	1.47	1.45	1.58
Mining	168	126	130	170.2	178.0	155.5	0.99	0.71	0.84
Manufacturing	140	146	147	1,851.2	1,883.9	1,709.2	0.08	0.08	0.09
Construction	182	174	129	455.4	475.1	409.7	0.40	0.37	0.31
Transportation	220	198	160	842.8	849.6	826.4	0.26	0.23	0.19
Trade	73	60	61	1,555.6	1,629.0	1,575.9	0.05	0.04	0.04
Finance	8	9	5	517.1	533.1	534.7	0.02	0.02	0.01
Service	86	83	69	2,766.5	2,932.4	2,965.9	0.03	0.03	0.02
Public administration	44	62	49	635.6	628.3	646.6	0.07	0.10	0.08
Unknown	15	5	7	..	..	..	..	..	..
Total	1,041	960	859	9,033.6	9,339.8	9,038.6	0.12	0.10	0.10

Note: See footnotes, Table 48.
[1] Includes fatalities resulting from occupational chest diseases such as silicosis, lung cancer, etc. [2] The rates may be understated because only 80 per cent of workers in the Statistics Canada employment estimates are covered by workers' compensation.
p Preliminary; .. Not available.

TABLE 48. CANADA, INDUSTRIAL FATALITIES PER THOUSAND WORKERS, BY INDUSTRY GROUPS, 1976-82

	1976	1977	1978	1979	1980	1981	1982P
Agriculture	0.13	0.11	0.05	0.10	0.05	0.11	0.13
Forestry	1.14	0.92	1.28	1.51	1.11	0.91	1.20
Fishing[1]	3.60	2.37	1.44	1.25	1.47	1.45	1.58
Mining[2]	1.18	0.92	0.82	0.93	0.99	0.71	0.84
Manufacturing	0.11	0.10	0.10	0.09	0.08	0.08	0.09
Construction	0.42	0.37	0.38	0.38	0.40	0.37	0.31
Transportation[3]	0.28	0.22	0.25	0.26	0.26	0.23	0.19
Trade	0.04	0.05	0.04	0.04	0.05	0.04	0.04
Finance[4]	0.02	0.02	0.01	0.01	0.02	0.02	0.01
Service[5]	0.03	0.03	0.02	0.03	0.03	0.03	0.02
Public administration	0.09	0.08	0.12	0.10	0.07	0.10	0.08
Total	0.13	0.11	0.12	0.12	0.12	0.10	0.10

1 Includes trapping, hunting. 2 Includes quarrying and oil wells. 3 Includes storage, communication, electric power and water utilities and highway maintenance. 4 Includes insurance and real estate. 5 Includes community, business and personal service.
P Preliminary.

TABLE 49. CANADA, INDUSTRIAL FATALITIES BY OCCUPATIONAL INJURIES AND ILLNESSES[1], 1980-82

	Occupational Injuries			Occupational Illnesses			Total		
	1980	1981	1982P	1980	1981	1982P	1980	1981	1982P
Agriculture	7	12	13	0	0	0	7	12	13
Forestry	66	49	54	1	0	0	67	49	54
Fishing	19	20	17	0	0	0	19	20	17
Mining	93	70	88	67	52	40	160	122	128
Manufacturing	88	83	90	30	40	35	118	123	125
Construction	146	149	100	10	6	9	156	155	109
Transportation	197	176	143	4	1	6	201	177	149
Trade	56	47	52	0	1	0	56	48	52
Finance	5	6	4	0	0	0	5	6	4
Service	68	64	49	1	3	1	69	67	50
Public administration	38	48	39	0	2	0	38	50	39
Unknown	12	1	0	2	0	0	14	1	0
Total	795	725	649	115	105	91	910	830	740

1 Excludes the Province of Québec for which data is unavailable.
P Preliminary.

TABLE 50. CANADA, NUMBER OF STRIKES AND LOCKOUTS BY INDUSTRIES, 1980-82

	1980			1981			1982		
	Strikes and lock-outs	Workers involved	Duration in person-days	Strikes and lock-outs	Workers involved	Duration in person-days	Strikes and lock-outs	Workers involved	Duration in person-days
Agriculture	1	30	900	3	65	7,750	3	64	7,320
Forestry	8	3,588	337,220	14	3,292	349,400	3	215	7,840
Fishing and trapping	2	16,082	395,870	1	400	330	0	0	0
Mines	33	21,400	418,270	42	24,359	580,720	8	12,686	257,140
Manufacturing	404	86,247	3,137,370	423	152,207	4 638,290	292	63,959	1,690,560
Construction	69	57,940	1,107,060	44	5,780	43,280	63	94,228	2,199,610
Transportation and utilities	106	27,329	729,070	101	58,135	1,513,970	67	24,005	565,740
Trade	109	7,855	218,550	90	4,886	149,170	72	4,465	171,180
Finance, insurance and real estate	20	1,238	47,710	18	3,480	294,760	15	746	49,620
Service	218	136,193	1,883,280	221	57,248	577,400	110	27,846	415,380
Public administration	58	83,123	700,090	90	17,696	717,420	43	36,088	251,030
Various industries	-	-	-	1	6,000	6,000	1	180,000	180,000
All industries	1,028	441,025	8,975,390	1,048	338,548	8,878,490	677	444,302	5,795,420

- Nil.

TABLE 51. CANADA, NUMBER OF STRIKES AND LOCKOUTS BY MINING AND MINERAL MANUFACTURING, 1980-82

	1980			1981			1982		
	Strikes and lock-outs	Workers involved	Duration in person-days	Strikes and lock-outs	Workers involved	Duration in person-days	Strikes and lock-outs	Workers involved	Duration in person-days
Mines	33	21 400	418 270	42	24 359	580 720	8	12 686	257 140
Metal	18	10 749	189 570	25	11 457	248 930	2	10 211	248 300
Mineral fuels	5	7 486	99 450	9	11 159	306 690	2	2 400	4 670
Nonmetals	7	3 039	121 750	5	1 674	16 130	-	-	-
Quarries	3	126	7 500	3	69	8 970	4	75	4 170
Mineral manufacturing	52	10 086	530 620	62	30 770	1 553 000	29	6 839	291 600
Primary metals	18	5 212	321 530	29	27 169	1 429 150	11	4 259	199 900
Nonmetallic mineral products	31	3 208	123 310	33	3 601	123 850	17	2 576	91 600
Petroleum and coal products	3	1 666	85 780	0	0	0	1	4	100

TABLE 52. CANADA, SOURCE OF ORES HOISTED OR REMOVED FROM SELECTED TYPES OF MINES, 1979-81

	1979			1980			1981		
Mines	Under-ground	Open Pit	Total	Under-ground	Open Pit	Total	Under-ground	Open Pit	Total
					(kilotonnes)				
Asbestos	2 151	29 371	31 522	1 997	26 106	28 103	1 789	23 874	25 664
Gold-quartz	5 144	334	5 478	5 193	1 153	6 346	5 835	975	6 810
Gypsum	754	7 556	8 310	1 062	6 549	7 611	685	5 535	6 220
Iron Ore	3 641	127 158	130 799	3 222	119 886	123 107	3 269	115 309	118 579
Nickel-copper-gold-silver	23 570	85 867	109 437	30 840	90 559	121 399	31 193	106 516	137 710
Silver-lead-zinc	8 692	6 386	15 078	9 822	6 397	16 219	9 943	6 021	15 964
Uranium	5 408	733	6 141	5 981	1 171	7 152	6 664	790	7 454
Miscellaneous metals	1 212	6 610	7 822	1 491	14 381	15 871	1 518	13 496	15 014
Total	50 572	264 015	314 587	59 608	266 201	325 809	60 896	272 516	333 415
Percentage	16.0	84.0	100.0	18.3	81.7	100.0	18.3	81.7	100.0

TABLE 53. CANADA, SOURCE OF MATERIAL HOISTED OR REMOVED FROM METAL MINES, 1981

	Underground		Open Pit		
	Ore	Waste	Ore	Waste	Overburden
	(kilotonnes)				
Gold-quartz	5 835	683	975	413	5 340
Nickel-copper-gold-silver	31 193	3 449	106 516	191 681	16 781
Silver-lead-zinc	9 943	621	6 021	38 184	6 607
Iron	3 269	135	115 309	43 604	19 562
Uranium	6 664	472	790	2 575	-
Miscellaneous metals	1 518	89	13 496	14 015	20
Total	58 423	5 448	243 108	290 471	48 309

- Nil.

TABLE 54. CANADA, ORE MINED AND ROCK QUARRIED IN THE MINING INDUSTRY, 1975-81

	1975	1976	1977	1978	1979	1980	1981
				(kilotonnes)			
Metals							
Gold-quartz	5 901	5 921	5 768	5 914	5 478	6 346	6 810
Silver-lead-zinc	16 169	14 309	16 730	15 859	15 078	16 219	15 964
Nickel-copper-gold-silver	120 921	125 062	129 361	109 613	109 437	121 399	137 709
Iron	101 482	133 073	127 057	96 323	130 799	123 107	118 579
Uranium	3 449	3 663	5 014	6 126	6 141	7 152	7 454
Miscellaneous metals	16 296	14 499	15 599	14 221	7 822	15 871	15 014
Total	264 218	296 527	299 528	248 056	274 755	290 095	301 530
Nonmetals							
Asbestos	22 186	31 055	31 912	28 788	31 522	28 103	25 664
Potash	21 713	20 277	24 813	24 856	25 511	26 988	30 344
Gypsum	5 578	5 978	7 216	8 393	8 310	7 611	6 220
Rock salt	3 627	5 080	4 974	5 050	5 639	5 321	4 927
Total	53 104	62 390	68 915	67 087	70 982	68 023	67 155
Structural materials	88 921	87 876	120 163	122 144	109 719	103 366	86 860
Stone, all kinds quarried[1]	13 654	13 350	12 614	13 051	13 982	14 138	14 047
Stone used to make cement	2 980	3 442	3 534	3 178	3 028	4 751	1 626
Stone used to make lime							
	105 555	104 668	136 310	138 373	126 729	122 255	102 533
Total							
	422 877	463 585	504 753	453 516	472 466	480 373	471 218
Total ore mined and rock quarried							

[1] Excludes stone used to manufacture cement and lime.

TABLE 55. CANADA, EXPLORATION AND CAPITAL EXPENDITURES IN THE MINING INDUSTRY[1], BY PROVINCES AND TERRITORIES, 1979-81

		Capital						Repair						
		Construction												
		On-property exploration	On-property development	Structures	Total	Machinery and equipment	Total capital	Construction	Machinery and equipment	Total repair	Total capital and repair	Outside or general exploration	Land and mining rights	Total all expenditures
		($ million)												
Atlantic provinces	1979	2.2	47.0	27.7	76.9	51.4	128.3	10.4	173.2	183.6	311.9	21.1	0.6	333.6
	1980	2.7	60.3	22.4	85.4	60.0	145.4	14.8	168.2	183.0	328.4	35.5	0.2	364.1
	1981P	6.3	63.5	80.7	150.4	115.4	265.8	11.0	185.2	196.2	462.1	50.8	1.5	514.4
Quebec	1979	7.5	109.6	40.0	157.1	72.9	230.0	25.2	200.1	225.3	455.3	39.5	1.3	496.1
	1980	15.6	151.6	81.3	248.5	98.8	347.3	45.4	281.8	327.2	674.5	58.5	9.2	742.2
	1981P	28.0	156.1	106.5	290.6	135.9	436.5	49.3	261.7	311.0	737.5	81.7	2.1	821.3
Ontario	1979	6.4	150.7	68.2	225.3	127.2	352.5	23.2	221.6	244.8	597.3	18.4	0.9	616.6
	1980	12.1	179.3	124.5	315.9	120.2	436.1	66.2	235.9	302.1	738.0	58.5	3.4	799.9
	1981P	17.9	206.2	148.8	372.9	177.2	550.1	70.6	281.7	352.3	902.4	79.5	6.4	988.3
Manitoba	1979	(2)	(2)	(2)	46.8	15.9	62.7	(2)	34.2	(2)	96.9	11.8	-	108.7
	1980	(2)	(2)	(2)	39.2	11.3	50.5	6.6	44.2	50.8	101.3	21.2	0.3	122.8
	1981P	8.3	27.3	13.5	49.1	34.0	83.1	5.1	44.2	49.3	132.4	20.6	0.3	153.3
Saskatchewan	1979	4.9	29.3	40.0	74.2	66.9	141.1	5.6	76.8	82.4	223.5	52.6	8.1	284.2
	1980	7.0	40.4	62.1	109.5	87.1	196.6	9.1	90.3	99.4	296.0	56.4	4.7	357.1
	1981P	20.2	39.0	101.6	160.8	175.7	336.5	11.5	120.5	132.0	468.5	45.4	8.1	522.0
Alberta	1979	(2)	(2)	(2)	19.3	40.7	60.0	(2)	38.7	(2)	98.7	8.5	1.2	108.4
	1980	(2)	(2)	(2)	34.5	41.8	76.3	1.2	57.5	58.7	135.0	14.2	(2)	(2)
	1981P	2.6	20.1	52.6	75.3	52.2	127.5	0.9	59.0	59.9	187.4	23.9	(2)	(2)
British Columbia	1979	17.8	95.1	115.6	228.5	85.8	314.3	10.7	178.0	188.7	503.0	48.3	1.5	552.8
	1980	31.1	154.1	302.6	487.8	233.3	721.1	21.8	232.5	254.3	975.4	91.0	3.7	1,070.1
	1981P	34.9	139.7	490.3	664.9	197.2	862.1	24.1	338.9	363.0	1,225.1	111.7	1.5	1,338.3
Yukon and Northwest Territories	1979	5.6	11.3	10.2	27.1	23.4	50.5	5.7	46.0	51.7	102.2	48.7	18.6	169.5
	1980	8.6	26.9	99.2	134.7	82.3	217.0	4.7	50.4	55.1	272.1	68.3	(2)	(2)
	1981P	16.3	43.4	155.3	215.0	106.5	321.5	5.4	57.4	62.8	384.3	78.2	(2)	(2)
Canada	1979	49.2	476.3	329.7	855.2	484.2	1,339.4	84.8	964.6	1,049.4	2,388.8	248.9	32.2	2,669.9
	1980	85.4	646.8	723.3	1,455.5	734.8	2,189.3	169.8	1,160.8	1,330.6	3,520.9	403.6	43.6	3,968.1
	1981P	134.5	695.3	1,149.3	1,979.1	994.1	2,973.2	177.9	1,348.6	1,526.5	4,499.7	491.8	29.8	5,021.3

[1] Excludes the crude oil and natural gas industries and the operating and refining industries; [2] Confidential, included in total.
[P] Preliminary; - Nil.

TABLE 56. CANADA, EXPLORATION AND CAPITAL EXPENDITURES[1] IN THE MINING INDUSTRY, BY TYPE OF MINING, 1979-1981

		Capital						Repair						
		Construction												
		On-property exploration	On-property development	Structures	Total	Machinery and equipment	Total capital	Construction	Machinery and equipment	Total repair	Total capital and repair	Outside or general exploration	Land and mining rights	Total, all expenditures
		($ million)												
Metal Mining														
Gold	1979	4.1	29.4	6.7	40.2	16.8	57.0	3.2	23.4	26.6	83.6	5.6	-	89.2
	1980	22.6	63.4	36.7	122.7	38.2	160.9	6.8	27.9	34.7	195.6	20.0	(2)	(2)
	1981P	21.7	111.8	179.7	313.2	96.3	409.5	13.9	44.7	58.6	468.1	40.1	2.7	510.9
Copper-gold-silver	1979	10.2	78.4	76.5	165.1	84.5	249.6	17.1	165.0	182.1	431.7	8.5	(2)	(2)
	1980	24.1	93.3	187.6	305.0	185.9	490.9	24.2	211.0	235.2	726.1	8.4	(2)	(2)
	1981P	28.2	91.2	157.1	276.5	161.6	438.1	29.7	292.2	321.9	760.0	13.5	0.6	774.7
Silver-lead-zinc	1979	8.1	20.3	25.8	54.2	33.4	87.6	5.2	43.8	49.0	136.6	6.2	18.5	161.3
	1980	9.4	35.4	97.1	141.9	86.1	228.0	7.0	61.4	68.4	296.4	10.7	(2)	307.1
	1981P	21.5	55.2	95.4	172.1	104.7	276.8	6.8	75.4	82.2	359.0	15.4	0.6	375.0
Iron	1979	(2)	81.4	15.4	96.8	40.3	137.1	27.5	268.4	295.9	433.0	(2)	-	(2)
	1980	(2)	(2)	26.3	123.9	44.1	167.0	39.2	298.0	337.2	505.2	(2)	-	(2)
	1981P	(2)	(2)	19.9	127.9	60.4	187.4	35.6	302.8	338.4	526.7	(2)	(2)	(2)
Other metal mining	1979	11.5	140.5	96.1	248.1	104.7	352.8	17.2	131.1	148.3	501.1	(2)	(2)	(2)
	1980	14.7	178.8	214.3	407.8	109.3	517.1	60.1	169.1	229.2	746.3	(2)	1.4	(2)
	1981P	37.3	198.6	204.0	439.9	149.1	589.0	65.8	184.8	250.6	839.6	(2)	(2)	(2)
Total metal mining	1979	(2)	383.9	220.5	604.4	279.7	884.1	70.2	631.7	701.9	1,586.0	29.8	19.7	1,635.5
	1980	(2)	(2)	562.0	1,101.3	463.6	1,564.9	137.3	767.4	894.7	2,469.6	54.4	4.4	2,528.4
	1981P	(2)	(2)	656.1	1,329.6	572.1	1,901.7	151.8	899.9	1,051.7	2,953.4	97.0	24.9	3,075.3
Nonmetal mining														
Asbestos	1979	0.5	49.7	19.0	69.2	29.7	98.9	5.6	93.8	99.4	198.3	0.4	(2)	(2)
	1980	0.7	56.4	8.0	65.1	23.1	88.2	7.4	106.0	113.4	201.6	(2)	(2)	(2)
	1981P	(2)	(2)	5.5	53.7	15.3	69.0	4.0	79.5	83.5	152.5	(2)	-	(2)
Other non-metal mining	1979	12.4	78.0	89.2	179.6	172.9	352.5	9.0	238.7	247.7	600.2	10.2	(2)	(2)
	1980	9.6	120.8	150.9	281.3	244.5	525.8	25.1	287.1	312.2	838.0	(2)	(2)	(2)
	1981P	21.3	85.4	487.4	594.1	402.4	996.5	22.0	368.3	388.3	1,386.8	(2)	12.6	(2)
Total non-metal mining	1979	12.9	127.7	108.2	248.8	202.6	451.4	14.6	232.5	247.1	798.5	10.6	10.0	819.1
	1980	10.3	177.2	158.9	346.4	267.6	614.0	32.5	393.1	425.6	1,039.6	18.4	9.4	1,067.4
	1981P	(2)	(2)	492.9	647.8	417.7	1,065.5	26.0	447.8	473.8	1,539.3	38.5	12.6	1,590.4
Metal and nonmetal exploration	1979	(2)	1.0	1.0	2.0	1.9	3.9	-	0.4	0.4	4.3	201.9	2.5	208.7
	1980	(2)	(2)	2.4	7.8	3.6	11.4	-	0.3	0.3	11.7	330.8	9.3	351.8
	1981P	(2)	(2)	0.3	1.7	4.3	6.0	0.1	0.9	1.0	7.0	356.3	12.8	376.1
Total mining	1979	49.2	476.3	329.7	855.2	484.2	1,339.4	84.8	964.6	1,049.4	2,388.8	248.9	32.2	2,669.9
	1980	85.4	646.8	723.3	1,455.5	734.8	2,185.3	169.8	1,160.8	1,330.6	3,520.9	403.6	43.6	3,968.1
	1981P	134.5	695.3	1,149.3	1,979.1	994.1	2,973.2	177.9	1,348.6	1,526.5	4,499.7	491.8	29.8	5,021.3

[1] Excludes expenditures in the petroleum and natural gas industries. (2) Confidential, included in total.
P Preliminary; - Nil.

TABLE 57. CANADA, DIAMOND DRILLING IN THE MINING INDUSTRY, BY MINING COMPANIES WITH OWN EQUIPMENT AND BY DRILLING CONTRACTORS, 1979-1981

		1979			1980			1981		
		Exploration	Other	Total	Exploration	Other	Total	Exploration	Other	Total
						(metres)				
Metal mining										
Gold-quartz	Own equipment	13 455	-	13 455	27 775	1 000	28 775	45 162	1 524	46 686
	Contractors	170 711	14 789	185 500	154 812	4 048	158 860	234 432	25 079	259 511
	Total	184 166	14 789	198 955	182 587	5 048	187 635	279 594	26 603	306 197
Nickel-copper-gold-silver	Own equipment	251 019	-	251 019	239 469	-	239 469	318 530	223	318 753
	Contractors	175 830	10 713	186 543	286 536	40 605	327 141	355 586	1 373	356 959
	Total	426 849	10 713	437 562	526 005	40 605	566 610	674 116	1 596	674 712
Silver-lead-zinc and silver-cobalt	Own equipment	18 609	4 090	22 699	42 161	19 545	61 706	68 716	199 151	267 867
	Contractors	106 569	1 764	108 333	198 171	-	198 171	207 126	3 761	210 887
	Total	125 178	5 854	131 032	240 332	19 545	259 877	275 842	202 912	478 754
Iron mines	Own equipment	-	-	-	38 424	-	38 424	-	-	-
	Contractors	28 266	-	28 266	30 007	27 474	57 481	15 817	-	15 817
	Total	28 266	-	28 266	68 431	27 474	95 905	15 817	-	15 817
Uranium	Own equipment	23 509	-	23 509	-	-	-	28 279	-	28 279
	Contractors	45 255	3 269	48 524	10 884	-	10 884	59 232	21 668	80 900
	Total	68 764	3 269	72 033	10 884	-	10 884	87 511	21 668	109 179
Miscellaneous metal mining	Own equipment	4 629	-	4 629	-	-	-	-	-	-
	Contractors	45 090	-	45 090	67 156	-	67 156	45 373	-	45 373
	Total	49 719	-	49 719	67 156	-	67 156	45 373	-	45 373
Total metal mining	Own equipment	311 221	4 090	315 311	347 829	20 545	368 374	460 687	200 898	661 585
	Contractors	571 721	30 535	602 256	747 566	72 127	819 093	917 566	51 881	969 447
	Total	882 942	34 625	917 567	1 095 395	92 672	1 188 067	1 378 253	252 779	1 631 032
Nonmetal mining										
Asbestos	Own equipment	-	-	-	-	-	-	-	-	-
	Contractors	20 238	-	20 238	28 790	-	28 790	10 814	-	10 814
	Total	20 238	-	20 238	28 790	-	28 790	10 814	-	10 814
Gypsum	Own equipment	1 779	-	1 779	1 314	-	1 314	-	-	-
	Contractors	4 177	-	4 177	4 463	-	4 463	1 841	-	1 841
	Total	5 956	-	5 956	5 777	-	5 777	1 841	-	1 841

Salt	Own equipment	2 632	-	2 632	-	-	-	1 552	-	1 552
	Contractors	-	-	-	-	-	-	-	-	-
	Total	2 632	-	2 632	-	-	-	1 552	-	1 552
Miscellaneous nonmetal mining	Own equipment	1 958	-	1 958	2 844	-	2 844	404	-	404
	Contractors	671	-	671	798	-	798	1 128	-	1 128
	Total	2 629	-	2 629	3 642	-	3 642	1 532	-	1 532
Total nonmetal mining	Own equipment	6 369	-	6 369	4 158	-	4 158	1 956	-	1 956
	Contractors	25 086	-	25 086	34 051	-	34 051	13 783	-	13 783
	Total	31 455	-	31 455	38 209	-	38 209	15 739	-	15 739
Total mining industry	Own equipment	317 590	4 090	321 680	351 987	20 545	372 532	462 648	200 898	663 541
	Contractors	596 807	30 535	627 342	781 617	72 127	853 744	931 349	51 881	983 230
	Total	914 397	34 625	949 022	1 133 604	92 672	1 226 276	1 393 992	252 779	1 641 771

- Nil.

TABLE 58. CANADA, ORE MINED AND ROCK QUARRIED IN THE MINING INDUSTRY, 1952-81

	Metals	Nonmetal[1]	Total
		(million tonnes)	
1952	47.4	40.0	87.4
1953	49.3	42.8	92.1
1954	53.5	55.7	109.2
1955	62.7	57.6	120.3
1956	70.2	66.2	136.4
1957	76.4	74.5	150.9
1958	71.4	71.2	142.6
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	262.1
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	274.8	162.6	437.3
1974	278.7	178.8	457.6
1975	264.2	158.7	422.9
1976	296.5	167.1	463.6
1977	299.5	205.2	504.8
1978	248.1	205.5	453.5
1979	274.8	197.7	472.5
1980	290.1	190.3	480.4
1981	301.5	169.7	471.2

[1] Includes nonmetallic mineral mining and all stone quarried, including stone used to make cement and lime. From 1973 onwards, coverage is the same as in Table 54.

TABLE 59. CANADA, TOTAL DIAMOND DRILLING, METAL DEPOSITS, 1952-81

	Gold-quartz deposits	Copper-gold-silver and nickel-copper deposits	Silver-lead-zinc and silver-cobalt deposits	Other metal bearing deposits[1]	Total metal deposits
			(metres)		
1952	808 245	1 187 024	456 146	56 032	2 507 447
1953	675 598	976 514	367 864	65 279	2 085 255
1954	737 266	826 288	271 873	199 097	2 034 524
1955	717 674	875 942	341 857	537 612	2 473 085
1956	682 600	1 490 298	399 679	383 431	2 956 008
1957	706 273	1 098 490	323 704	287 364	2 415 831
1958	546 861	923 026	297 792	286 970	2 054 649
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	503 741	1 128 091	255 101	221 079	2 199 452
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	1 826 727
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	227 065	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

[1] Includes iron, titanium, uranium, molybdenum and other metal deposits.

TABLE 60. CANADA, EXPLORATION DIAMOND DRILLING, METAL DEPOSITS, 1952-81

	Mining companies with own personnel and equipment	Diamond drill contractors	Total
		(metres)	
1952	416 467	951 104	1 367 571
1953	318 970	872 668	1 191 638
1954	295 613	1 109 844	1 405 457
1955	464 118	1 546 025	2 010 143
1956	474 562	1 644 735	2 119 297
1957	358 300	1 233 323	1 591 623
1958	237 133	1 200 625	1 437 758
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

See footnotes to Table 59.

TABLE 61. CANADA, DIAMOND DRILLING, OTHER THAN FOR EXPLORATION, METAL DEPOSITS, 1952-81

	Mining companies with own personnel and equipment	Diamond drill contractors	Total
		(metres)	
1952	..	..	1 139 876
1953	..	..	893 617
1954	..	..	629 067
1955	410 925	52 017	462 942
1956	790 522	46 188	836 710
1957	524 724	156 060	680 784
1958	444 376	172 516	616 892
1959	488 783	238 753	727 536
1960	450 246	308 860	759 105
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

The total footage drilled shown in Tables 60 and 61 equals the total footage drilled reported in Table 59. Nonproducing companies excluded since 1964.
.. Not available.

TABLE 62. CANADA, CRUDE MINERALS TRANSPORTED BY CANADIAN RAILWAYS, 1980-82

	1980	1981	1982
		(tonnes)	
Metallic minerals			
Alumina and bauxite	2 752	3 133	2 793
Copper ores and concentrates	1 546	1 624	1 507
Iron ores and concentrates	54 167	49 788	35 101
Iron pyrite	46	30	295
Lead ores and concentrates	515	511	545
Lead-zinc ores and concentrates	353	3	1
Manganese ores	7	8	5
Nickel-copper ores and concentrates	4 983	4 457	1 890
Nickel ores and concentrates	628	612	228
Tungsten ores and concentrates	2	2	4
Zinc ores an concentrates	1 442	1 630	1 638
Metallic ores and concentrates, nes	32	29	40
Total metallic minerals	66 473	61 827	44 047
Nonmetallic minerals			
Abrasives, natural	70	61	37
Asbestos	400	332	190
Barite	133	72	21
Clay	621	606	485
Gravel	13	7	4
Gypsum	4 652	4 767	3 591
Limestone, agricultural	72	61	42
Limestone, industrial	331	299	177
Limestone, nes	3 801	4 139	3 049
Nepheline syenite	340	340	274
Phosphate rock	2 912	2 572	1 665
Potash (KCl)	10 652	9 703	7 681
Refractory materials, nes	4	4	3
Salt, rock	1 015	909	1 078
Salt, nes	120	102	83
Sand, industrial	1 105	986	743
Sand, nes	13	11	10
Silica	33	16	12
Sodium carbonate	581	552	481
Sodium sulphate	547	600	623
Stone, building, rough	62	9	6
Stone, nes	236	185	87
Sulphur, liquid	1 750	1 905	1 518
Sulphur, nes	5 728	5 931	4 855
Nonmetallic minerals, nes	178	221	145
Total nonmetallic minerals	35 369	34 390	26 860
Mineral fuels			
Coal, anthracite	125	69	56
Coal, bituminous	22 177	23 054	23 293
Coal, lignite	486	1 148	1 312
Coal, nes	18	21	12
Natural gas and other crude bituminous substances	4	4	7
Oil, crude	172	163	91
Total mineral fuels	22 982	24 459	24 771
Total crude minerals	124 824	120 676	95 678
Total revenue freight moved by Canadian railways	254 447	246 643	212 542
Per cent crude minerals of total revenue freight	49.1	48.9	45.0

nes Not elsewhere specified.

TABLE 63. CANADA, CRUDE MINERALS TRANSPORTED BY CANADIAN RAILWAYS, 1953-82

	Total Revenue Freight	Total Crude Minerals	Crude Minerals as % of Revenue Freight		Total Revenue Freight	Total Crude Minerals	Crude Mineral as % of Revenue Freight
	(million tonnes)				(million tonnes)		
1953	141.7	44.7	31.2	1968	195.4	86.7	44.4
1954	129.8	45.0	31.5	1969	189.0	81.9	43.4
1955	152.2	61.2	34.6	1970	211.6	97.5	46.1
1956	172.0	68.7	40.2	1971	214.5	95.6	44.6
1957	157.9	64.2	39.9	1972	215.8	89.4	41.4
1958	139.2	52.4	40.6	1973	241.2	113.1	46.9
1959	150.6	62.8	37.6	1974	246.3	115.3	46.8
1960	142.8	57.1	41.7	1975	226.0	110.6	49.0
1961	138.9	54.1	39.9	1976	238.5	116.6	48.9
1962	146.0	60.3	38.9	1977	247.2	121.1	49.0
1963	154.6	62.9	41.3	1978	238.8	107.7	45.1
1964	180.0	74.6	40.7	1979	257.9	127.2	49.3
1965	186.2	80.9	43.5	1980	254.4	124.8	49.1
1966	194.5	80.6	41.5	1981	246.6	120.7	48.9
1967	190.0	81.2	42.7	1982	212.5	95.7	45.0

TABLE 64. CANADA, FABRICATED MINERAL PRODUCTS TRANSPORTED BY CANADIAN RAILWAYS, 1980-82

	1980	1981	1982
		(000 tonnes)	
Metallic mineral products			
Ferrous mineral products			
Ferroalloys	75	102	47
Pig iron	80	134	42
Ingots, blooms, billets, slabs of iron and steel	425	933	630
Other primary iron and steel	64	210	21
Castings and forgings, iron and steel	198	179	114
Bars and rods, steel	728	825	521
Plates, steel	553	590	314
Sheet and strip, steel	992	1 016	666
Structural shapes and sheet piling, iron and steel	445	467	216
Rails and railway track material	101	131	94
Pipes and tubes, iron and steel	546	767	448
Wire, iron or steel	39	29	21
Iron and steel scrap	2 087	1 806	1 162
Slag, dross, etc.	128	162	52
Total ferrous mineral products	6 461	7 351	4 348
Nonferrous mineral products			
Aluminum paste, powder, pigs, ingots, shot	128	115	291
Aluminum and aluminum alloy fabricated material	230	229	234
Copper matte and precipitates	3	1	351
Copper and alloys, in primary form	389	379	327
Copper and alloys, nes	58	44	23
Lead and alloys	128	126	119
Nickel and nickel-copper matte	96	94	46
Nickel and alloys	30	35	15
Zinc and alloys	447	453	406
Other nonferrous base metals and alloys	29	19	13
Nonferrous metal scrap	103	60	48
Total nonferrous mineral products	1 641	1 555	1 873
Total metallic mineral products	8 102	8 906	6 221
Nonmetallic mineral products			
Natural stone basic products, chiefly structural	227	196	160
Bricks and tiles, clay	45	46	20
Fire brick and similar shapes	111	86	47
Dolomite and magnesite, calcined	85	71	39
Refractories, nes	36	33	16
Glass basic products	102	91	84
Asbestos and asbestos-cement basic products	33	36	23
Portland cement, standard	1 763	1 804	1 349
Concrete pipe	20	10	4
Cement and concrete basic products, nes	324	333	169
Plaster	21	18	13
Gypsum wallboard and sheathing	22	25	14
Gypsum basic products, nes	3	7	7
Lime, hydrated and quick	303	219	186
Nonmetallic mineral basic products, nes	458	424	299
Fertilizers and fertilizer materials, nes	2 092	1 937	1 581
Total nonmetallic mineral products	5 645	5 336	4 011

TABLE 64. (cont'd)

	1980	1981	1982
		(000 tonnes)	
Mineral fuel products			
Gasoline	1 455	1 511	1 376
Aviation turbine fuel	54	63	32
Diesel fuel	2 898	2 778	2 223
Kerosene	1	1	2
Fuel oil, nes	1 000	1 080	890
Lubricating oils and greases	389	342	296
Petroleum coke	626	463	537
Coke, nes	708	701	567
Refined and manufactured gases, fuel type	2 737	3 010	2 991
Asphalts and road oils	187	214	256
Bituminous pressed or molded fabricated material	1	1	1
Other petroleum and coal products	747	766	641
Total mineral fuel products	10 803	10 930	9 812
Total fabricated mineral products	24 550	25 172	20 044
Total revenue freight moved by Canadian railways	254 447	246 643	212 542
Fabricated mineral products as a percentage of total revenue freight	9.6	10.2	9.4

nes Not elsewhere specified.

TABLE 65. CANADA, CRUDE AND FABRICATED MINERALS TRANSPORTED THROUGH THE ST. LAWRENCE SEAWAY, 1980-82

	Montreal-Lake Ontario Section			Welland Canal Section		
	1980	1981	1982	1980	1981	1982
	(tonnes)					
Crude minerals						
Coal	204 715	1 519 188	1 046 580	6 616 010	5 935 727	6 478 426
Iron ore	9 993 769	11 727 044	6 740 758	10 358 099	12 468 808	6 364 815
Aluminum ores and concentrates	112 581	149 932	96 024	112 581	144 525	96 024
Clay and bentonite	250 526	180 280	129 267	250 526	180 280	129 266
Gravel and sand	34 000	36 651	33	195 676	203 970	118 341
Petroleum, crude	-	-	-	3 515	-	-
Stone, ground or crushed	163 545	23 036	30 839	1 046 175	952 603	102 695
Stone, rough	167	122	2 025	167	122	2 026
Salt	709 809	1 029 608	648 547	1 286 050	1 599 337	1 287 540
Phosphate rock	38 036	27 432	-	75	-	-
Sulphur	142 592	25 615	2 733	142 592	25 613	2 733
Other crude minerals	598 101	706 831	449 397	475 227	620 819	475 377
Total crude minerals	12 247 841	15 452 739	9 146 203	20 486 693	22 131 804	15 057 243
Fabricated mineral products						
Coke	1 271 222	773 992	617 617	1 301 705	880 911	686 590
Gasoline	202 471	112 348	144 035	157 557	136 566	157 842
Fuel oil	1 418 321	1 667 865	909 030	1 510 057	1 652 474	972 930
Lubricating oils and greases	83 667	64 677	44 330	83 605	51 026	34 414
Other petroleum products	139 139	151 924	157 202	83 453	111 501	139 305
Tar, pitch and creosote	46 573	39 613	38 236	26 822	37 482	45 328
Pig iron	183 667	183 752	138 048	174 772	173 884	128 814
Iron and steel: bars, rods, slabs	159 477	314 656	103 714	107 989	299 479	99 304
Iron and steel: nails, wire	7 284	7 364	15 005	6 657	6 949	10 705
Iron and steel: manufactured	1 724 459	2 313 521	2 412 338	1 072 857	1 861 767	1 459 619
Scrap iron and steel	689 676	79 254	414 788	611 508	57 564	382 445
Cement	82 864	2 512	3 129	268 433	259 002	215 523
Total fabricated minerals	6 008 820	5 711 478	4 997 472	5 405 415	5 528 605	4 332 819
Total crude and fabricated minerals	18 256 661	21 137 217	14 143 675	25 892 108	27 660 409	19 390 062
Total all products	42 142 459	45 875 658	38 841 399	54 073 636	53 388 616	44 473 919
Crude and fabricated minerals as a per cent of total	43.3	46.1	36.4	47.9	51.8	43.6

- Nil.

TABLE 66. CANADA, CRUDE MINERALS LOADED AND UNLOADED IN COASTWISE SHIPPING, 1981

	Loaded				Unloaded			
	Atlantic	Great Lakes	Pacific	Total	Atlantic	Great Lakes	Pacific	Total
	(tonnes)							
Metallic minerals								
Alumina and bauxite ores	9 160	-	-	9 160	-	9 160	-	9 160
Copper ore and concentrates	20 947	-	-	20 947	20 947	-	-	20 947
Iron ore and concentrates	4 333 481	1 074 008	-	5 407 489	1 741 410	3 666 079	-	5 407 489
Titanium ore	1 920 407	-	-	1 920 407	1 920 407	-	-	1 920 407
Zinc ore and concentrates	-	-	13 344	13 344	-	-	13 344	13 344
Ores and concentrates, nes	50	-	-	50	50	-	-	50
Iron and steel scrap	7 577	16 614	11 249	35 440	7 577	16 614	11 249	35 440
Total metals	6 291 622	1 090 622	24 593	7 406 837	3 690 391	3 691 853	24 593	7 406 837
Nonmetallic minerals								
Dolomite	-	25 393	-	25 393	25 393	-	-	25 393
Gypsum	555 082	-	41 928	597 010	444 756	110 326	41 928	597 010
Limestone	4 341	1 813 060	708 149	2 525 550	4 341	1 813 060	708 149	2 525 550
Phosphate rock	35 526	-	-	35 526	35 526	-	-	35 526
Salt	324 221	1 152 453	51 145	1 527 819	1 125 928	350 746	51 145	1 527 819
Sand and gravel	221 843	-	2 371 780	2 593 623	221 843	-	2 371 780	2 593 623
Stone, crude, nes	1	397 542	150 495	548 038	1	397 542	150 495	548 038
Sulphur in ores	18 399	7 224	4 159	29 782	25 623	-	4 159	29 782
Crude nonmetallic minerals, nes	13 066	-	-	13 066	9 567	3 499	-	13 066
Total nonmetals	1 172 479	3 395 672	3 327 656	7 895 807	1 892 978	2 675 173	3 327 656	7 895 807
Mineral fuels								
Coal, bituminous	1 254	2 036 882	75 079	2 113 215	101 524	2 011 691	-	2 113 215
Oil, crude	432 578	555	-	433 133	433 133	-	-	433 133
Total mineral fuels	433 832	2 037 437	75 079	2 546 348	534 657	2 011 691	-	2 546 348
Total crude minerals	7 897 933	6 523 731	3 427 328	17 848 992	6 118 026	8 378 717	3 352 249	17 848 992
Total, all commodities	20 184 435	25 031 921	26 054 737	71 271 093	30 453 843	14 867 381	25 949 869	71 271 093
Crude minerals as a per cent of all commodities	39.1	26.1	13.2	25.0	20.9	56.4	12.9	25.0

- Nil; nes Not elsewhere specified.

TABLE 67. CANADA, CRUDE MINERALS LOADED AND UNLOADED AT CANADIAN PORTS IN INTERNATIONAL SHIPPING TRADE, 1979-81

	1979		1980		1981P	
	Loaded	Unloaded	Loaded	Unloaded	Loaded	Unloaded
			(tonnes)			
Metallic minerals						
Alumina, bauxite ore	-	2 981 940	15 945	3 934 926	6 595	3 886 501
Copper ores and concentrates	709 050	-	587 352	26 223	1 034 946	78 240
Iron ore and concentrates	49 187 843	6 408 111	35 239 362	5 202 888	41 830 097	7 707 694
Lead ore and concentrates	118 655	-	74 749	5 092	124 939	3 833
Manganese ore	16 147	78 015	19 800	129 682	25 959	168 395
Nickel ore and concentrates	64 568	624	71 262	1 463	85 603	2 620
Titanium ore	89 294	-	130 913	-	855 586	14 936
Zinc ore and concentrates	1 026 594	800	292 799	524	728 140	-
Ores and concentrates, nes	39 969	121 416	603 092	603 071	68 776	91 105
Iron and steel scrap	327 879	-	355 042	6 162	79 811	6 285
Nonferrous metal scrap	1 910	3 172	74 565	8 523	47 514	16 145
Slag, dross, residue	485 618	45 315	3 861	247	3 203	57
Total metals	52 067 527	9 639 393	37 468 742	9 918 801	44 891 169	11 975 811
Nonmetallic minerals						
Asbestos	453 339	306	891 831	10 682	706 622	25 286
Barite	1 981	3 625	-	36	-	8 158
Bentonite	-	294 799	14 317	151 649	4	176 559
China clay	-	48 321	93	19 059	-	34 693
Clay materials, nes	58 656	23 309	15 258	78 405	1 334	5 533
Dolomite	1 032 139	-	907 715	38 413	948 552	-
Fluorspar	23 567	143 842	-	145 838	-	190 592
Gypsum	5 505 915	147 189	4 733 725	175 759	5 062 237	134 252
Limestone	239 852	2 953 876	1 842 439	1 365 421	1 711 487	2 261 324
Phosphate rock	16	1 515 346	-	1 368 116	-	1 197 106
Potash (KCl)	2 703 604	-	3 843 013	32 723	4 253 511	18
Salt	1 649 916	899 917	1 879 269	991 855	1 431 460	1 327 244
Sand and gravel	38 959	884 694	78 678	804 079	151 833	1 322 115
Stone, crude, nes	118 508	36 307	235 805	548 113	95 377	27 290
Stone, crushed	-	33 290	100 974	330 230	13 442	62 766
Sulphur	3 287 497	4 990	5 011 131	43 550	5 726 661	3
Crude, nonmetallic minerals, nes	67 671	183	60 891	120 844	145 860	26 201
Total nonmetals	15 181 620	6 989 994	15 772 126	6 192 049	20 248 380	6 799 140
Mineral fuels						
Coal	12 328 621	17 178 491	13 735 346	15 137 034	17 458 453	16 066 286
Coal, nes	-	197 976	1 093	13	194	3
Oil, crude	107 231	16 188 498	920 578	15 198 039	408 408	14 070 091
Total fuels	12 435 852	33 564 965	14 657 017	30 335 086	17 867 055	30 136 380
Total crude minerals	79 684 999	50 194 352	67 897 885	46 445 936	83 006 604	48 911 331
Total, all commodities	134 638 829	67 414 437	138 161 219	67 834 656	145 445 080	68 187 889
Crude minerals as a per cent of all commodities	59.2	74.5	49.1	68.5	57.1	71.7

- Nil; nes - Not elsewhere specified.

TABLE 68. CANADA, FABRICATED MINERAL PRODUCTS LOADED AND UNLOADED AT CANADIAN PORTS IN INTERNATIONAL SHIPPING TRADE, 1979-81

	1979		1980		1981P	
	Loaded	Unloaded	Loaded	Unloaded	Loaded	Unloaded
	(tonnes)					
Metallic products						
Aluminum	215 076	16 385	398 230	174 109	272 585	47 503
Copper and alloys	37 055	9 023	480 212	25 843	224 600	44 540
Ferroalloys	29 986	65 092	18 426	28 958	24 858	50 890
Iron and steel, primary	78 164	15 224	28 884	53 666	2 737	29 898
Iron, pig	221 359	19 350	468 308	20	458 534	7 717
Iron and steel, other						
bars and rods	17 545	214 058	343 034	103 467	79 921	199 244
castings and forgings	13 370	21 815	225 155	62 617	120 633	64 419
pipes and tubes	16 346	49 799	58 664	191 210	62 462	278 956
plates and sheet	108 606	490 158	1 438 646	442 783	191 667	1 282 572
rails and track material	76 751	12 198	99 726	7 028	97 644	12 433
structural shapes	69 596	342 272	97 094	69 109	24 030	240 887
wire	859	6 252	35 685	70 625	15 910	132 814
Lead and alloys	25 225	-	103 421	21 173	53 320	3 781
Nickel and alloys	2 212	915	52 520	12 385	40 847	7 661
Zinc and alloys	73 428	50	388 341	3 707	140 043	19 277
Nonferrous metals, nes	6 279	11 049	115 726	144 951	68 487	155 811
Metal fabricated basic products	6 713	11 682	470 038	607 827	56 351	170 980
Total metals	998 570	1 285 322	4 822 110	2 019 478	1 934 629	2 749 383
Nonmetallic products						
Asbestos basic products	1 642	-	5 349	1 345	5 606	1 907
Bricks and tiles, nes	23 880	12 469	38 490	25 126	31 527	36 057
Cement	2 829 351	61 244	1 704 324	75 130	1 719 170	130 990
Cement basic products	439	57	42 639	4 289	850	681
Drain tiles and pipes	-	-	5	104	-	-
Glass basic products	1 151	1 893	32 801	15 773	35 226	15 631
Nonmetallic mineral basic products	12 056	24 969	45 401	201 778	54 739	73 732
Fertilizers, nes	144 528	286 157	148 320	57 843	138 603	125 364
Total nonmetals	3 013 047	386 789	1 869 009	323 545	1 985 721	384 362
Mineral fuel products						
Asphalts, road oils	129	14 475	16 366	14 001	44 512	36 388
Coal tar, pitch	13 004	69 959	9 819	42 693	17 028	83 515
Coke	740 027	1 085 687	1 059 856	1 319 773	666 609	1 110 170
Fuel oil	3 710 585	1 858 914	2 101 989	2 352 355	3 380 547	1 888 349
Gasoline	385 648	26 638	1 250 230	221 458	615 796	63 450
Lubricating oils and greases	1 683	9 446	355 314	457 521	14 801	9 051
Petroleum and coal products, nes	38 048	71 274	285 609	242 793	266 081	47 448
Total fuels	4 889 124	3 136 393	5 079 183	4 650 594	5 005 374	3 238 371
Total fabricated mineral products	8 900 741	4 808 504	11 770 302	6 993 617	8 925 724	6 372 116
Total, all commodities	134 638 829	67 414 437	138 161 219	67 834 656	145 445 080	68 187 889
Fabricated mineral products as a per cent of all commodities	6.6	7.1	8.5	10.3	6.1	9.3

- Nil; nes Not elsewhere specified.

TABLE 69. CANADA, FINANCIAL STATISTICS OF CORPORATIONS IN THE MINING INDUSTRY[1], BY DEGREE OF NON-RESIDENT OWNERSHIP, 1980

	Corporations		Assets		Equity		Sales		Profits		Taxable Income	
	(number)	(%)	($million)	(%)	($million)	(%)	($million)	(%)	($million)	(%)	($million)	(%)
Metal mines												
Reporting corporations												
Canadian	77	56.6	13,699	68.7	7,292	67.3	6,340	60.3	2,187	66.9	860	70.4
Foreign	40	29.4	6,237	31.3	3,549	32.7	4,178	39.7	1,084	33.1	362	29.6
Unclassified	19	14.0	1	--	-	-	1	--	--	--	--	--
Total, all corporations	136	100.0	19,937	100.0	10,841	100.0	10,519	100.0	3,270	100.0	1,222	100.0
Mineral fuels												
Reporting corporations												
Canadian	628	56.9	18,100	46.7	7,625	41.0	4,892	25.8	2,078	34.3	389	14.8
Foreign	217	19.6	20,655	53.3	10,950	58.9	14,082	74.2	3,967	65.6	2,236	85.1
Unclassified	259	23.5	23	--	8	0.1	14	--	7	0.1	4	0.1
Total, all corporations	1,104	100.0	38,778	100.0	18,582	100.0	18,988	100.0	6,052	100.0	2,629	100.0
Other mining (including mining services)												
Reporting corporations												
Canadian	1,785	44.7	5,366	57.9	2,242	55.8	2,889	55.1	416	43.8	218	31.7
Foreign	218	5.5	3,743	40.4	1,739	43.2	2,193	41.8	520	54.8	450	65.4
Unclassified	1,986	49.8	158	1.7	41	1.0	161	3.1	13	1.4	20	2.9
Total, all corporations	3,989	100.0	9,266	100.0	4,082	100.0	5,243	100.0	949	100.0	688	100.0
Total mining												
Reporting corporations												
Canadian	2,490	47.6	37,165	54.7	17,159	51.3	14,121	40.6	4,681	45.6	1,467	32.3
Foreign	475	9.1	30,635	45.0	16,237	48.5	20,453	58.9	5,571	54.2	3,048	67.2
Unclassified	2,264	43.3	181	0.3	49	0.2	176	0.5	19	0.2	24	0.5
Total, all corporations	5,229	100.0	67,981	100.0	33,444	100.0	34,750	100.0	10,271	100.0	4,539	100.0

Note: Footnotes for Table 69 apply to this table. Figures may not add to totals due to rounding.
[1] Classification of the industry is the same as in Table 29.
-- Amount too small to be expressed; - Nil.

TABLE 70. CANADA, FINANCIAL STATISTICS OF CORPORATIONS IN THE MINERAL MANUFACTURING INDUSTRIES[1], BY DEGREE OF NON-RESIDENT OWNERSHIP, 1980

	Corporations[2]		Assets[4]		Equity[5]		Sales[6]		Profits[7]		Taxable income[8]	
	(number)	(%)	($million)	(%)	($million)	(%)	($million)	(%)	($million)	(%)	($million)	(%)
Primary metal products												
Reporting corporations[2]												
Canadian	248	62.6	10,847	86.5	4,870	84.2	10,332	84.4	1,197	87.3	657	85.2
Foreign	47	11.9	1,682	13.4	911	15.7	1,898	15.5	173	12.6	113	14.7
Unclassified[3]	101	25.5	10	0.1	3	0.1	18	0.1	1	0.1	1	0.1
Total, all corporations	396	100.0	12,539	100.0	5,785	100.0	12,247	100.0	1,371	100.0	771	100.0
Nonmetallic mineral products												
Reporting corporations[2]												
Canadian	776	50.9	1,749	28.6	574	22.8	1,908	38.6	87	21.2	70	27.6
Foreign	93	6.1	4,304	70.4	1,939	76.9	2,943	59.6	321	78.4	179	70.5
Unclassified[3]	657	43.0	58	1.0	9	0.3	91	1.8	2	0.4	5	1.9
Total, all corporations	1,526	100.0	6,111	100.0	2,522	100.0	4,942	100.0	409	100.0	254	100.0
Petroleum and coal products												
Reporting corporations[2]												
Canadian	33	58.9	6,949	30.2	3,454	26.5	4,494	18.0	762	23.0	287	..
Foreign	17	30.4	16,092	69.8	9,575	73.5	20,489	82.0	2,546	77.0	1,997	..
Unclassified[3]	6	10.7	1	--	-	-	1	--	--	--	x	x
Total, all corporations	56	100.0	23,041	100.0	13,029	100.0	24,984	100.0	3,308	100.0	x	x
Total mineral manufacturing industries												
Reporting corporations[2]												
Canadian	1,057	53.5	19,545	46.9	8,898	41.7	16,734	39.7	2,046	40.2	1,014	..
Foreign	157	7.9	22,078	53.0	12,425	58.2	25,330	60.1	3,040	59.7	2,289	..
Unclassified[3]	764	38.6	69	0.1	12	0.1	110	0.2	3	0.1	x	x
Total, all corporations	1,978	100.0	41,691	100.0	21,336	100.0	42,173	100.0	5,088	100.0	x	x

[1] Classification of industries is the same as in Table 30. [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] Corporations exempt from reporting under the Corporations and Labour Unions Returns Act. These include corporations reporting under other acts, small companies and corporations and non-profit organizations. [4] 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. [5] 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. [6] For non-financial corporations, sales are gross revenues from non-financial operations. For financial corporations sales include income from financial as well as non-financial sources. [7] 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. [8] 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.
-- Amount too small to be expressed; x Confidential; .. Not available; - Nil.

TABLE 71. CANADA, FINANCIAL STATISTICS OF CORPORATIONS IN NON-FINANCIAL INDUSTRIES, BY MAJOR INDUSTRY GROUP AND BY CONTROL, 1979 AND 1980

	Agriculture, forestry, fishing and trapping		Mines Quarries & Oil Wells		Manufacturing		Construction		Transportation, communication and other utilities		Trade		Services		Total	
	1979	1980P	1979	1980P	1979	1980P	1979	1980P	1979	1980P	1979	1980P	1979	1980P	1979	1980P
								(number)								
Number of corporations																
Canadian control	6,943	8,338	2,074	2,490	15,143	16,592	14,189	15,829	5,255	5,888	39,655	44,550	18,186	21,022	101,445	114,709
Foreign control	116	104	516	475	2,280	2,107	232	205	337	307	2,141	1,953	720	635	6,342	5,786
Other corporations	9,418	10,027	2,143	2,264	16,719	17,291	35,317	38,048	11,775	12,651	67,995	70,371	64,180	69,326	207,547	219,978
Total corporations	16,477	18,469	4,733	5,229	34,142	35,990	49,738	54,082	17,367	18,846	109,791	116,874	83,086	90,983	315,334	340,473
								($ million)								
Assets																
Canadian control	4,936	6,395	27,998	37,165	62,545	74,272	14,623	16,599	93,801	107,994	48,651	55,847	19,796	23,446	272,349	321,718
Foreign control	295	332	28,027	30,635	62,423	68,791	2,116	2,108	5,798	5,140	13,807	14,729	4,126	4,724	116,592	126,458
Other corporations	887	937	168	181	1,311	1,354	2,244	2,366	837	908	4,943	5,138	3,798	4,104	14,188	14,989
Total corporations	6,118	7,664	56,192	67,981	126,279	144,416	18,983	21,073	100,436	114,042	67,402	75,714	27,720	32,274	403,129	463,165
Equity																
Canadian control	1,496	1,966	13,532	17,159	25,066	28,738	3,404	3,767	24,781	30,112	14,318	16,458	4,894	5,901	87,490	104,100
Foreign control	111	106	14,876	16,237	30,671	34,827	697	692	2,177	1,762	4,701	5,138	1,529	1,727	54,761	60,489
Other corporations	204	206	41	49	268	260	510	531	168	168	1,180	1,154	906	932	3,277	3,301
Total corporations	1,811	2,279	28,448	33,444	56,004	63,824	4,610	4,991	27,126	32,042	20,199	22,750	7,329	8,560	145,527	167,891
Sales																
Canadian control	4,665	5,689	10,885	14,121	81,655	95,488	20,984	24,033	37,533	44,426	122,604	141,266	18,027	22,009	296,354	347,033
Foreign control	250	289	18,895	20,453	95,986	100,509	2,572	2,670	3,624	3,265	36,478	39,854	4,827	5,464	162,633	172,505
Other corporations	935	1,020	155	176	2,396	2,522	4,519	4,927	1,296	1,430	10,166	10,678	5,854	6,505	25,323	27,259
Total corporations	5,851	6,998	29,936	34,750	180,037	198,520	28,075	31,630	42,452	49,122	169,250	191,798	28,709	33,979	484,309	546,797
Profits																
Canadian control	417	514	3,660	4,681	6,750	6,945	819	981	4,091	4,551	4,853	5,194	1,494	1,765	22,084	24,630
Foreign control	31	22	5,052	5,571	7,364	8,093	198	140	502	454	1,088	1,270	542	623	14,778	16,173
Other corporations	84	86	10	19	100	101	159	195	53	65	350	364	457	515	1,213	1,345
Total corporations	533	622	8,722	10,271	14,213	15,139	1,176	1,316	4,646	5,070	6,292	6,828	2,493	2,902	38,075	42,148

Note: Figures may not add to totals due to rounding.
P Preliminary.

TABLE 72. CANADA, CAPITAL AND REPAIR EXPENDITURES BY SELECTED INDUSTRIAL SECTOR; 1981-1983

		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	1981	1,280.8	3,579.1	4,859.9	336.1	1,037.6	1,373.7	1,616.9	4,616.7	6,233.6
	1982[P]	1,376.9	3,069.9	4,446.8	350.0	1,152.2	1,502.2	1,726.9	4,222.1	5,949.0
	1983[f]	1,257.9	3,033.8	4,291.7	364.1	1,145.1	1,509.2	1,622.0	4,178.9	5,800.9
Forestry	1981	132.9	148.8	281.7	87.4	248.5	335.9	220.3	397.3	617.6
	1982[P]	84.9	60.6	145.5	74.4	215.9	290.3	159.3	276.5	435.8
	1983[f]	80.4	55.2	135.6	87.9	232.6	320.5	168.3	287.8	456.1
Mining[1]	1981	7,804.2	2,200.4	10,004.6	692.3	1,987.6	2,679.9	8,496.5	4,188.0	12,684.5
	1982[P]	7,501.8	1,963.3	9,465.1	693.3	1,874.9	2,568.2	8,195.1	3,838.2	12,033.3
	1983[f]	8,205.0	1,637.4	9,842.4	748.7	1,923.2	2,671.9	8,953.7	3,560.6	12,514.3
Construction	1981	208.6	1,096.0	1,304.6	28.9	837.3	866.2	237.5	1,933.3	2,170.8
	1982[P]	204.2	1,074.2	1,278.4	28.2	820.5	848.7	232.4	1,894.7	2,127.1
	1983[f]	203.6	1,070.4	1,274.0	28.1	817.6	845.7	231.7	1,888.0	2,119.7
Housing	1981	13,135.4	-	13,135.4	3,229.4	-	3,229.4	16,364.8	-	16,364.8
	1982[P]	9,890.6	-	9,890.6	3,451.0	-	3,451.0	13,341.6	-	13,341.6
	1983[f]	10,726.8	-	10,726.8	3,687.6	-	3,687.6	14,414.4	-	14,414.4
Manufacturing	1981	3,074.3	9,665.0	12,739.3	850.8	4,104.3	4,955.1	3,925.1	13,769.3	17,694.4
	1982[P]	2,771.0	8,351.7	11,122.7	803.1	3,962.8	4,765.9	3,574.1	12,314.5	15,888.6
	1983[f]	2,041.4	7,061.2	9,102.6	858.5	4,107.3	4,965.8	2,899.9	11,168.5	14,068.4
Utilities	1981	8,588.1	7,655.4	16,243.5	1,442.3	3,623.3	5,065.6	10,030.4	11,278.7	21,309.1
	1982[P]	10,273.9	7,626.4	17,900.3	1,469.6	3,949.0	5,418.6	11,743.5	11,575.4	23,318.9
	1983[f]	9,245.9	7,830.8	17,076.7	1,610.4	4,248.8	5,859.2	10,856.3	12,079.6	22,935.9
Trade	1981	595.4	1,403.8	1,999.2	189.8	259.3	449.1	785.2	1,663.1	2,448.3
	1982[P]	535.9	1,199.6	1,735.5	181.7	253.5	435.2	717.6	1,453.1	2,170.7
	1983[f]	522.5	1,156.0	1,678.5	189.2	261.2	450.4	711.7	1,417.2	2,128.9
Other[2]	1981	13,040.1	5,995.8	19,035.9	2,165.4	1,065.4	3,230.8	15,205.5	7,061.2	22,266.7
	1982[P]	13,568.8	5,524.9	19,093.7	2,483.7	1,039.2	3,522.9	16,052.5	6,564.1	22,616.6
	1983[f]	13,121.8	5,515.9	18,637.7	2,563.3	1,076.9	3,640.2	15,685.1	6,592.8	22,277.9
Total	1981	47,859.8	31,744.3	79,604.1	9,022.4	13,163.3	22,185.7	56,882.7	44,907.6	101,789.8
	1982[P]	46,208.0	28,870.6	75,078.6	9,535.0	13,268.0	22,803.0	55,743.0	42,138.6	97,881.6
	1983[f]	45,405.3	27,360.7	72,766.0	10,137.8	13,812.7	23,950.5	55,543.1	41,173.4	96,716.5
Mining as a percentage of total	1981	16.3	6.9	12.6	7.7	15.1	12.1	14.9	9.3	12.5
	1982[P]	16.3	6.8	12.6	7.3	14.1	11.3	14.7	9.1	12.3
	1983[f]	18.1	6.0	13.5	7.4	13.9	11.2	16.1	8.6	12.9

[1] Includes mines, quarries and oil wells. [2] Includes finance, real estate, insurance, commercial services, institutions and government departments.
[P] Preliminary; [f] Forecast; - Nil.

TABLE 73. CANADA, CAPITAL AND REPAIR EXPENDITURES IN MINING[1] BY GEOGRAPHICAL REGION; 1981-1983

		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	1981	544.7	266.4	811.1	11.1	187.0	198.1	555.8	453.4	1,009.2
	1982P	876.6	280.4	1,157.0	11.3	193.4	204.7	887.9	473.8	1,361.7
	1983f	1,263.7	238.3	1,502.0	10.8	191.6	202.4	1,274.5	429.9	1,704.4
Québec	1981	298.0	135.9	433.9	49.3	262.4	311.7	347.3	398.3	745.6
	1982P	198.2	76.8	275.0	75.2	255.6	330.8	273.4	332.4	605.8
	1983f	180.7	58.6	239.3	65.0	265.2	330.2	245.7	323.8	569.5
Ontario	1981	420.9	182.2	603.1	78.4	285.5	363.9	499.3	467.7	967.0
	1982P	396.1	122.7	518.8	59.3	210.2	269.5	455.4	332.9	788.3
	1983f	333.2	118.0	451.2	65.8	234.3	300.1	399.0	352.3	751.3
Prairie Region	1981	4,666.7	951.4	5,618.1	472.6	821.2	1,293.8	5,139.3	1,772.6	6,911.9
	1982P	4,028.7	825.5	4,854.2	474.6	845.1	1,319.7	4,503.3	1,670.6	6,173.9
	1983f	4,475.8	806.5	5,282.3	529.0	849.5	1,378.5	5,004.8	1,656.0	6,660.8
British Columbia	1981	984.8	209.1	1,193.9	72.8	371.6	444.4	1,057.6	580.7	1,638.3
	1982P	897.5	215.4	1,112.9	65.9	307.5	373.4	963.4	522.9	1,486.3
	1983f	893.0	167.4	1,060.4	71.1	321.8	392.9	964.1	489.2	1,453.3
Yukon and Northwest Territories	1981	889.1	455.4	1,344.5	8.1	59.9	68.0	897.2	515.3	1,412.5
	1982P	1,104.7	442.5	1,547.2	7.0	63.1	70.1	1,111.7	505.6	1,617.3
	1983f	1,058.6	248.6	1,307.2	7.0	60.8	67.8	1,065.6	309.4	1,375.0
Canada, total	1981	7,804.2	2,200.4	10,004.6	692.3	1,987.6	2,679.9	8,496.5	4,188.0	12,684.5
	1982P	7,501.8	1,963.3	9,465.0	693.3	1,874.9	2,568.2	8,195.1	3,838.2	12,033.3
	1983f	8,205.0	1,637.4	9,842.3	748.7	1,923.2	2,671.9	8,953.7	3,560.6	12,514.3

[1] Includes mines, quarries and oil wells.
P Preliminary; f Forecast.

TABLE 74. CANADA, CAPITAL AND REPAIR EXPENDITURES IN MINING[1] AND MINERAL MANUFACTURING INDUSTRIES, 1981-1983

	1981			1982[p]			1983[f]		
	Capital	Repair	Total	Capital	Repair	Total	Capital	Repair	Total
					($ million)				
Mining industry									
Metal mines									
Gold	409.5	58.6	468.1	298.2	53.5	351.7	245.8	57.0	302.8
Silver-lead-zinc	276.8	82.2	359.0	167.9	124.5	292.4	111.1	126.9	238.0
Copper-gold-silver	438.1	321.9	760.0	223.3	230.3	453.6	213.6	229.9	443.5
Iron	188.3	338.4	526.7	151.7	366.2	517.9	109.3	334.4	443.7
Other metal mines	595.0	251.6	846.6	506.2	189.0	695.2	449.9	203.4	653.3
Total metal mines	1,907.7	1,052.1	2,960.4	1,347.3	963.5	2,310.8	1,129.7	951.6	2,081.3
Nonmetal mines									
Asbestos	69.0	83.5	152.5	46.2	59.7	105.9	42.1	78.6	120.7
Other nonmetal mines[2]	996.6	390.3	1,386.8	1,427.9	372.3	1,800.2	1,351.9	416.5	1,768.4
Total nonmetal mines	1,065.5	473.8	1,539.3	1,474.1	432.0	1,906.1	1,394.0	495.1	1,889.1
Mineral fuels									
Oil, crude and gas[3]	7,031.4	1,153.4	8,184.8	6,643.7	1,172.7	7,816.4	7,318.7	1,225.2	8,543.9
Total mining industries	10,004.6	2,679.9	12,684.5	9,465.1	2,568.2	12,033.3	9,842.4	2,671.9	12,514.3
Mineral manufacturing									
Primary metal industries									
Iron and steel mills	710.0	699.2	1 409.2	444.7	664.0	1 108.7	195.4	619.1	814.5
Steel pipe and tube mills	175.7	70.0	245.7	194.4	72.0	266.4	83.4	61.1	144.5
Iron foundries	19.8	25.1	44.9	16.6	39.1	55.7	19.3	43.5	62.8
Smelting and refining	643.3	353.4	996.7	519.7	243.5	763.2	455.6	297.3	752.9
Aluminum rolling, casting and extruding	32.9	25.9	58.8	13.0	28.4	41.4	11.4	31.4	42.8
Copper and copper alloy rolling, casting and extruding	24.1	6.1	30.2	21.2	5.1	26.3	6.9	5.9	12.8
Metal rolling, casting and extruding	13.9	12.6	26.5	9.3	11.6	20.9	8.2	10.5	18.7
Total primary metal industries	1,619.7	1,192.3	2,812.0	1,218.9	1,063.7	2,282.6	780.2	1,068.8	1,849.0
Nonmetallic mineral products									
Cement	150.6	78.3	228.9	59.0	73.7	132.7	33.5	69.7	103.2
Stone products	2.5	0.5	3.0	4.5	1.0	5.5	0.3	0.5	0.8
Concrete products	16.5	35.4	51.9	8.4	18.8	27.2	9.0	17.0	26.0
Ready-mix concrete	29.7	48.6	78.3	19.3	46.9	66.2	11.4	44.5	55.9
Clay products	13.4	8.7	22.1	8.6	7.9	16.5	8.3	8.5	16.8
Glass and glass products	50.1	20.0	70.1	31.0	18.8	49.8	38.7	23.8	62.5
Abrasives	27.9	15.8	43.7	11.9	13.4	25.3	12.1	13.7	25.8
Lime	3.1	2.3	5.4	2.0	1.4	3.4	1.2	1.5	2.7
Other nonmetallic mineral products	53.6	41.6	95.2	35.7	42.8	78.5	24.2	46.6	70.8
Total nonmetallic mineral products	347.4	251.2	598.6	180.4	224.7	405.1	138.7	225.8	364.5
Petroleum and coal products	844.9	302.0	1,146.9	1,113.5	304.7	1,418.2	791.9	320.8	1,112.7
Total mineral manufacturing industries	2,812.0	1,745.5	4,557.5	2,512.8	1,593.1	4,105.9	1,710.8	1,615.4	3,326.2
Total mining and mineral manufacturing industries	12,816.6	4,425.4	17,242.0	11,977.9	4,161.3	16,139.2	11,553.2	4,287.3	15,840.5

[1] Does not include cement, lime and clay products (domestic clay) manufacturing, smelting and refining. [2] Includes coal mines, gypsum, salt, potash and miscellaneous nonmetal mines and quarrying. [3] The total of capital expenditures shown under "petroleum and gas" is equal to the total capital expenditure under the column entitled "petroleum and natural gas extraction" and under the column "natural gas processing plants" of Table 76.
[p] Preliminary; [f] Forecast.

TABLE 74. CANADA, CAPITAL AND REPAIR EXPENDITURES IN MINING[1] AND MINERAL MANUFACTURING INDUSTRIES, 1981-1983

	1981			1982[p]			1983[f]		
	Capital	Repair	Total	Capital	Repair	Total	Capital	Repair	Total
					($ million)				
Mining industry									
Metal mines									
Gold	409.5	58.6	468.1	298.2	53.5	351.7	245.8	57.0	302.8
Silver-lead-zinc	276.8	82.2	359.0	167.9	124.5	292.4	111.1	126.9	238.0
Copper-gold-silver	438.1	321.9	760.0	223.3	230.3	453.6	213.6	229.9	443.5
Iron	188.3	338.4	526.7	151.7	366.2	517.9	109.3	334.4	443.7
Other metal mines	595.0	251.6	846.6	506.2	189.0	695.2	449.9	203.4	653.3
Total metal mines	1,907.7	1,052.1	2,960.4	1,347.3	963.5	2,310.8	1,129.7	951.6	2,081.3
Nonmetal mines									
Asbestos	69.0	83.5	152.5	46.2	59.7	105.9	42.1	78.6	120.7
Other nonmetal mines[2]	996.6	390.3	1,386.8	1,427.9	372.3	1,800.2	1,351.9	416.5	1,768.4
Total nonmetal mines	1,065.5	473.8	1,539.3	1,474.1	432.0	1,906.1	1,394.0	495.1	1,889.1
Mineral fuels									
Oil, crude and gas[3]	7,031.4	1,153.4	8,184.8	6,643.7	1,172.7	7,816.4	7,318.7	1,225.2	8,543.9
Total mining industries	10,004.6	2,679.9	12,684.5	9,465.1	2,568.2	12,033.3	9,842.4	2,671.9	12,514.3
Mineral manufacturing									
Primary metal industries									
Iron and steel mills	710.0	699.2	1 409.2	444.7	664.0	1 108.7	195.4	619.1	814.5
Steel pipe and tube mills	175.7	70.0	245.7	194.4	72.0	266.4	83.4	61.1	144.5
Iron foundries	19.8	25.1	44.9	16.6	39.1	55.7	19.3	43.5	62.8
Smelting and refining	643.3	353.4	996.7	519.7	243.5	763.2	455.6	297.3	752.9
Aluminum rolling, casting and extruding	32.9	25.9	58.8	13.0	28.4	41.4	11.4	31.4	42.8
Copper and copper alloy rolling, casting and extruding	24.1	6.1	30.2	21.2	5.1	26.3	6.9	5.9	12.8
Metal rolling, casting and extruding	13.9	12.6	26.5	9.3	11.6	20.9	8.2	10.5	18.7
Total primary metal industries	1,619.7	1,192.3	2,812.0	1,218.9	1,063.7	2,282.6	780.2	1,068.8	1,849.0
Nonmetallic mineral products									
Cement	150.6	78.3	228.9	59.0	73.7	132.7	33.5	69.7	103.2
Stone products	2.5	0.5	3.0	4.5	1.0	5.5	0.3	0.5	0.8
Concrete products	16.5	35.4	51.9	8.4	18.8	27.2	9.0	17.0	26.0
Ready-mix concrete	29.7	48.6	78.3	19.3	46.9	66.2	11.4	44.5	55.9
Clay products	13.4	8.7	22.1	8.6	7.9	16.5	8.3	8.5	16.8
Glass and glass products	50.1	20.0	70.1	31.0	18.8	49.8	38.7	23.8	62.5
Abrasives	27.9	15.8	43.7	11.9	13.4	25.3	12.1	13.7	25.8
Lime	3.1	2.3	5.4	2.0	1.4	3.4	1.2	1.5	2.7
Other nonmetallic mineral products	53.6	41.6	95.2	35.7	42.8	78.5	24.2	46.6	70.8
Total nonmetallic mineral products	347.4	251.2	598.6	180.4	224.7	405.1	138.7	225.8	364.5
Petroleum and coal products	844.9	302.0	1,146.9	1,113.5	304.7	1,418.2	791.9	320.8	1,112.7
Total mineral manufacturing industries	2,812.0	1,745.5	4,557.5	2,512.8	1,593.1	4,105.9	1,710.8	1,615.4	3,326.2
Total mining and mineral manufacturing industries	12,816.6	4,425.4	17,242.0	11,977.9	4,161.3	16,139.2	11,553.2	4,287.3	15,840.5

[1] Does not include cement, lime and clay products (domestic clay) manufacturing, smelting and refining. [2] Includes coal mines, gypsum, salt, potash and miscellaneous nonmetal mines and quarrying. [3] The total of capital expenditures shown under "petroleum and gas" is equal to the total capital expenditure under the column entitled "petroleum and natural gas extraction" and under the column "natural gas processing plants" of Table 76.
[p] Preliminary; [f] Forecast.

TABLE 75. CANADA, CAPITAL AND REPAIR EXPENDITURES IN THE MINING INDUSTRY[1], 1977-1983

	1977	1978	1979	1980	1981	1982P	1983f
				($ million)			
Metal mines							
Capital							
Construction	626.8	407.3	606.4	1,109.1	1,331.3	925.9	732.9
Machinery	352.0	169.3	281.6	467.2	576.4	421.4	396.8
Total	978.8	576.6	888.0	1,576.3	1,907.7	1,347.3	1,129.7
Repair							
Construction	63.1	53.7	70.2	137.3	151.9	157.7	150.6
Machinery	536.7	487.6	632.1	767.7	900.8	805.8	801.0
Total	599.8	541.3	702.3	905.0	1,052.7	963.5	951.6
Total capital and repair	1,578.6	1,117.9	1,590.3	2,481.3	2,960.4	2,310.8	2,081.3
Nonmetal mines[2]							
Capital							
Construction	214.8	187.5	248.8	346.4	647.8	913.2	962.6
Machinery	225.8	236.4	202.6	267.6	417.7	560.9	431.4
Total	440.6	423.9	451.4	614.0	1,065.5	1,474.1	1,394.0
Repair							
Construction	20.8	18.2	14.6	32.5	26.0	23.2	27.9
Material	273.2	289.1	332.5	393.1	447.8	408.8	467.2
Total	294.0	307.3	347.1	425.6	473.8	432.0	495.1
Total capital and repair	734.6	731.2	798.5	1,039.6	1,539.3	1,906.1	1,889.1
Mineral fuels							
Capital							
Construction	1,998.0	2,520.9	3,820.3	5,453.1	5,825.1	5,662.7	6,509.5
Machinery	447.5	382.0	494.9	800.3	1,206.3	981.0	809.2
Total	2,445.5	2,902.9	4,315.2	6,253.4	7,031.4	6,643.7	7,318.7
Repair							
Construction	318.3	389.6	444.1	627.6	514.4	512.4	570.2
Machinery	101.2	100.2	242.1	313.6	639.0	660.3	655.0
Total	419.5	489.8	686.2	941.2	1,153.4	1,172.7	1,225.2
Total capital and repair	2,865.0	3,392.7	5,001.4	7,194.6	8,184.8	7,816.4	8,543.9
Total mining							
Capital							
Construction	2,839.6	3,115.7	4,675.5	6,908.6	7,804.2	7,501.8	8,205.0
Machinery	1,025.3	787.7	979.1	1,535.1	2,200.4	1,963.3	1,637.4
Total	3,864.9	3,903.4	5,654.6	8,443.7	10,004.6	9,465.1	9,842.4
Repair							
Construction	402.2	461.5	528.9	797.4	692.5	693.3	748.7
Machinery	911.1	876.9	1,206.7	1,474.4	1,987.6	1,874.9	1,923.2
Total	1,313.3	1,338.4	1,735.6	2,271.8	2,679.9	2,568.2	2,671.9
Total capital and repair	5,178.2	5,241.8	7,390.2	10,715.5	12,684.5	12,033.3	12,514.3

[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; f Forecast.

TABLE 76. CANADA, CAPITAL AND REPAIR EXPENDITURES IN THE MINERAL MANUFACTURING INDUSTRIES[1], 1977-1983

	1977	1978	1979	1980	1981	1982P	1983f
				($ million)			
Primary metal industries[2]							
Capital							
Construction	171.2	130.7	153.4	328.2	330.1	253.3	171.4
Machinery	549.1	475.4	621.1	960.9	1,289.6	965.6	608.8
Total	720.3	606.1	774.5	1,289.1	1,619.7	1,218.9	780.2
Repair							
Construction	85.3	80.8	87.6	122.1	139.0	86.7	98.9
Machinery	662.8	780.1	887.7	998.5	1,053.3	977.0	969.9
Total	748.1	860.9	975.3	1,120.6	1,192.3	1,063.7	1,068.8
Total capital and repair	1,468.4	1,467.0	1,749.8	2,409.7	2,812.0	2,282.6	1,849.0
Nonmetallic mineral products[3]							
Capital							
Construction	63.3	62.0	102.0	70.0	93.4	31.7	22.4
Machinery	215.5	217.9	293.5	249.7	254.0	148.7	116.3
Total	278.8	279.9	395.5	319.7	347.4	180.4	138.7
Repair							
Construction	16.1	17.5	20.2	16.7	23.7	28.0	29.5
Machinery	169.5	190.3	206.1	213.8	227.5	196.7	196.3
Total	185.6	207.8	226.3	230.5	251.2	224.7	225.8
Total capital and repair	464.4	487.7	621.8	550.2	598.6	405.1	364.5
Petroleum and coal products							
Capital							
Construction	268.2	215.6	180.0	215.6	629.9	821.3	594.9
Machinery	98.4	99.5	94.0	109.1	215.0	292.2	197.0
Total	366.6	315.1	274.0	324.7	844.9	1,113.5	791.9
Repair							
Construction	125.7	117.5	158.1	190.5	212.9	228.1	237.3
Machinery	45.8	57.4	61.3	76.2	89.1	76.6	83.5
Total	171.5	174.9	219.4	266.7	302.0	304.7	320.8
Total capital and repair	538.1	490.0	493.4	591.4	1,146.9	1,418.2	1,112.7
Total mineral manufacturing industries							
Capital							
Construction	502.7	408.3	435.4	613.8	1,053.4	1,106.3	788.7
Machinery	863.0	792.8	1,008.6	1,319.7	1,758.6	1,406.5	922.1
Total	1,365.7	1,201.1	1,444.0	1,933.5	2,812.0	2,512.8	1,710.8
Repair							
Construction	227.1	215.8	256.9	329.3	375.6	342.8	365.7
Machinery	878.1	1,027.8	1,155.1	1,288.5	1,369.9	1,250.3	1,249.7
Total	1,105.2	1,243.6	1,412.0	1,617.8	1,745.5	1,593.1	1,615.4
Total capital and repair	2,470.9	2,444.7	2,865.0	3,551.3	4,557.5	4,105.9	3,326.2

[1] Industry groups are the same as in Table 28. [2] Includes smelting and refining. [3] Includes cement, lime and clay products manufacturing.
P Preliminary; f Forecast.

TABLE 77. CANADA, CAPITAL EXPENDITURES IN THE PETROLEUM, NATURAL GAS AND ALLIED INDUSTRIES[1], 1977-1983

	Petroleum and natural gas extraction[2]	Transportation including rail, water and pipelines	Marketing (chiefly outlets of oil companies)	Natural gas distribution	Petroleum and coal products industries	Natural gas processing plants	Total capital expenditures
				($ million)			
1977	2,290.0	374.9	135.5	213.0	366.6	155.5	3,535.5
1978	2,684.1	312.4	145.6	246.6	315.1	218.8	3,922.6
1979	4,013.4	229.3	134.3	262.5	274.0	301.8	5,215.3
1980	5,744.2	602.1	205.2	386.4	324.7	311.5	7,574.1
1981	6,444.9	1,745.7	264.1	408.7	844.9	311.6	10,046.9
1982P	6,022.3	2,021.1	270.2	516.3	1,113.5	503.6	10,447.0
1983f	6,802.7	871.4	363.7	552.7	791.9	373.8	9,756.2

[1] The petroleum and natural gas industries in this table include all companies engaged in whole or in part in oil and gas activities. [2] Does not include expenditures for geological and geophysical operations. See also Footnote 3 to Table 71.

P Preliminary; f Forecast.

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