MINERAL REPORT 31

CANADIAN MINERALS YEARBOOK, 1981

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Foreword

This issue of the Canadian Minerals Yearbook is a comprehensive report of developments in the mineral industry during 1981. 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, 1981. 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. The text is also supported by pocket map 900A, Principal Mineral Areas of Canada.

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.

December 29, 1983

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Readers wishing more recent information than that contained in this volume should obtain the 1982 series of mineral reviews: a complete set costs \$48 in Canada and \$57.60 in other countries, while individual copies sell for \$1.00 in Canada and \$1.20 in other countries. They may be ordered from Canadian Government Publishing Centre, Supply and Services Canada, Hull, Quebec, Canada, K1A 0S9. Prices subject to change without notice.

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 CANADIAN ECONOMY IN 1981

Worldwide economic recession was the phrase quoted by economists in 1981. Weakness in the European, United States and Canadian economies contributed to a sector-wide industrial decline in demand, output, commodity prices and company earnings. The impact of this decline in world demand was reflected in the performance of Canada's resource sector. After two quarters of relatively strong economic growth, the Canadian economy experienced a sharp downturn in the third quarter of 1981. Gross National Product reached $331 billion during the year, up from $292 billion the previous year representing a growth of 3.1 per cent in real terms, but that increase occurred in the first half of the year only. Growth rates in real terms from one quarter to the next in 1981 measured 1.2 per cent, 1.6 per cent, -1.1 per cent and -1.3 per cent respectively.

A general weakening in the overall economy in the second half of the year was further revealed by the levels of other economic indicators. The consumer price index, after reaching the double-digit level of 10.1 per cent in 1980 was fueled by higher domestic energy costs and ended 1981 at a level of 12.5 per cent. A record Bank of Canada lending rate of 21.24 per cent was set on August 7, shortly after a record decline in the Canadian dollar occurred to a forty-eight year low of 82.24 cents U.S. The bank lending rate stood at 17.93 per cent at the end of the year, compared with 12.89 per cent in 1980. The high interest rates combined with reduced operating margins for almost all corporations, contributed to an overall drop of 23.3 per cent in 1981 after-tax profits.

The unemployment rate averaged 7.6 per cent for the year, up from 7.5 per cent the previous year, while growth in employment was weak.

Canada's merchandise trade balance, in the past a source of strength, was down considerably in 1981. After a surplus of $7.8 billion in 1980, it reached $6.6 billion this year contributing to an increase in the current account deficit from $1.9 billion in 1980 to $6.6 billion in 1981. Canada's dependence on trade for strong economic growth is undisputed, and there has been a traditional reliance on the merchandise trade surplus to offset large deficits on service transactions. The balance has become much more difficult to achieve as the major trading partners also suffer from the current recession. World trade volume, after increasing by only 1.5 per cent in 1980 showed a slight decline in 1981 due to weak economic performance in the industrialized world. With its dependence on world markets for most of its output, the mineral industry felt the adverse impact of the prevailing economic downturn.

THE MINERAL INDUSTRY IN 1981

Production

The value of production in the mineral industry in 1981, reached an all-time high of $32.3 billion, despite the strong recessionary pressures. Of that total, metals contributed $8.7 billion; non-metals $2.7 billion; structural materials $1.8 billion; and fuels $19.0 billion. Value of production of metals dropped 10.3 per cent from the $9.7 billion recorded in 1980, but non-metals, structurals, and fuels increased 8.0 per cent, 5.9 per cent and 6.1 per cent respectively. The value of Alberta mineral production far exceeded that of the other provinces, providing 53 per cent of the total, while Ontario contributed 13 per cent.

Metallic Minerals

Faced with reduced demand, depressed prices and stagnation in the housing and automobile industries, the nonferrous metals

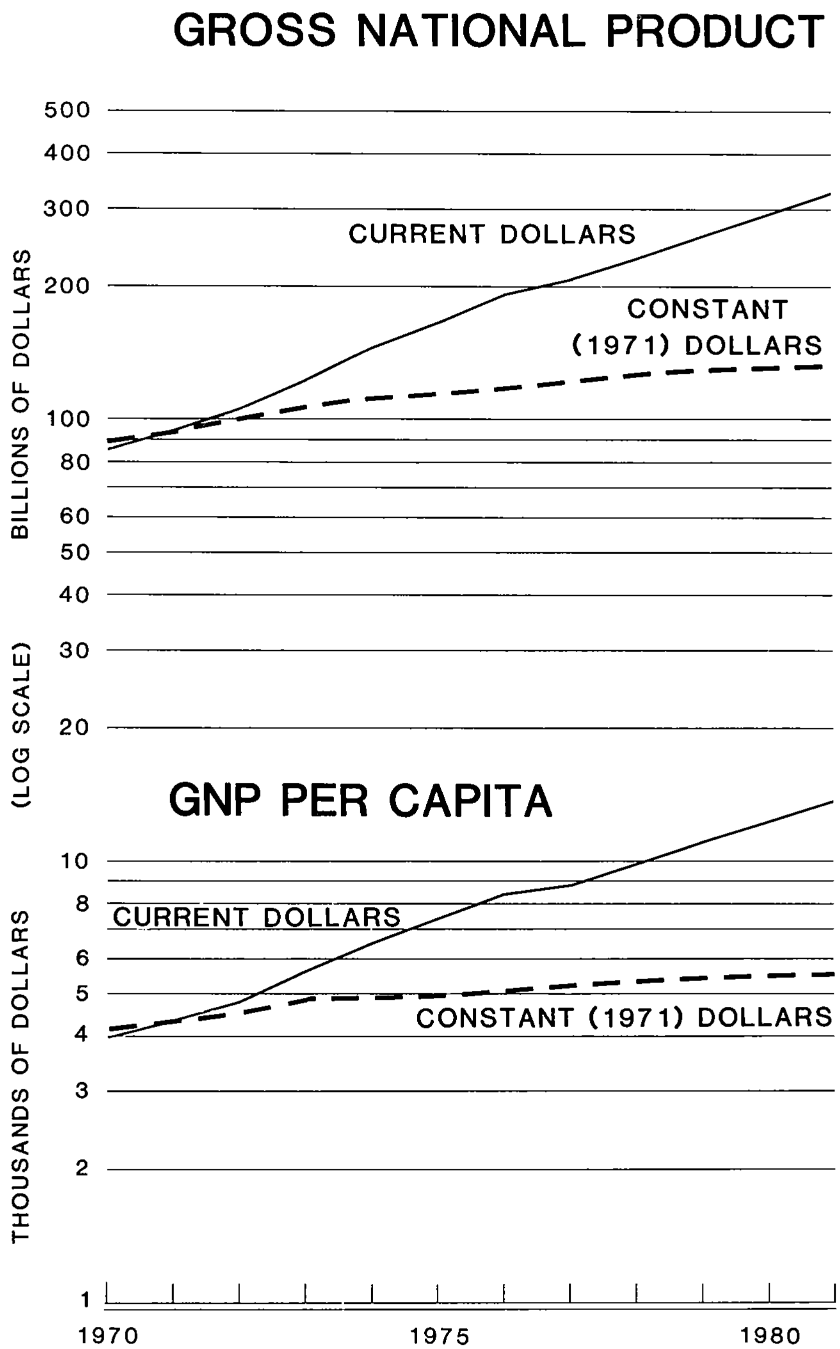
GROSS NATIONAL PRODUCT
500
400
300
CURRENT DOLLARS
200
CONSTANT
(1971) DOLLARS
100
80
60
50
40
30
20
BILLIONS OF DOLLARS
(LOG SCALE)
GNP PER CAPITA
10
8
CURRENT DOLLARS
6
5
4
CONSTANT (1971) DOLLARS
3
2
1
THOUSANDS OF DOLLARS
1970
1975
1980

Figure 1

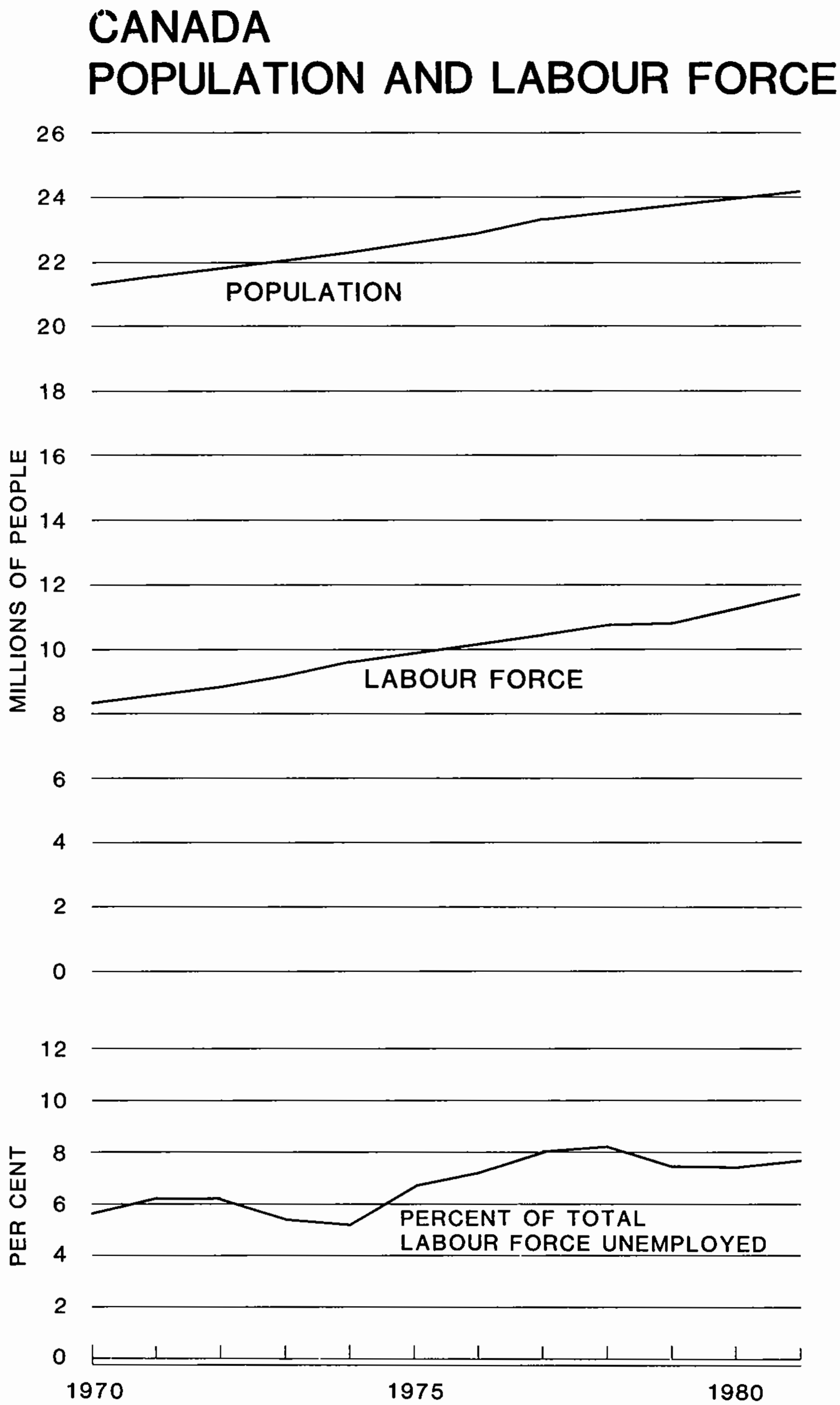
CANADA
POPULATION AND LABOUR FORCE
26
24
22
20
18
16
14
12
10
8
6
4
2
0
MILLIONS OF PEOPLE
POPULATION
LABOUR FORCE
12
10
8
6
4
2
0
PER CENT
PERCENT OF TOTAL
LABOUR FORCE UNEMPLOYED
1970
1975
1980

Figure 2

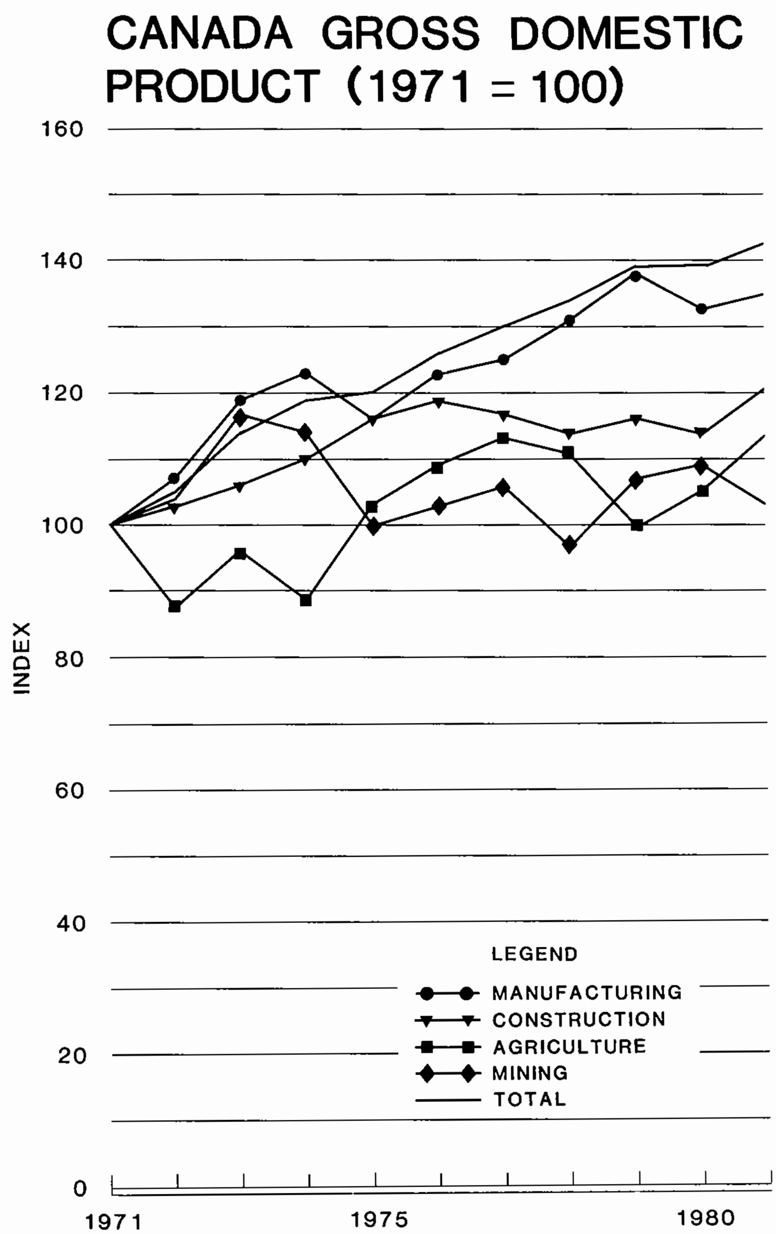
CANADA GROSS DOMESTIC PRODUCT (1971 = 100)
160
140
120
100
80
60
40
20
0
INDEX
1971
1975
1980
LEGEND
MANUFACTURING
CONSTRUCTION
AGRICULTURE
MINING
TOTAL

Figure 3

industry experienced a difficult year. World consumption of most of the principal base-metals fell in 1981 resulting in considerable increases in stocks in some cases.

In the aluminum industry, world production fell 2.2 per cent, and consumption decreased 5.0 per cent from 1980 levels. Canadian production reached 1.1 million t, 3.0 per cent higher than in 1980, but exports of aluminum ingot and other non fabricated forms dropped by 4.0 per cent. Weakness in world markets led the Aluminum Company of Canada, Limited (Alcan) to delay indefinitely the start-up of its second 57,000 t potline at Grande Baie, Québec, which was completed in September. Stocks of the metal at worldwide smelters reached 3.4 million t by mid-year forcing producers to hold production to an average of 75 per cent of capacity by the end of the year. The published selling prices and exchange quotations were also subject to considerable uncertainty over the period.

Copper production fell slightly in Canada in 1981 to 691 328 t from 716 363 t in 1980, while the value declined almost 18 per cent. The Canadian producer price for full-plate cathode ranged from $1.05 per pound at the beginning of the year to $0.94 at the end. Fluctuations occurred but they were not great and any upward swings could not be maintained as demand for the metal declined. World supply, especially from CIPEC countries outstripped demand, preventing any improvement in price, which in real terms had fallen to near 1930 levels.

The nickel industry faced the most difficult situation of the principal nonferrous metals. Plagued by slumping demand for steel, Canadian output was reduced to 160 247 t from 184 802 t in 1980. Besides operating well below capacity, Inco Metals Company instituted temporary production shutdowns while Falconbridge Nickel Mines Limited held production near the 70 per cent rate of 1980. However, while North American producers endeavoured to keep supply and demand in balance, others including the Soviet Union and Cuba began offering nickel at relatively low prices. Posted nickel prices that averaged approximately $US 3.45 were not representative of actual sales, as discounts were offered in an attempt to reduce inventories.

With more concern caused by the decline in the use of lead in batteries and gasoline, that commodity did not fare well either. Although Canadian production of lead in all forms increased 8.5 per cent, value of production was down 2.0 per cent. The producer price at the beginning of the year was 45.5 cents per pound in Canada, and showed strength until mid-year but it could not be maintained. It closed the year at around 40 cents per pound. Battery sales failed to provide their customary stimulus to the lead market as automobile sales floundered.

Compared to all other major metals, zinc was the bright spot of the year. A 13 per cent increase in volume combined with a 39 per cent increase in value made it the healthiest contributor to base-metals in 1981. Concentrate supplies remained tight, resulting in some smelter closures in the United States and Europe. The average Canadian price in 1981 reached 54.46 cents per pound compared with 44.05 cents in 1980. Potential plans in the United States to switch from a copper penny to a copper plated zinc one-cent coin could help offset declining consumption in other areas.

Precious metals continued to act as a buffer against weakness in base-metals, especially where coproducts were produced, but downward pressure partly due to monetary policies curtailed any of the strong upward swings characteristic of 1980.

The price of gold slipped considerably from the all-time high of $US 850 per oz in January 1980. The average Canadian price of $551 per troy oz in 1981 was much lower than the $716 average the previous year, but still high enough to stimulate exploration. In Ontario, gold fever continued as the number of mining claims staked rose to 14,456 in the first eight months of 1981 from 14,282 in the corresponding period of 1980.

Silver prices fell as well, from a Canadian monthly average of $17.57 per oz in January 1981 to $10.02 in December. Volume of output increased 5.5 per cent during the year but value fell 45 per cent from $828 million in 1980 to $458 million in 1981.

In ferrous metal markets, the economic downturn was also prevalent, as weak demand for steel worldwide resulted in reduced production in the iron ore mining industry. In the United States, steel production dropped from 80 per cent of capacity early in the year to less than 60 per cent by year-end, a situation that made it difficult for Canadian producers tied to that market. Shipments of iron ore increased slightly to 49 551 000 t from

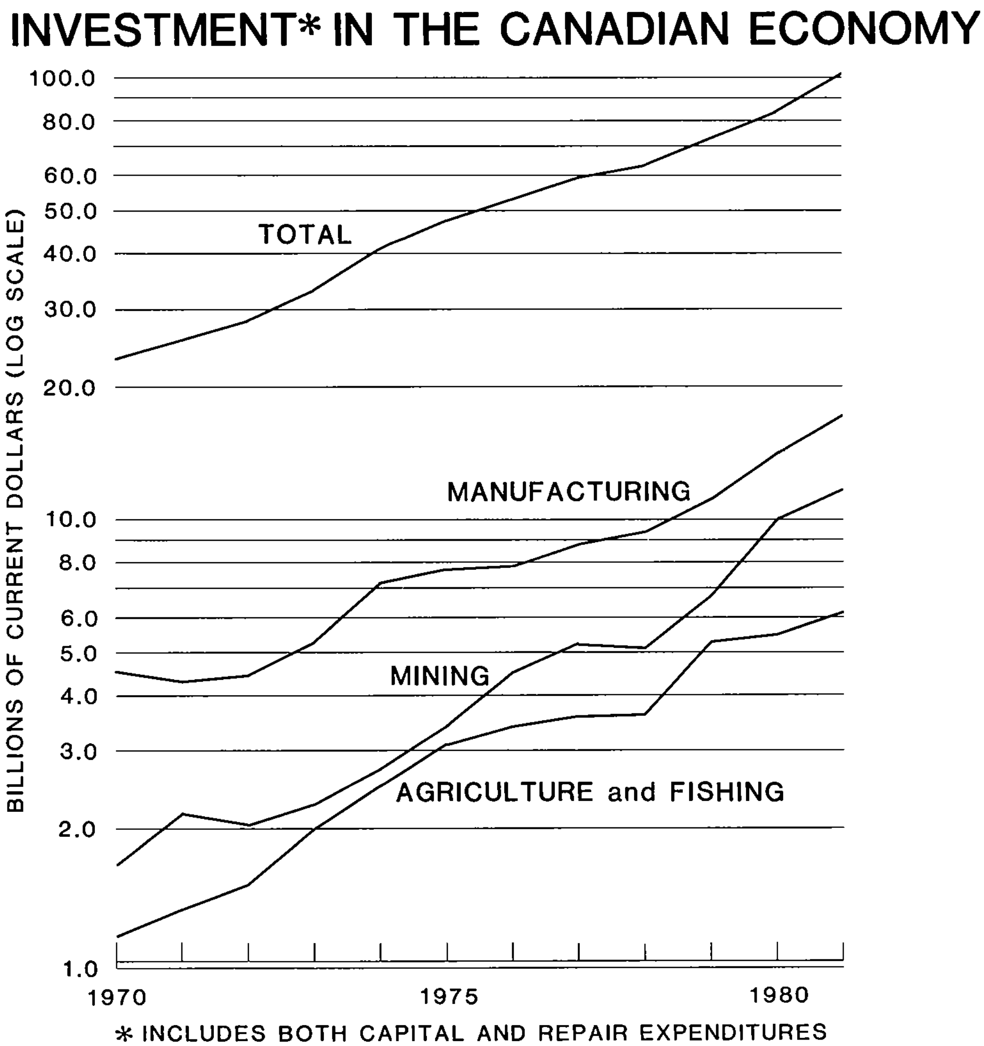
INVESTMENT* IN THE CANADIAN ECONOMY
BILLIONS OF CURRENT DOLLARS (LOG SCALE)
100.0
80.0
60.0
50.0
40.0
30.0
20.0
10.0
8.0
6.0
5.0
4.0
3.0
2.0
1.0
TOTAL
MANUFACTURING
MINING
AGRICULTURE and FISHING
1970
1975
1980
* INCLUDES BOTH CAPITAL AND REPAIR EXPENDITURES

Figure 4

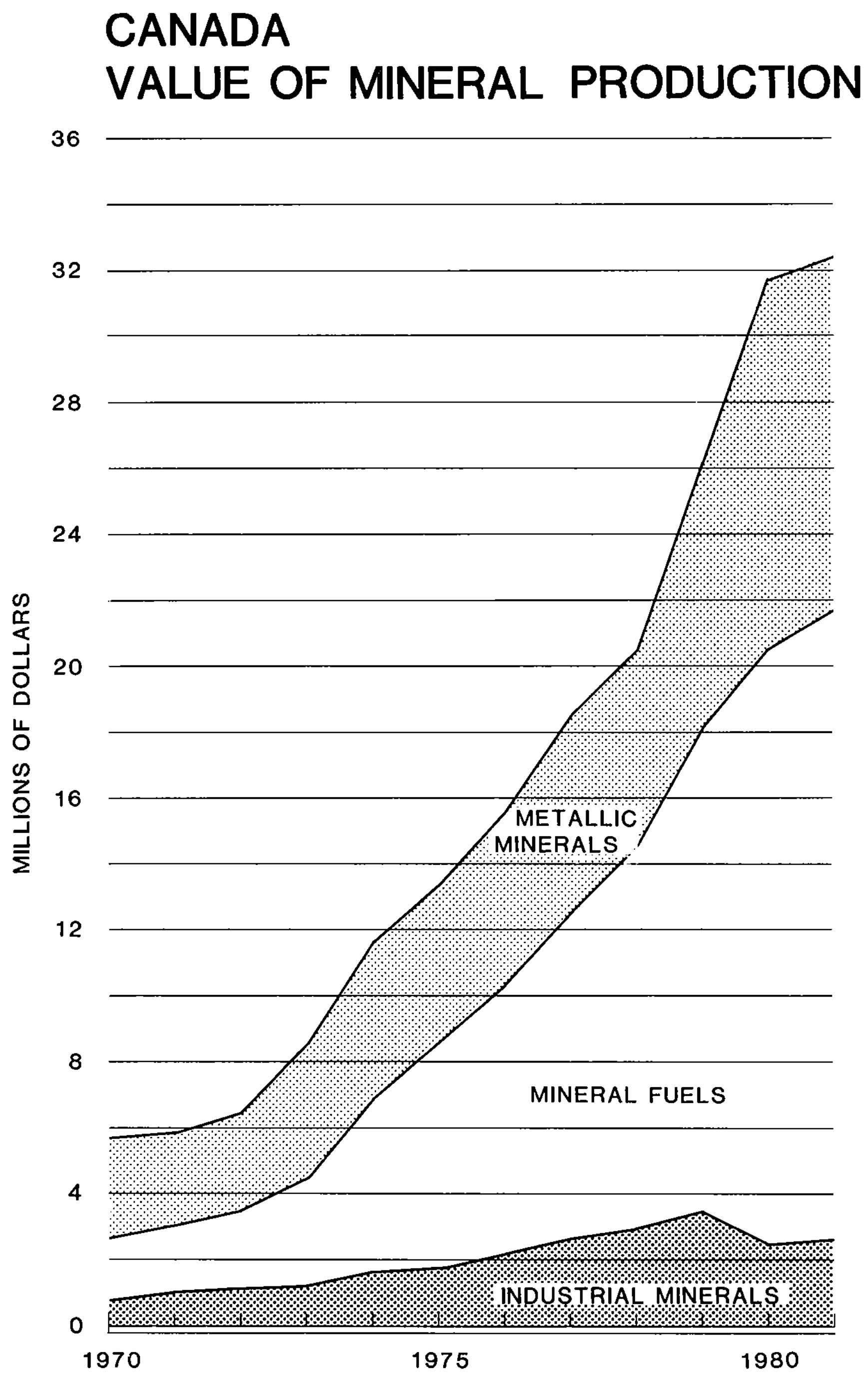
CANADA
VALUE OF MINERAL PRODUCTION
MILLIONS OF DOLLARS
36
32
28
24
20
16
12
8
4
0
1970
1975
1980
METALLIC MINERALS
MINERAL FUELS
INDUSTRIAL MINERALS

Figure 5

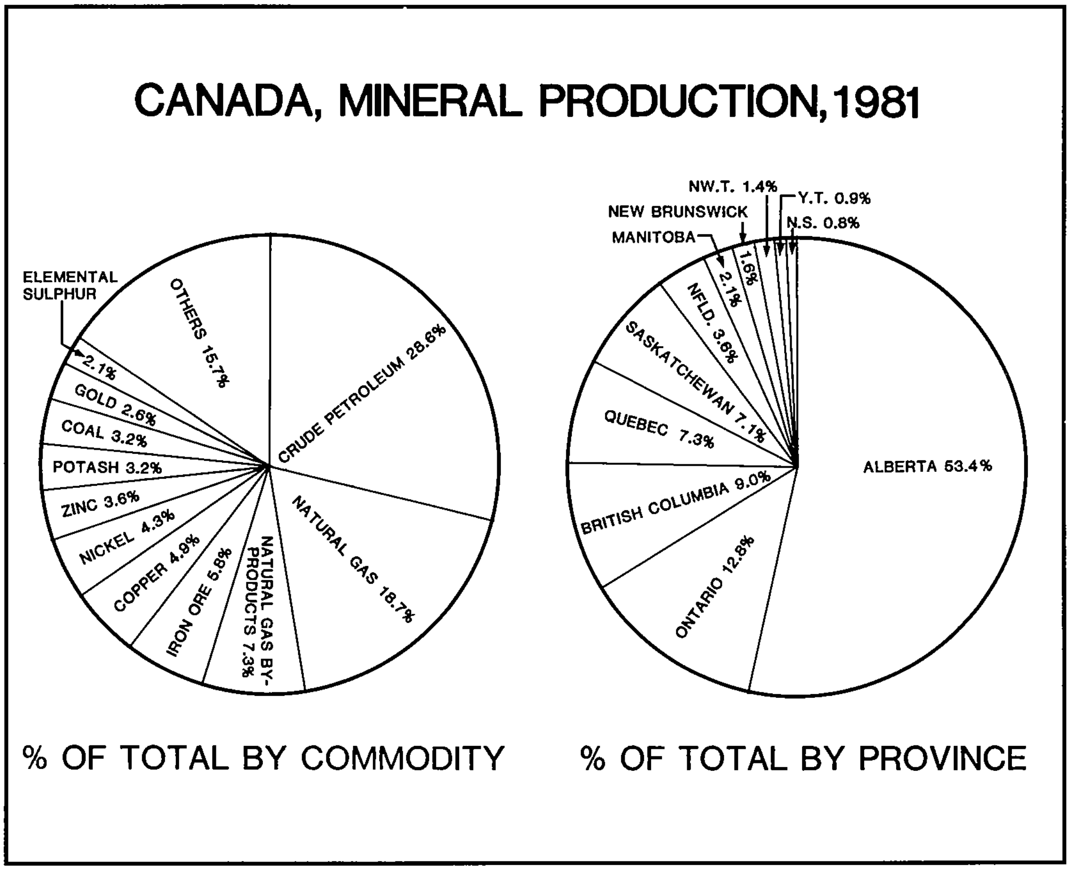

Figure 6

49 068 000 t in 1980 despite production cutbacks and layoffs at several iron ore mines and processing plants in Québec, Labrador and Ontario. Canadian demand for steel was unusually buoyant in the first half of the year and domestic steel producers had difficulty satisfying some orders due to a four-month strike that halted steel production in one-third of the industry, but a softening of markets in the latter part of the year led to a situation of over supply by December.

Molybdenum, heavily dependent on a healthy steel industry, suffered as a result. Termed "the darling of the mining industry in the 1970s", recession and world oversupply caused molybdenum prices to fall and weak markets are expected to continue in the next few years. Producer prices which peaked at $US 23/kg in 1980 declined to around $17 in 1981.

INDUSTRIAL MINERALS

Most industrial minerals suffered fates similar to the base-metals though not as strongly or as pervasively. Overall value of output rose 8.0 per cent compared with the previous year. Asbestos suffered along with the construction industry as shipments declined by 14 per cent. Layoffs were widespread during the summer and fall in the Québec mining towns of Thetford and Asbestos, while the Advocate Mines Limited operation at Baie Verte, Newfoundland closed at the end of the year.

Potash, on the other hand, had a healthy year as sales rose and mine expansions in Saskatchewan continued. Strong markets encouraged new mine developments in New Brunswick and exploration in Nova Scotia. Increased world demand for fertilizer, particularly by Third World countries, led to active exploration within Canada.

The value of sulphur output increased from \$444 million in 1980 to \$695 million in 1981, an increase of 57 per cent. Prices rose dramatically in 1981 as offshore demand for Canadian sulphur grew. Canada accounted for about 40 per cent of world trade in sulphur in 1981.

Mineral Fuels

In the fuel sector, volume of natural gas and oil production was down 5.7 per cent and 10.4 per cent respectively in 1981 from 1980.

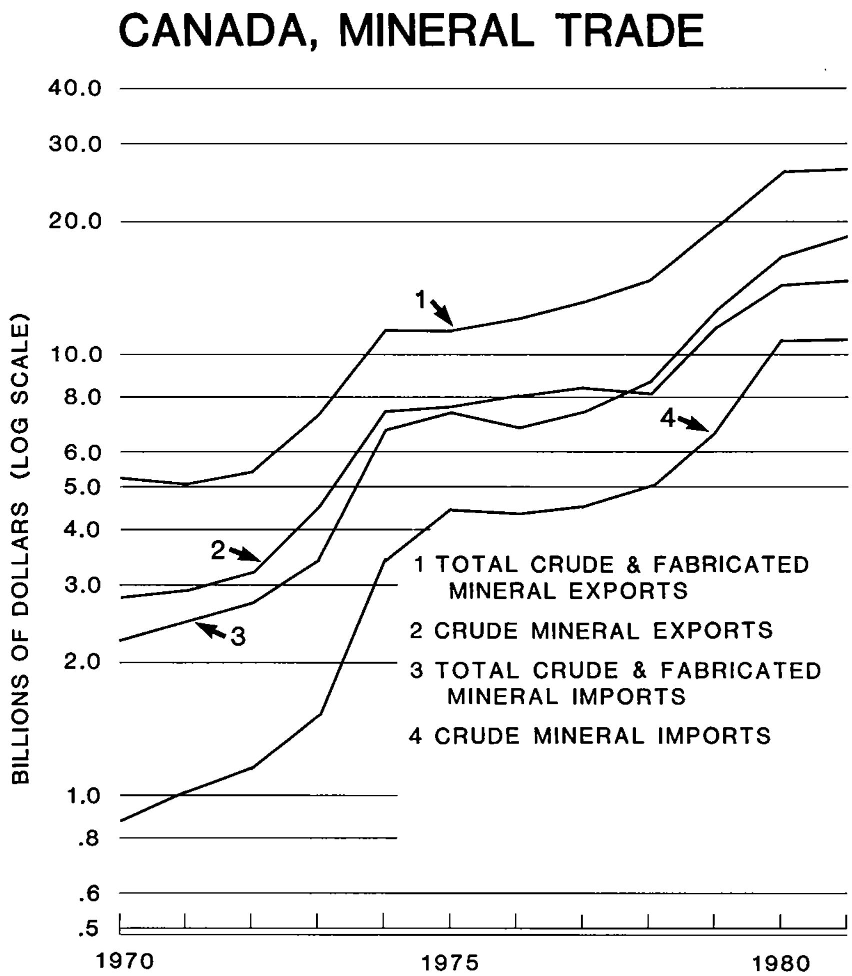

Figure 7

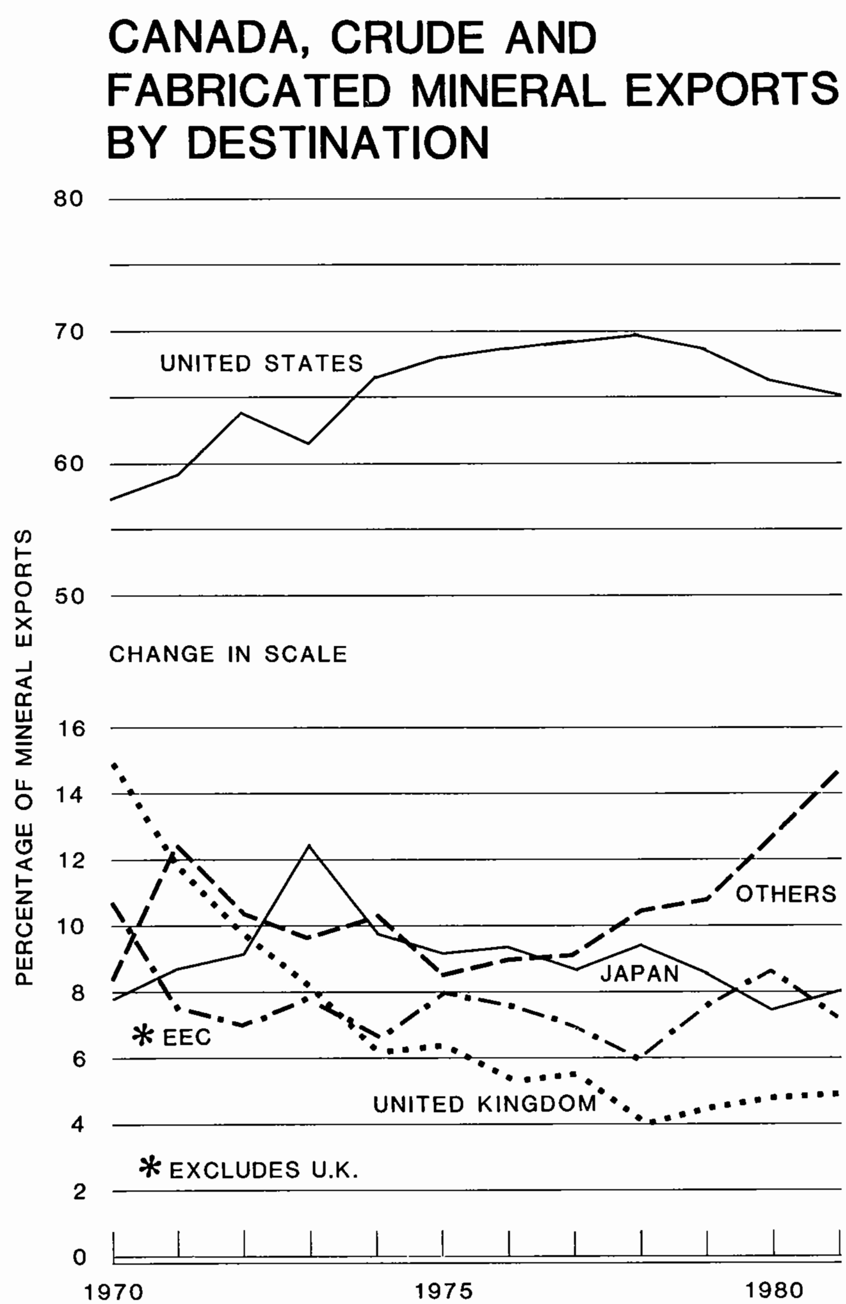
CANADA, CRUDE AND FABRICATED MINERAL EXPORTS BY DESTINATION
PERCENTAGE OF MINERAL EXPORTS
80
70
60
50
UNITED STATES
CHANGE IN SCALE
16
14
12
10
8
6
4
2
0
OTHERS
JAPAN
* EEC
UNITED KINGDOM
* EXCLUDES U.K.
1970
1975
1980

Figure 8

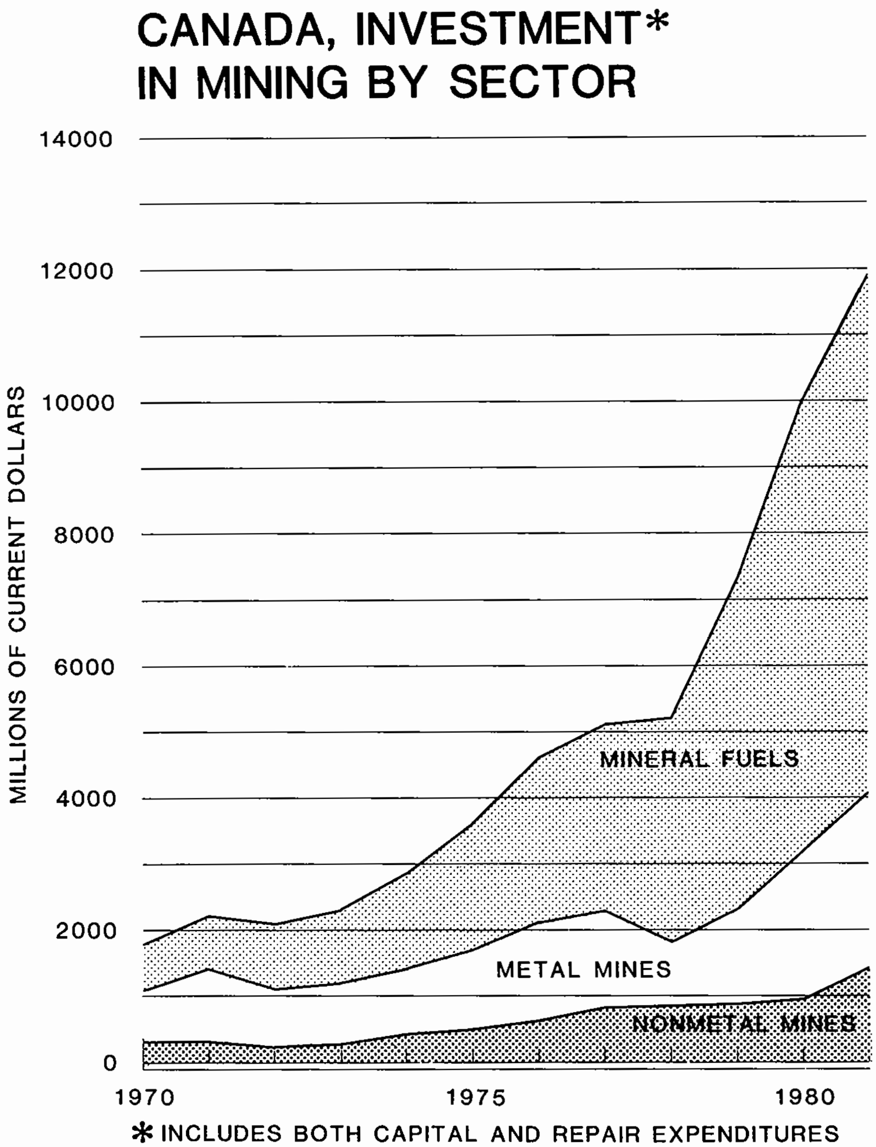
CANADA, INVESTMENT*
IN MINING BY SECTOR
14000
12000
10000
8000
6000
4000
2000
0
MILLIONS OF CURRENT DOLLARS
MINERAL FUELS
METAL MINES
NONMETAL MINES
1970
1975
1980
* INCLUDES BOTH CAPITAL AND REPAIR EXPENDITURES

Figure 9

Values were up slightly but the industry suffered from cutbacks and uncertainties until agreement on pricing policies was reached between the federal and provincial governments in September. The Petroleum Monitoring Agency reported a 21 per cent decline in net income in the first half of 1981 for 75 oil firms, although total industry revenues rose 22 per cent during the period.

The coal industry on the other hand had a boom year as the search for energy substitutes grew. Both volume and value of production increased, with output increasing in all producing provinces except Nova Scotia, where a strike at Cape Breton Development Corporation (Devco) kept totals down. New offshore markets in Europe and Japan gave impetus to several mega-projects in British Columbia and Nova Scotia. The project by Quintette Coal Limited and Teck Corporation in the Peace River area, including railway extensions, a port on the Pacific coast, a new town and 1,000 railway hopper cars, involves expenditures of $2.0 to $2.5 billion.

Industrial Production

The seasonally adjusted index of industrial production, a measure of real output in the industrial economy, declined steadily from mid-July. The mining sector contributed strongly to that decline. Just how much the industry suffered was illustrated by the fact that several key mineral companies reported their first losses in many years. The reported losses were substantial and reflected the economic conditions in which they were operating during 1981, while other mineral companies reported substantial reductions in profits.

Investment

Reductions or delays in capital spending marked the year. The Canadian Mining Journal's Capital[1] Spending Report revealed $8.522 billion committed to projects involving minerals in Canada compared to $8.516 billion reported for 1980. Statistics Canada estimated 1981 spending intentions to drop to $1.8 billion in metallic mining compared with expenditures of almost $2.5 billion in 1980. Expenditures in the category of Mines, Quarries and Oil Wells were estimated to rise overall with commodities such as coal, uranium and potash leading the others, but "The high cost of money, inflation and weak metal markets took their toll this year".[1]

International Trade

The value of exports of crude minerals reached $14.7 billion in 1981, while imports totalled $10.9 billion for an overall contribution to the merchandise trade surplus of $3.8 billion. Crude and fabricated mineral exports reached $26 billion, representing 32 per cent of total exports in the economy. In value terms, exports of copper, lead, molybdenum and silver recorded declines during the year, of 26 per cent, 24 per cent, 22 per cent and 38 per cent respectively while others such as zinc, gold, iron ore and sulphur increased significantly. Export levels of nickel were maintained at $1.23 billion in 1981 compared with $1.26 billion in 1980. Total Canadian exports of all products increased by 9.0 per cent over that of 1980 in spite of the severe downcycle. The length and severity of this downcycle is difficult to predict. Strong improvement cannot be expected in the near-term, indeed increased growth in the mineral industry will occur only when a sharp turnaround in the world economies materializes. Policies of restraint and cutbacks on the part of mining companies have been instituted to survive the present downturn. World economic recovery will necessitate a heavy demand for mineral products and with renewed vitality, the gap between potential and actual growth in mining could be lessened.

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[1] Canadian Mining Journal, October 1981, Industry Activity Report.

Regional Review

T.M. BUCH

The value of Canadian mineral production in 1981 reached an all-time high of \$33.08 billion, an increase of \$1.24 billion, or 3.9 per cent, over the previous year's value. Output of energy commodities increased \$1.07 billion although physical output of petroleum and natural gas declined. Metallic mineral output declined \$299 million, or 3.1 per cent. The value of output of non-metals and of structural materials increased 11.9 per cent and 10.4 per cent, respectively.

Behaviour of the non-energy minerals was mixed. Copper and iron ore output increased in volume marginally, but since copper prices fell, the value of copper output declined about 12 per cent. Iron ore value increased by about the same amount as prices strengthened. Zinc increased about 12 per cent in output, and 39 per cent in value. Gold output was down 6.8 per cent in volume, but 27.9 per cent in value, whereas the platinum group of metals increased 48 per cent in volume and 40.6 per cent in value. Nickel production declined 29 600 t or 16 per cent.

Asbestos production declined 14.4 per cent in volume and 4.7 per cent in value, and potash output fell 5.4 per cent in volume, but rose 2.9 per cent in value. The value of the major structural materials, cement and sand and gravel, increased 7.6 per cent and 17.1 per cent respectively.

NEWFOUNDLAND

In 1981 the value of total mineral production was \$1.19 billion, up 15.3 per cent compared with 1980, which compares favourably with most other provinces. However, the increase, about \$160 million, was due almost entirely to a 18.2 per cent increase in the value of iron ore production.

Output of asbestos fell by nearly \$6 million, or 12.9 per cent; copper by \$317,000 or 2.5 per cent and silver by \$4 million or 56.8 per cent. The output of structural materials rose by \$2.6 million, or 16 per cent.

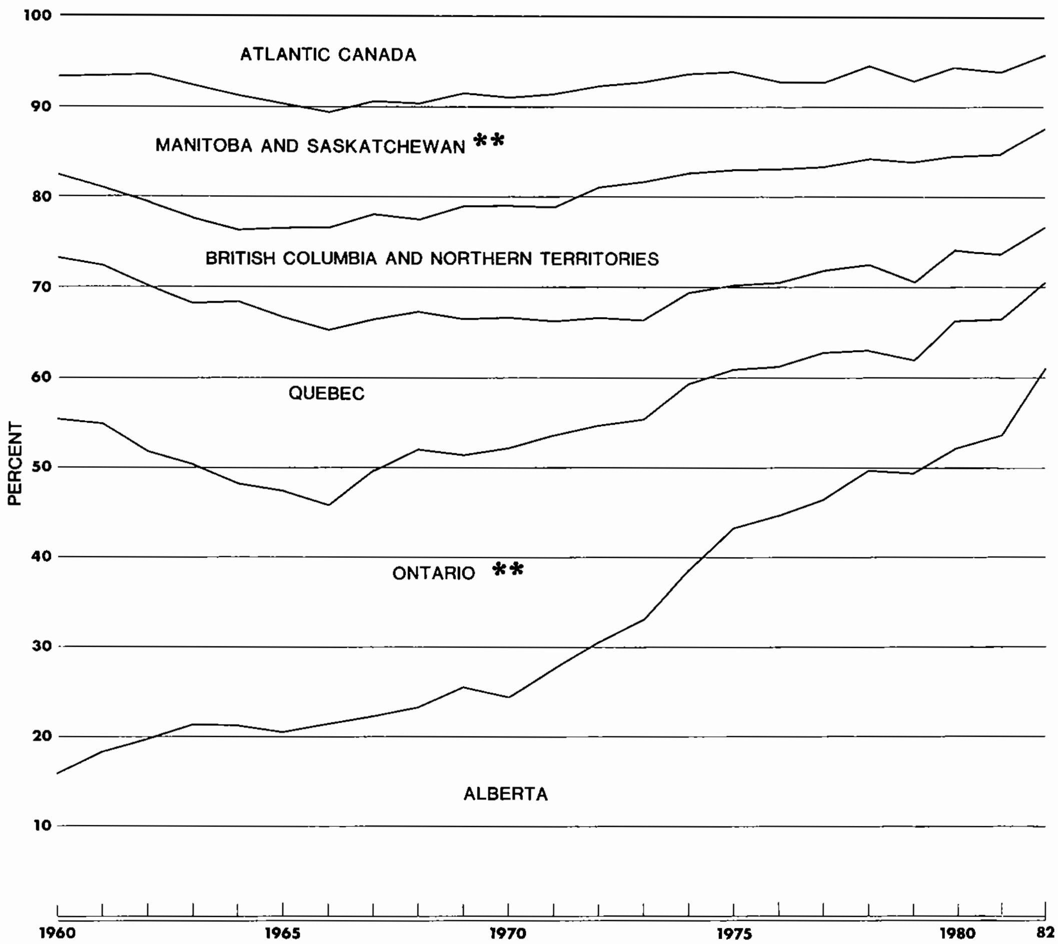
Exploration activity continued to increase. More than 13,000 claims were staked in 1981, bringing the total in good standing at year-end to more than 25,000. By the end of 1981, according to a provincial spokesman, 80 per cent of Crown land in insular Newfoundland and 95 per cent in Labrador was open for staking. This compares with only 10 per cent available in the whole province in 1970.

Westfield Minerals Limited continued, with its joint venture partners, the largest single exploration project in the province, in the Deer Lake Basin. To the south and west, Riocanex Inc. outlined approximately one million t of ore-grade material on its gold-silver-base-metal property near Port-Aux-Basques. The search for lead-zinc deposits in carbonate rocks in northwestern Newfoundland continued.

Iron ore shipments, which account for more than half of the total Canadian output, were affected in 1981 by the economic slow-down in the United States and Europe. Companies laid off workers in the summer, and again towards the year-end.

Operations continued at the Buchans mine, which had been scheduled to close in 1979. An extension of the MacLean orebody was reported to contain about 400 000 t of reserves. Following modification of part of the Buchans plant, production of barite from old tailings started during 1981.

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



*Based upon current dollar production data

**Does not include uranium prior to 1977

The Baie Verte asbestos operations of Advocate Mines Limited were closed temporarily in August, and 150 of the 650 employees were laid off. Operations resumed after about a two-week shutdown, but the company announced that the mine would close. Several companies, including Transpacific Asbestos Inc., expressed an interest in aquiring the property. Also at Baie Verte, Consolidated Rambler Mines Limited announced that its copper mine would operate on a month-to-month basis.

The five year, $12-million Canada-Newfoundland Mineral Development Subsidiary Agreement, designed to improve the geoscientific knowledge base in Newfoundland and Labrador, ended March 31, 1982. Under the agreement, bedrock geological map coverage has been greatly extended, core-storage facilities have been built or are under construction, and a survey has been made of construction aggregates. A lake sediment survey has been carried out and element distribution maps will be published at a scale of 1:250,000. A comprehensive geochemical atlas was in preparation.

NOVA SCOTIA

The value of mineral production in Nova Scotia rose by 6.1 per cent in 1981 to $262 million. For salt and gypsum, both price and quantity increased, helping to offset the 5.4 per cent decline to $126 million in the value of coal, caused by a three-month strike at the Cape Breton mines, the first since 1947. Nova Scotia is Canada's largest producer of gypsum, second in salt and third in coal.

Esso Minerals Canada suspended production at its Gays River lead-zinc mine in August until methods are devised to improve the mining of the complex orebody and to prevent underground flooding. In September, the Yava lead mine of Barymin Explorations Limited closed because of continuing operating losses. Shell Canada Resources Limited is expected to make a decision in early 1982 on whether to develop its East Kemptville tin deposit.

To replace oil for power generation, the No. 26 Colliery is being rehabiliated, output from the Prince and Lingan mines was increased and preliminary work was under way on the proposed Donkin-Morien mine near Sydney. Coal exploration will be conducted by Petro-Canada offshore in the Bay of Aspy area, by BP Exploration Canada Limited in Cumberland county, and by Brinco Mining Limited and Suncor Inc. near Stellarton.

The Scotia Coal Synfuels Project, a consortium of three Crown and two private sector corporations, initiated a $2.5 million feasibility study into the possible liquefaction of Nova Scotia coals.

For a number of years, several companies have been exploring for uranium in the farming belt along the Bay of Fundy. Several promising deposits were found, and the best are believed to be in the Annapolis Valley. During 1981, public pressure mounted against uranium exploration and development in Nova Scotia. The province first appointed a committee of 10 legislators to investigate the environmental and health impact of uranium exploration and development. Prior to the fall provincial election, the Cabinet placed a moratorium on new exploration licences and renewals. After the re-election of the government, Judge Robert McCleave was appointed to a one-man commission to investigate uranium exploration and development in the province.

The Honourable Judy Erola, federal Minister of State (Mines), and the provincial Minister of Mines and Energy, the Honourable Ronald Barkhouse, signed an agreement on December 1 that provides for cooperative programs of geoscientific surveys and mineral development activities, to run until March 31, 1984. The federal funding is $2.7 million and the provincial funding $1.24 million.

NEW BRUNSWICK

The value of mineral production increased by 43.5 per cent in 1981 compared with the previous year, to $534.6 million. This increase reflects production lost in 1980 during a long strike at the mine and smelter operations of Brunswick Mining and Smelting Corporation Limited. Compared with 1979, production increased by 11.5 per cent.

In April, Brunswick Mining and Smelting completed a $56 million expansion program at the No. 12 underground mine to increase production from 8 900 tpd to 10 250 tpd and replace production from the No. 6 open-pit mine, where ore reserves are exhausted. The company, in conjunction with Heath Steele Mines Limited, has received federal and provincial incentives to construct a 100 000 tpy zinc reduction plant at Belledune that will cost $360 million and will create 400 permanent jobs.

TABLE 1. (cont'd)

	Value of production ($ million)	Proportion of total (%)	Change from 1980 (%)
British Columbia			
Copper	684.1	23.0	-0.4
Coal	532.6	17.9	19.6
Natural gas	336.5	11.3	10.6
Molybdenum	299.7	10.1	6.5
Crude petroleum	237.9	8.0	23.4
Total	2,971.7	100.0	6.3
Yukon Territory			
Zinc	103.8	34.8	17.6
Silver	69.5	23.3	-39.1
Lead	50.7	17.0	-29.1
Total	298.2	100.0	-17.5
Northwest Territories			
Zinc	269.1	57.6	55.9
Gold	64.9	13.9	-43.1
Lead	63.9	13.7	14.3
Total	467.2	100.0	10.1
Canada			
Petroleum	9,411.2	28.4	4.1
Natural gas	6,156.9	18.6	0.1
Natural gas byproducts	2,398.2	7.2	31.4
Iron ore	1,917.6	5.8	12.7
Copper	1,590.8	4.8	-14.5
Nickel	1,414.7	4.3	-5.5
Zinc	1,193.5	3.6	39.1
Potash	1,050.5	3.2	2.9
Coal	1,045.5	3.2	12.2
Gold	881.1	2.7	-24.4
Total	33,084.3	100.0	3.9

Source: Energy, Mines and Resources Canada.
P Preliminary.

value, while output of associated platinum group metals rose 48 per cent in volume and 40.3 per cent in value. Zinc production declined 2.0 per cent, but rose 21.1 per cent in value.

The value of Ontario's chief non-metal, salt, rose 8.0 per cent to $77 million. Structural materials production, associated with highways and other construction, increased 13.6 per cent in 1981; cement was up 22.7 per cent, sand and gravel 6.0 per cent and stone 6.3 per cent.

Much of the exploration and development work done during the past year was related to the gold mining industry. New and previously known properties were examined and producing mines expanded.

At Red Lake, Dickenson Mines Limited mine is scheduled to reach 900 tpd by 1983, nearly 2½ times its 1979 level and expansion of the Campbell Red Lake Mines Limited mine was completed.

Former gold producers being examined or refurbished include the Cochenour mine at Red Lake, the Consolidated Professor Mines Limited property on Shoal Lake, near Kenora; and in the Beardmore-Geraldton district, the old Northern Empire Mines Limited mine and the Consolidated Louanna Gold Mines Limited's property. Also near Beardmore, Goldwater Mines Limited acquired a number of properties and intends to build a mill, as does Goldlund Mines Limited near Sioux Lookout.

Other companies examining gold prospects in various parts of the province include Corona Resources Ltd. at Hemlo, 30 km east of Marathon, Chester Resources Inc just west of Gogama, and Asarco Exploration Company of Canada, Limited, and Nickel Offsets, Limited near Timmins.

While the gold mining industry had a reasonably good year, nonferrous metal mining, in general, suffered from the overall low level of industrial activity. Inco Metals Company announced plans for a four-week summer shutdown of its Ontario mining and processing operations, reduction to single shift at Shebandowan, and supervision of production at the Coleman mine at Sudbury, March 1, 1982. Also, the company announced a reduction of 850 persons from its Sudbury workforce. Falconbridge Nickel Mines Limited also announced plans for a five-week, later extended to ten-week, summer shutdown.

Among the nonferrous metal mines of Northwestern Ontario, the Geco division of Noranda Mines Limited, at Manitouwadge, is spending $2.4 million on surface and underground improvements, due to be completed in 1982. East of Sioux Lookout, the Sturgeon Lake Mines Limited mine closed.

Falconbridge Nickel opened its new Frazer mine, named after late Dr. Horace J. Frazer, who was managing director from 1957 until his death in 1969. When the operation reaches its full scheduled output in 1983 about 500 people will be employed and production will be 2 300 tpd. Work continued on Inco Limited's new electro-cobalt refinery at Port Colborne. At Elliot Lake, following a brief strike,a new three-year agreement was signed at Rio Algom Limited and Denison Mines Limited that will make these employees among the highest-paid in Canada, with the lowest-rated employees receiving $15.27 an hour in 1987. The employee's union, the United Steel Workers of America, have also won the right to appoint safety inspectors to the mine sites.

Silver output from Cobalt was up for the first nine months of 1981 compared with the previous year. However, in the last quarter, with the falling price of silver and the closing of the local custom refinery, the Penn mill of Agnico-Eagle Mines Limited was closed.

MANITOBA

Mineral production in Manitoba in 1981 was valued at $671.3 million, 16.3 per cent lower than in 1980, but comparable to the value in 1979. Most base metals suffered a decline in value and quantity shipped, however, shipments and value of construction materials such as cement and gypsum increased significantly.

November 17, 1981 saw the election of the New Democratic Government headed by the Honourable M.H. Pawley. During the election campaign, he indicated that the Crown corporation, Manitoba Mineral Resources Ltd. would expand its role in mineral exploration, including participation in joint ventures with the private sector.

The new government indicated that it will continue the negotiations started by the previous government with Aluminum Company of Canada, Limited and International Minerals & Chemical Corporation (Canada) Limited. The first of these involves construction of a $800 million, 200 000 tpy aluminum smelter within 50 km of Winnipeg. The other is the development of a 1.8 million tpy potash mine at McAuley, near the Manitoba-Saskatchewan border. These projects will benefit southern Manitoba, in contrast to mineral industry activity in the past, which has been mainly confined to the north.

Mining in northern Manitoba is dominated by three companies: Hudson Bay Mining and Smelting Co., Limited (HBMS), Inco Metals Company and Sherritt Gordon Mines Limited. During 1981, HBMS continued development of three new mines in the Flin Flon area, namely Trout Lake, due to start production by mid-1982, Spruce Point by the end of 1982, and Rod by early 1983. At Thompson, Inco started work on a $72 million open-pit mine, slated for production in 1984. However, this schedule may be affected by the three-month strike that ended December 15, 1981. At year-end, Sherritt announced a layoff of 373 employees at its Fox and Ruttan mines and at headquarters at Lynn Lake, due to the low copper price.

Although most pf the $30 million estimated to have been spent on exploration last year was directed towards base metals, there was considerable activity in gold mining and exploration. Sherritt extended underground its exploration program on the Lynn Lake property of Agassiz Resources Ltd. If a decision is made to go ahead, production could start by the end of 1983.

In southeastern Manitoba, a joint venture between Brinco Limited and New Forty-Four Mines Limited will put the old San Antonio gold mine at Bissett back into production in 1982.

TABLE 2. EMPLOYMENT STATISTICS IN MINING[1] BY PROVINCE, 1979-81

		Nfld	NS	NB	PEI	Que	Ont	Man	Sask	Alta	BC	YT & NWT	Canada
Mining employ't[1] 1979	'000	5.8	5.0	3.0	..	24.2	29.7	5.6	8.1	51.5	15.0	3.1	151.0
% of total province		4.2	2.0	1.5	..	1.1	0.9	1.6	3.0	6.4	1.6	8.4	1.7
Total prov. employ't[2]	'000	138.0	254.9	197.9	31.5	2,203.7	3,438.1	355.5	268.0	810.8	957.4	36.7	8,692.5
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	67.6	18.3	3.8	178.1
% of total province		4.0	1.8	1.5	..	1.0	1.0	1.6	3.4	7.3	1.7	9.4	1.9
Total prov. employ't[2]	'000	140.4	264.8	203.9	31.1	2,284.5	3,603.2	368.7	283.9	931.5	1,039.1	40.3	9,191.4

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

SASKATCHEWAN

The value of mineral production in Saskatchewan rose by 4.1 per cent to $2.41 billion in 1981. Potash output increased slightly to $1.050 billion, while crude petroleum fell by 4.3 per cent to $827 million because of reduced quantity produced. The value of uranium production rose to $302 million due to a 31.4 per cent increase in the quantity produced. Saskatchewan produces all of Canada's potash, almost all of its sodium sulphate, 39 per cent of its uranium, and is a significant producer of crude petroleum and coal.

Elements in the uranium sector in the north continued to dominate the Saskatchewan mineral industry. In December, Eldorado Nuclear Limited announced that it will close its Beaverlodge uranium mine at Uranium City, effective June 30, 1982, due to declining ore grade, low uranium prices and rising production costs. In 1980, the company processed 292 000 t of ore and produced 0.5 million kg of uranium oxide. The closure will affect 830 people in a town of 2,500 that is wholly dependent on the mine. There is no alternative employment available in the area.

Amok Ltd. officially opened its Cluff Lake mine in April. Although open-pit mining from the high-grade D orebody had begun in June 1980, and the concentrator was operational by the end of 1980. The company completed mining the 'D' orebody by the end of 1981, stockpiling ore in excess of mill capacity. Lower grade adjacent deposits will be developed. The company employs over 200 people who are flown to the mine site, almost half of them from northern communities.

In August, the province and Key Lake Mining Corporation signed a surface lease agreement that will permit development of the first of the two Key Lake uranium deposits. Scheduled to start-up in mid-1983, the Gaertner mine is expected to produce over 5 million kg of uranium concentrate per year, employ about 400 people, and cost over $450 million. The lease agreement stipulated environmental guarantees, safeguards for the health and safety of the workers, and incentives for northern development.

Gulf Minerals Canada Limited announced plans to develop a new mine at Collins Bay, 11 km north of its Rabbit Lake operation. The Rabbit Lake mine has sufficient ore for only a few more years, after which production from Collins Bay will be necessary in order to maintain output at the Rabbit Lake concentrator.

Other potential uranium developments in the north are Esso Minerals Canada at Midwest Lake, Asamera Inc. at Dawn Lake, and Canadian Occidental Petroleum Ltd. at McClean Lake.

The only non-uranium mineral project in the north was a gold mine and 220 tpd mill being readied for production in the spring of 1982 by Flin Flon Mines Ltd.

Major capital projects were under way or are planned in the potash-producing region of the province. The largest expenditures, are by the Potash Corporation of Saskatchewan (PCS) of $2.5 billion on mine expansions and development. These include major expansion under way at its PCS Rocanville mine and another planned at its jointly-owned Esterhazy operations, and a new 3.5 million tpy mine planned near Bredenbury, north of Esterhazy to be constructed beginning in 1982. Other major potash mine expansions were under way by Cominco Ltd. and by Potash Company of America on their mines near Saskatoon.

ALBERTA

The value of mineral production in Alberta increased 7.3 per cent to $17.57 billion in 1981, chiefly because of higher prices for crude petroleum, natural gas and natural gas byproducts. Higher prices caused a 55 per cent increase in the value of elemental sulphur to $675 million, while coal output increased slightly to $309 million. Alberta produces 88 per cent of Canada's fossil fuels and 97 per cent of its elemental sulphur.

Coal dominates the non-petroleum mineral industry in Alberta with a number of new mine developments and expansions under way or proposed.

In the west-central coalfields, near Hinton, expansion of the Cardinal River Coals Ltd. operation and Luscar Sterco Ltd.'s Coal Valley mine were under way. In conjunction with six Japanese steel firms, Manalta Coal Ltd. was developing a new coking coal mine on its Gregg River Coal Ltd. property to begin production in 1983 and eventually produce over 2 million tpy. Evaluating development of new thermal coal mines were Manalta, at its McLeod River and

Mercoal properties, and Union Oil Company of Canada Limited on its Obed Marsh property, where a 3 million tpy mine could begin production in late-1983.

In the central region, near Edmonton, the Highvale mine that currently supplies coal to the Sundance station of TransAlta Utilities Corporation was planned to be expanded to 11 million tpy to supply the new Keephills station, scheduled to begin operation in the early 1980s. Southeast of Edmonton, Luscar Ltd. was developing a new mine to supply additional coal to the recently expanded Battle River station of Alberta Power Limited.

West of Drumheller, Manalta Coal Ltd. was planning to expand its Rosylyn mine to 1.7 million tpy by 1985 to supply the new Sheerness power station. Fording Coal Limited was involved in a proposal with TransAlta and Alberta Power for a coal mine and thermal station development to produce power for export to the United States. Near Lethbridge, Fording Coal was considering an underground thermal coal mine on its Shaughnessy property and Petro-Canada was evaluating the feasibility for an underground thermal coal mine in the same area.

BRITISH COLUMBIA

British Columbia is third in value in mineral production in Canada at $2.972 billion in 1981, an increase of 6.3 per cent from 1980. The value of copper and molybdenum remained steady at $684 and $300 million, respectively, as falling prices were offset by increased quantities produced. The value of coal increased by 19.6 per cent to $533 million. Higher prices caused the value of natural gas and crude petroleum to increase to $336 and $238 million, respectively. British Columbia is Canada's largest producer of copper, coal, molybdenum and lead.

Coal remains the most active sector of the British Columbia mineral industry. In the northeast, the long awaited multibillion-dollar development can now begin, following agreement in early December on terminal throughput charges by the initial shippers, Teck Corporation and Denison Mines Limited, and the operators of the new coal port facilities at Ridley Island, near Prince Rupert. The agreement calls for completion of terminal and rail facilities to allow shipments to Japan by late-1983. The terminal will have an initial capacity of 12 million tpy. Shipments from the first two mines will eventually total 7.7 million tpy. Other companies exploring in the region include Petro-Canada, BP Canada Inc., Norco Resources Ltd., Utah Mines Ltd. and Ranger Oil Limited.

In the southeast region of the province, several new coal developments are planned or under way. B.C. Coal Ltd. (formerly Kaiser Resources Ltd.) has begun to develop its new 2 million tpy Greenhills mine and is expanding its Westshore Terminals Ltd. facilities at Roberts Bank, south of Vancouver. The new Line Creek coal mine of Crows Nest Resources Limited is expected to begin production in 1982, and will eventually produce nearly 2 million tpy of coal for export. Fording Coal Limited is also carrying out a major expansion and upgrading program at its Elkford coal mine which will increase its output potential by 2 million tpy. Other companies active in the area include Byron Creek Colleries Limited, already in production, and Elco Mining Limited and Sage Creek Coal Limited, both of which are considering new mine projects.

A potential coal development on Vancouver Island, near Campbell River, is being investigated by Quinsam Coal Ltd. Near Kamloops, British Columbia Hydro and Power Authority is evaluating the possibility of a 2 000 MW thermal electric station fired by low-grade coal from the Hat Creek deposit.

Several metal mining projects are under way or were completed during 1981. In the north, near Cassiar, United Hearne Resources Ltd. and Plaza Mining Corporation, started up a small gold producing operation, and to the northeast, near Atlin, Trident Resources Inc. opened a small silver mine. In the Stewart area, Amax of Canada Limited brought its Kitsault molybdenum mine on-stream in April and Scottie Gold Mines Ltd. started up a small gold mine. Further to the west, Du Pont Canada Inc. began milling operations on its gold property. In the Queen Charlotte Islands, Consolidated Cinola Mines Ltd. operated a pilot plant on its gold property.

In the central region, Placer Development Limited officially opened its Equity silver mine and installed a secondary processing plant at its Endako molybdenum mine. In the Cariboo, Noranda Mines Limited is expanding mining and concentrating capacity at its Boss Mountain molybdenum mine.

In the Highland Valley area, near Kamploops, Lornex Mining Corporation Ltd. completed the $160 million expansion to its copper-molybdenum mine in July. Nearby, Teck Corporation started full production at its new Highmont copper-molybdenum mine in June. During the year, Cominco Ltd. acquired control of Bethlehem Copper Corporation and now completely controls the huge Valley Copper deposit.

In the southeast region, Noranda is developing the Goldstream copper-zinc-gold mine near Revelstoke that should be in production in 1982. Cominco is continuing the multimillion dollar modernization and expansion program of the Trail lead-zinc smelter and the Sullivan mine at Kimberley.

NORTHWEST TERRITORIES

Mineral production in the Northwest Territories rose to $467 million in 1981, up 10 per cent from 1980. Output of gold and silver were down, and tungsten, suffered a 57 per cent decrease in output due to the seven-month strike at the Canada Tungsten Mining Corporation Limited (Cantung) mine. Volumes of zinc, lead and copper were all up. Some $30 million to $50 million was spent on exploration activity which reached a new high in 1981 as 214 properties were examined compared with 164 the previous year.

Giant Yellowknife Mines Limited anticipated spending $7.2 million by mid-1982 on underground exploration to assess its Salmita gold property at Courageous Lake, about 240 km northeast of Yellowknife. Several high-grade silver veins have been reported from Terra Mining and Exploration Limited's $25 million exploration program at its mines in the Camsell River district, 400 km northwest of Yellowknife. Pine Point Mines Limited's 1981 exploration program has discovered enough ore to maintain reserves, including a new orebody about 20 km west of the concentrator.

Two new mines came into production in 1981. Cullaton Lake Gold Mines Ltd.'s 300 tpd mine, 400 km northwest of Churchill, Manitoba started up in October, and Cominco's Polaris lead-zinc mine in November. The historic voyage of the barge-mounted ore processing plant through the Northwest Passage to the mine site on Little Cornwallis Island was successfully completed in the summer of 1981. The Mining Corporation of Canada Limited's Camlaren gold mine, which started production in 1980, closed in the summer, and Echo Bay Mines Ltd.'s Port Radium silver mine will be phased out during 1982.

Two new mines are expected to be brought into production in 1982. Echo Bay Mines Ltd.'s Lupin gold mine near Contwoyto Lake, about 400 km northeast of Yellowknife, was on schedule and expected to begin full-scale production by mid-1982, although the original $108 million cost estimate rose by $20 million. The Prairie Creek silver-lead-zinc property of Cadillac Explorations Limited, about 482 km west of Yellowknife, was on schedule for production in 1982 with proven reserves of almost 1.8 million t.

The strike at the Cantung mine of Canada Tungsten Mining Corporation Limited, which began in November 1980, was settled by mid-May and the operation returned to full production by June 15, 1981.

Responsibility for safety and inspection of mines, formerly under the Department of Indian and Northern Affairs, was transferred to the territorial government last summer.

The negotiations between the Committee for Original Peoples Entitlement and the federal government remained suspended.

In April 1981, the federal negotiator for the land claims of the Dene and Metis of the Mackenzie Valley was appointed and negotiations began.

Land claims negotiations between the Inuit Tapirisat and the federal government resulted in the signing of an agreement in principle on wildlife in October.

YUKON

The value of mineral production in the Yukon in 1981 fell 17 per cent compared with 1980, to $298 million. Production volumes were down for most metals, however the value of zinc increased 17 per cent. Gold and silver production increased, although values for both were down.

Exploration expenditures for metallic minerals increased from $35 million in 1980 to $38.9 million but dropped from $3 million to $1.6 million for coal. A $3 million diamond drill program for 1981, carried out on the Red Mountain molybdenum property of Tintina Mines Limited, 80 km northeast of Whitehorse, has shown good grade mineralization. Cima Resources Limited completed its Mt. Hundere program, 56 km north of Watson Lake, which increased the East Zone proven reserves to 124 000 t.

In November 1981, United Keno Hill Mines Limited suspended all operations at its Venus mine project, south of Whitehorse. The strike at the company's Elsa mine, in progress since September 1980, was settled in June. The new contract runs to October 1982.

The Mactung tungsten property and the Jason, Tom and Howard's Pass zinc-lead deposits on the Yukon/Northwest Territories border, is the focus of an industry-government task force formed to promote the orderly development of the region's resources. The task force is financing two studies: one to examine the feasibility of long distance commuting versus community development in the Pass and the other a wildlife inventory program.

During 1981, Hudson's Bay Oil and Gas Company Limited acquired control of Cyprus Anvil Mining Corporation from Standard Oil Company (Indiana) for $212.6 million and then purchased the remaining shares outstanding at a cost of over $335 million. Cyprus Anvil suffered a $7.2 million net loss for the first nine months of 1981 compared with $20.1 million profit for the same period in 1980, due to lower lead and zinc prices and lower concentrate production.

There were approximately 200 active placer mining operations in the Yukon in 1981, concentrated in the Klondike, Mayo and Sixty-Mile areas. The trend is toward larger operations. It was estimated that the amount of placer gold declared for royalty payments in 1981 was 3 110 000 g although actual production was likely much higher.

In July, the Department of Indian and Northern Affairs announced Cabinet approval of a new policy on northern land use planning for the Yukon and Northwest Territories to improve management of land resources in the North and to resolve conflicting interests of resource users.

At the October meeting of the Northern Mineral Advisory Committee (NMAC), the appointment of Bob Spence as Minerals Advisor to the Minister of Indian and Northern Affairs was announced. The NMAC formed a sub-committee which will advise the Department of Indian and Northern Affairs in its development of a northern mineral policy by raising many of the factors which influence mineral development in the North.

Land claims negotiations with the Council of Yukon Indians (CYI) progressed throughout the year and several new agreements in principle were signed. The CYI has expressed a strong desire to form a native development corporation for the purpose of becoming involved in Yukon non-renewable resource development.

Canadian Reserves of Selected Mineral Commodites

(Data available as of 1981)

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 1981 - 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**	16 830 600 t[1]
	Nickel	8 304 400 t
	Lead	10 118 900 t
	Zinc	29 436 200 t
	Molybdenum	550 100 t
	Silver	33 614 t
	Gold	769 889 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, 1981. These quantities represent measured and indicated tonnages and exclude inferred tonnages[2].

(B) **Iron** 2 400 million t

This is the quantity of iron contained in known crude ore in producing mines and properties under development[3]. Ore in undeveloped deposits is not included.

(C) **Asbestos** 47.2 million t

This represents the fibre content (on average, a little over 5 per cent) of 887 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.

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

[2] W.H. Laughlin, MR **191**, **Canadian Reserves as of January 1, 1981, Copper, Nickel, Lead, Zinc, Molybdenum, Silver, Gold**; Energy, Mines and Resources Canada, 1981.

[3] 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.135/kg U or less	67 000	163 000
$135 to $200/kg U:	6 000	22 000

The tonnages refer to uranium contained in mineable ore. Unless otherwise specified, uranium "reserves" in Canada refer to the tonnages mineable at uranium prices of $135/kg U or less[4].

(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[5].

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4 **EP81-3, Uranium in Canada: 1980 Assessment of Supply and Requirements,** Energy, Mines and Resources Canada, 1981.

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

Aluminum

A. JOHNSTON

As a result of the world recession, demand for aluminum fell and the major producers in the United States, Japan and Europe reduced production. Consequently, the previous steady rise in world primary aluminum production was interrupted in 1981 as production fell 2 per cent from the previous year. Despite production cutbacks, inventories reached near record high tonnage levels at the end of the year. The recession also had an affect on the bauxite mining and alumina producing companies, particularly in Australia and Jamaica and to a lesser extent in Brazil, and various development projects were delayed. The increasing cost of electricity continues to be an important factor in decisions on plant operating rates and locations for new smelters; in this regard Canada is in a better position than most countries.

THE CANADIAN INDUSTRY

Canadian production of primary aluminum in 1981 reached a record high of 1 115 691 tonnes (t) (Table 1), up 4.4 per cent from the previous year. Consumption, which had fallen 17.4 per cent in 1980, recovered slightly in 1981 (Table 2).

Two companies produce primary aluminum metal in Canada - Canadian Reynolds Metals Company, Limited a subsidiary of Reynolds Metal Company of Richmond, Virginia and Aluminum Company of Canada, Limited (Alcan), a subsidiary of Alcan Aluminium Limited of Montreal. 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 smelters had a combined annual capacity of 1 018 000 t at year-end (Table 4). Alcan also operates an alumina refinery at Jonquière, with a capacity of 1 225 000 tpy, that transforms imported bauxite into alumina for use mainly in its Quebec smelters. The Kitimat smelter uses alumina produced in Australia.

Canada, in 1981, imported 23 per cent less bauxite while imports of alumina rose by 4 per cent. Brazil, Guinea and Guyana supplied most of the bauxite, whereas 82 per cent of the alumina came from Jamaica, Australia, and the United States (Table 1).

Alcan has updated its alumina refinery at Jonquière by the installation of energy-efficient fluid flash calciners and modernization of the alumina precipitation circuit. Alcan Smelters and Chemicals Limited announced that it will increase the annual capacity of the new fluoride plant under construction at Jonquière by 10 000 t to 40 000 tpy. The increase is due to a 13-year contract with Canadian Reynolds to supply fluoride for the latter's smelter expansion at Baie Comeau, which is scheduled to begin production in 1984.

Alcan Canada Products Limited completed the installation of a 215-centimetre-wide continuous direct chill casting machine at Jonquière, Quebec, with an annual capacity exceeding 100 000 t of reroll stock. Reroll is the stock from which sheet products, including aluminum foil, are produced. Although the new casting machine extends the range of alloys that can be continuously cast at the Arvida smelter, development work continues on the casting of a range of hard alloys.

The continuing weakness of worldwide market conditions led Alcan to delay indefinitely the start-up of its second 57 000 t potline at Grande Baie, Quebec, which was completed in 1981. Construction of the third line at the same site is continuing but it, too, will remain on standby when completed in 1983 unless markets improve. On completion of the third potline full productive capacity of the Grande Baie smelter will be 170 000 tpy. The first potline was officially opened in September 1980. The company also announced the closure of half a potline (20 000 tpy) at Kitimat. These reductions

TABLE 1. CANADA, ALUMINUM PRODUCTION AND TRADE, 1980 AND 1981

	1980		1981P	
	(tonnes)	($000)	(tonnes)	($000)
Production	1 068 198	..	1 115 691	..
Imports				
Bauxite ore				
Brazil	1 471 543	40,771	1 385 295	49,531
Guinea	1 505 879	39,612	661 246	20,333
Guyana	346 868	9,389	502 918	14,663
Surinam	62 651	7,321	71 153	8,879
United States	34 969	4,840	32 229	5,329
Australia	43 010	2,922	31 448	3,876
Trinidad-Tobago	10 685	189	11 664	565
Other countries	28 767	6,686	6 376	227
Total	3 504 372	111,730	2 702 329	103,403
Alumina				
Jamaica	128 666	32,191	299 849	85,089
United States	276 798	72,032	247 271	79,615
Australia	374 059	76,882	289 962	72,380
Japan	171 495	33,953	166 247	41,548
West Germany	32 955	9,039	17 238	5,135
Other countries	...	-	1	38
Total	983 973	224,097	1 020 568	283,805
Aluminum and aluminum alloy scrap	30 724	19,003	33 414	24,995
Aluminum paste and aluminum powder	4 053	8,523	2 886	7,305
Pigs, ingots, shot, slabs, billets, blooms and extruded wire bars	9 908	18,554	14 316	28,090
Castings	1 398	11,299	901	10,199
Forgings	1 421	17,245	761	10,919
Bars and rods, nes	11 010	24,606	3 287	10,049
Plates	12 866	51,262	12 059	38,150
Sheet and strip up to .025 inch thick	21 792	50,618	24 364	63,018
Sheet and strip over .025 inch up to .051 inch thick	8 484	24,514	11 487	34,510
Sheet and strip over .051 inch up to .125 inch thick	20 930	48,688	30 706	74,126
Sheet over .125 inch thick	28 763	61,419	32 140	75,548
Foil or leaf	837	127	1 417	5,135
Converted aluminum foil	..	18,316	..	22,508
Structural shapes	2 173	10,647	2 011	9,274
Pipe and tubing	1 019	4,810	1 157	5,334
Wire and cable, not insulated	3 408	8,957	1 891	6,454
Aluminum and aluminum alloy fabricated materials, nes	..	79,914	..	67,345
Total aluminum imports	..	458,502	..	492,959
Exports				
Pigs, ingots, shot, slabs, billets, blooms and extruded wire bars				
United States	438 067	766,043	509 784	929,878
Japan	125 009	203,961	124 631	208,921
Thailand	19 779	42,187	15 075	29,641
Turkey	2 241	4,902	8 025	16,720
Hong Kong	11 621	23,369	9 724	15,785
Malaysia	8 236	17,756	5 858	11,364
Brazil	12 528	26,540	5 091	10,349
New Zealand	-	-	4 469	7,847
Nigeria	6 156	13,101	3 748	7,210
South Korea	14 431	25,495	3 418	7,144
Columbia	2 543	5,202	3 543	6,281
Other countries	144 110	279,031	32 088	62,706
Total	784 721	1,407,587	725 454	1,313,846

TABLE 1. (cont'd)

	1980		1981P	
	(tonnes)	($000)	(tonnes)	($000)
Exports (cont'd)				
Castings and forgings				
United States	4 122	29,833	5 883	43,715
United Kingdom	49	3,400	32	3,955
West Germany	79	3,212	103	2,988
France	31	1,167	16	1,761
Other countries	67	1,631	72	1,893
Total	4 348	39,243	6 106	54,312
Bars, rods, plates, sheets and circles				
United States	11 988	28,018	14 551	37,455
Pakistan	4	13	1 750	3,863
Indonesia	428	1,151	914	2,541
Venezuela	572	1,627	528	1,813
Trinidad-Tobago	270	726	333	945
Guyana	278	766	210	698
Nigeria	-	-	218	682
Uruguay	-	-	272	678
Jamaica	192	505	237	660
Netherlands	782	2,486	192	579
Other countries	2 254	6,027	1 413	4,542
Total	16 768	41,319	20 618	54,456
Foil				
United States	26	77	117	379
Chile	76	290	31	145
Colombia	35	120	31	110
Dominican Republic	11	34	11	37
Cuba	-	-	7	28
Other countries	248	588	28	44
Total	396	1,109	225	743
Fabricated materials, nes				
United States	10 614	26,430	7 193	25,722
Cameroon	-	-	255	1,747
United Kingdom	381	1,482	339	1,448
Egyptian A.R.	-	-	580	1,418
Morocco	369	747	899	1,412
Iceland	...	1	448	1,159
Columbia	4 330	7,238	668	1,139
Other countries	2 444	7,198	3 217	9,653
Total	18 138	43,096	13 599	43,698
Ores and concentrates				
United States	33 253	10,482	38 031	15,711
United Kingdom	1 784	762	2 034	976
France	704	361	940	497
Venezuela	299	138	803	386
Brazil	326	160	526	303
Italy	2 127	908	430	185
Other countries	1 014	468	933	495
Total	39 507	13,279	43 697	18,553
Scrap				
United States	49 341	62,782	61 734	79,153
Japan	22 444	35,392	14 845	19,757
Taiwan	150	130	398	221
West Germany	1 724	2,251	146	168
Spain	1 058	891	352	141
Italy	888	997	151	134
Ireland	-	-	54	119
South Africa	-	-	52	87
Other countries	2 523	2,942	257	222
Total	78 128	105,385	77 989	100,002
Total aluminum exports	..	1,651,018	..	1,585,610

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

TABLE 2. CANADA, CONSUMPTION OF ALUMINUM AT FIRST PROCESSING STAGE, 1978-81

	1978	1979r	1980	1981P
		(tonnes)		
Castings				
Sand	1 496	1 792	1 788	1 396
Permanent mould	14 483	11 680	8 500	9 358
Die	23 234	26 293	20 452	18 777
Other	65	148	135	-
Total	39 278	39 913	30 875	29 531
Wrought products				
Extrusions, including tubing	87 625	99 438	94 129	89 126
Sheet, plate, coil and foil	159 720	166 049	112 890	138 905
Other wrought products (including rod, forgings and slugs)	81 833	80 910	83 001	71 210
Total	329 178	346 397	290 020	299 241
Other uses				
Destructive uses (deoxidizer), non-aluminum base alloys, powder and paste	11 834	12 524	8 505	8 285
Total consumed	380 290	398 834	329 400	337 057
Secondary aluminum[1]	44 627	35 527	39 723	48 453

	Metal entering plant				On hand December 31			
	1978	1979	1980	1981	1978	1979r	1980	1981
Primary aluminum ingot and alloys	345 589	344 215	297 515	291 132	88 634	94 106	92 659	79 369
Secondary aluminum	35 575	49 402	27 691	31 791	3 297	3 501	3 447	2 979
Scrap originating outside plant	52 150	47 367	42 166	46 532	15 340	16 287	16 037	13 740
Total	433 314	440 984	367 372	369 455	107 271	113 894	112 143	96 088

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

brought Alcan's total operating rate to 92 per cent of its rated capacity.

In February, labour contracts between Alcan and the employees at four of its Quebec smelters were extended for an additional 16 months to the end of 1983. Under terms of the agreement, employees will receive an increase of $3.52 an hour over the period covered.

Alcan reached agreement on electric power arrangements with the Government of Manitoba in April 1981 and continued its feasibility study on a possible 200 000 tpy Manitoba smelter. It was announced that the company had chosen Rockwood, 25 km north of Winnipeg, as the preferred location. However, with the recession combined with a change in the provincial government, further progress on this project became uncertain.

There were no further developments during 1981 in Alcan's plans to expand its Kitimat smelter, as the status of the proposed hydroelectric power expansion remained unsettled. Work is continuing to rebuild the carbon plant, however.

Canadian Reynolds and the Quebec government reached agreement on the basic terms of a power accord which will permit the proposed expansion of Reynold's Baie Comeau smelter from 158 760 to about 272 000 tpy. However, economic conditions have delayed the project. The company also plans a feasibility study for a $50 million aluminum can manufacturing plant which, if approved, would probably be built near the company's fabrication plant at Cap-de-la-Madeleine. Canadian Reynolds in association with La Brasserie Labatt Limitée announced a plan to introduce recycling of aluminum from cans into the province of Quebec. This will be the first aluminum can recycling in Canada.

Bernard Landry, Minister for Economic Development, announced at year-end that the Quebec government and Pechiney Ugine Kuhlmann, a French aluminum producer, had negotiated a power contract for the company's proposed 220 000 tpy smelter near Bécancour.

The Newfoundland government and Anaconda Aluminum Company announced in July that they would spend up to $500,000 on a joint study for a 270 000 tpy aluminum smelter in Newfoundland. Two areas have been mentioned as possible sites, one near the Lower Churchill River in Labrador and another near Corner Brook, Newfoundland.

WORLD INDUSTRY

Continued weakness of the world economy, especially in the latter half of 1981, led to reduced demand for aluminum with consequent cutbacks in aluminum production. The world consumed 7.2 per cent less primary aluminum than it produced in 1981 and production fell by 2.2 per cent (Table 7). Three countries account for one half the world production: United States, 29 per cent; U.S.S.R., 15 per cent; and Canada, 7 per cent. Japan and West Germany each produced about 5 per cent, with the remaining 40 per cent produced in 38 additional countries. Production rates were at high levels in all areas until mid-year, after which there was a gradual decrease. Even so, non-communist world inventories of primary aluminum continued to rise and reached 3.1 million t by the end of the year compared with 2.2 million t in January.

Estimated world production or bauxite fell 5.3 per cent in 1981 (Table 5) while non-communist world production of alumina fell 5.2 per cent (Table 6), returning to the 1979 production level. Australia was by far the largest bauxite producer, followed by Guinea and Jamaica. Development of large bauxite deposits, discovered in recent years, continued in countries such as Brazil, Ghana, India, Indonesia and Venezuela. The completion of some projects probably will be delayed due to current economic conditions.

TABLE 3. CANADA, PRIMARY ALUMINUM PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975, 1977-1981

	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 958r	398 834
1980	1 068 198	9 908	784 721	329 400
1981P	1 115 691	14 316	725 454	337 057

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

In the United States, which is by far the world's largest producer and consumer of primary aluminum, apparent consumption was the lowest since 1975. Production declined in 1981 as primary capacity was reduced in response to decreased consumer demand. By the end of the year the operating rate was down to 73 per cent of capacity. Some of the reduced capacity was caused by electrical power shortages in the Pacific Northwest, and by the shutdown of high cost reduction lines in southwest Texas.

Power rates were increased in 1981 for the aluminum industry in the Pacific Northwest and for two smelters at Massena, New York. Due to increasing costs of energy, companies are attempting to reduce power usage and to cut energy costs by various methods which, in the latter half of 1981, resulted in a 17 per cent reduction in the amount of energy needed to produce a pound of aluminum, compared to a base year of 1972.

Although the larger U.S. aluminum producers have no plans to increase capacity except through modernization and adoption of improved technology, Alumax, Inc. is considering a 90 000 t expansion of its new 200 000 t smelter at Mt. Holly, South

TABLE 4. CANADA, ALUMINUM SMELTER CAPACITY

(as of January 1, 1982)

	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.

Carolina, as well as a new 180 000 t smelter in Oregon in partnership with Mitsui Alumina Co. Ltd. to be completed by 1986. Anaconda Aluminum Company also may increase its capacity by 54 000 t at Columbia Falls, Montana. In February, Noranda Mines Limited announced plans for an additional 77 100 tpy potline at its New Madrid, Missouri smelter. Production is expected 18 months after construction begins. Consolidated Aluminum Corporation permanently closed its 33 000 t smelter at Lake Charles, Louisiana.

Reynolds Metals Company during September and October closed about 152 000 t of capacity at four of its smelters in the United States because of a combination of high inventories and increased power rates, reducing its overall operating rate to about 66 per cent. Kaiser Aluminum & Chemical Corporation curtailed production for the same reasons at its Ravenswood, West Virginia and Chalmette, Louisiana smelters. These curtailments reduced the company's overall operating rate to 76 per cent. Aluminum Company of America's (Alcoa) operating rate was also reduced to 75 per cent of capacity during the year.

TABLE 5. ESTIMATED WORLD PRODUCTION OF BAUXITE, 1980 AND 1981

	1980	1981P
	(million tonnes)	
Australia	27.6	25.5
Guinea	13.4	12.8
Jamaica	12.1	11.6
Brazil	4.2	4.7
Surinam	4.9	4.0
Greece	3.3	3.2
India	1.8	1.9
Guyana	3.1	1.9
France	1.9	1.8
Other market economy countries	6.1	5.9
Total market economy countries	78.4	73.3
Central economy countries[1]	14.8	15.0
World total	93.2	88.3

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

Australia remains the world's largest producer of bauxite and alumina, supplying 29 per cent of world bauxite production and processing about 75 per cent of that production into alumina. Bauxite and alumina production fell slightly from that in 1980 due partly to a strike at Weipa. Australia exports more than 80 per cent of its alumina production. Of the 7.8 million t of alumina produced at four refineries in 1981, Canada received 289 962 t from the Queensland Alumina Ltd. refinery owned 21.4 per cent by Alcan. Studies were under way to expand the plant in order to supply alumina for a new smelter proposed by Alcan in Queensland and for the expansion of its Kurri Kurri smelter in New South Wales. However, Alcan suspended plans to build the Queensland smelter in August because of rising costs and uncertain world markets.

Currently in Australia, there are three primary aluminum smelters which operated close to capacity in 1981 and produced an estimated 379 385 t of aluminum. If the various smelter projects, including six proposed smelters were to be completed, aluminum capacity could rise to 1.5 million tpy by 1985 and to over 2 million tpy beyond 1985. However, the rosy picture reported for Australia in 1980 was dimmed somewhat by the world recession, increased energy

TABLE 6. ESTIMATED NON-COMMUNIST WORLD PRODUCTION OF ALUMINA 1980 AND 1981

	1980	1981
	(million tonnes)	
Europe[1]	4.51	4.95
Africa	0.71	0.68
Asia	2.95	2.26
North America	8.09	7.17
South America	4.60	4.49
Australasia	7.25	7.09
Total	28.11	26.65
of which nonmetallic uses	2.32	2.19

Source: World Bureau of Metal Statistics.
[1] Excludes Yugoslavia.

prices, rising infrastructure costs and other considerations, all of which added a degree of uncertainty. Alcoa of Australia Ltd. moved the start-up date of its Wagerup alumina refinery in Western Australia from mid-1982 to later in 1983, depending on the recovery of the international aluminum market. Initial output is scheduled at 500 000 t, increasing eventually to a designed capacity of 2 million t. Alcoa has spent $70 million preparing a site for a new smelter at Portland, Victoria. However, resolution of initial opposition by the aborigines was followed by a 25 per cent increase in electric power rates by the State Electricity Commission. Alcoa suspended work on the project in August in response to the increased rates but agreed, at year-end to resume work if power rates are reviewed favourably.

State approval was given for the proposed Tomago and Lochinvar smelters in the Hunter Valley of New South Wales as well as for Alcan's expansion of Kurri Kurri. Local residents had feared that fluorine emissions would adversely affect the extensive Hunter Valley vineyards and consequently, stringent conditions were imposed on the smelters to ensure full environmental protection. The Tomago plant, to be built by Gove Alumina Ltd., is expected to be completed in 1984 with an initial annual capacity of 110 000 t, increasing eventually to 220 000 t. The 118 000 t Lochinvar plant was to have been completed in 1985 with partial operation beginning in 1984. The withdrawal of Alumax, Inc. from the consortium, apparently because of power price escalation, may delay this schedule. Alcan completed the second stage expansion of its Kurri Kurri smelter in New South Wales. A third stage 45 000 t expansion, which will increase capacity to 135 000 t annually, is expected to be completed in 1984. However, the company has suspended plans to build a 300 000 tpy smelter at Bundaberg, Queensland.

Australia's fourth smelter, the 206 000 tpy Boyne Island plant, under construction at Gladstone, Queensland, is scheduled to come into production in 1982. The smelter is owned by Gladstone Aluminium Ltd., a consortium comprising Comalco Limited, Kaiser and five Japanese companies.

There was an eight-week strike at the Nabalco Pty. Ltd. bauxite operations and refinery at Gove, Northern Territory. During that period production was eventually cut by half and, at the end of the strike, the reduced level was maintained because of reduced demand.

In the first half of the year, Jamaica's prime minister, Hon. Edward Seaga, was quite active in attempting to encourage the various bauxite companies operating on the island to increase bauxite output to a rated capacity of 15 million t and alumina production to 2.75 million t - levels not attained since the government introduced a bauxite levy in 1974. Actually, bauxite production fell to approximately 11.6 million t in 1981 (Table 5). In particular, the Aluminum Company of America (Alcoa) was asked to double the size of its Clarendon refinery. Financial backing for the expansion was under negotiation with several Norwegian aluminum producers but, at year-end, a plan involving Norsk Hydro A/S was under consideration to increase capacity by 340 000 t, or about 70 per cent. However, the current worldwide alumina oversupply is a factor likely to affect expansion plans.

Alcoa reduced output at the Clarendon refinery by 20 per cent in June, while Alcan Jamaica Ltd. (Jamalcan) (Alcan, 93 per cent) instituted two cutbacks of 30 000 t each to reduce output in 1981 to 1 043 000 t or 95 per cent of capacity, and Alumina Partners of Jamaica (Alpdart) reduced its output, by 45 000 t. Bauxite operating companies also reduced production because of the affects of the current recession. In November, Reynolds Jamaica Mines Ltd. announced a 50 per cent cutback at its 2 460 000 tpy bauxite mining operation.

TABLE 7. WORLD PRIMARY ALUMINUM PRODUCTION AND CONSUMPTION, 1980 AND 1981

	Production		Consumption	
	1980	1981P	1980	1981P
	(000 tonnes)			
United States	4 653.6	4 488.8	4 453.5	4 140.1
Europe[1]	3 597.3	3 548.6	3 709.4	3 351.7
Japan	1 091.5	770.6	1 639.0	1 567.8
Canada	1 068.2	1 115.7	329.4	337.1
Australia and New Zealand	459.7	534.8	273.2	279.8
Asia (excluding Japan and People's Republic of China)	475.7	563.7	699.5	731.7
Africa	437.3	483.2	168.9	171.1
America (excluding United States and Canada)	816.1	787.0	593.8	516.3
Sub-total	12 599.4	12 292.4	11 866.7	11 095.6
Central economy countries	3 447.3	3 398.7	3 477.2	3 464.5
Total	16 046.7	15 691.1	15 343.9	14 560.1

Sources: World Bureau of Metal Statistics; Energy, Mines and Resources Canada.
[1] Excludes Yugoslavia.
P Preliminary.

The International Bauxite Association, representing 11 major bauxite producing countries, met in Jamaica in November. Despite existing high stocks of bauxite and alumina it was agreed to maintain the existing prices, which are based on a percentage of the posted producers price in the U.S. The organization is also interested in having bauxite and alumina included in discussions under the International Commodity Fund in the United Nations Conference on Trade and Development. This could eventually involve the formation of an international commodity arrangement to include both producing and consuming countries.

Brazil is the sixth largest bauxite producing country, accounting for 5 per cent of world production. After a dramatic rise in 1980, bauxite production levelled-off in 1981 (Table 5). Continued expansion of the aluminum industry in Brazil is ensured by an abundant reserve of bauxite - estimated at 4.5 billion t - and very large hydroelectric power potential in the Amazon basin. Three new smelters under construction and the planned expansion of an existing smelter could raise capacity to 1.4 million t by 1990. Several bauxite mining operations have been proposed on the Trombetas River in the Amazon. The Brazilian government has agreed to allow Alcoa to mine the 250 million t Ludwig deposit on the Trombetas in order to feed the alumina-aluminum complex at Sao Luis, Maranhão. The latter, which is under construction by Alcoa Aluminio S.A. (60 per cent) and Billiton Metals SA (40 per cent), is scheduled to come on-stream in 1984 with initial alumina refinery capacity of 500 000 tpy and smelter capacity of 100 000 tpy. Bauxite during the early phase of operation will be supplied by the Trombetas bauxite mine of Mineração Rio do Norte SA that started mining two years ago in the northern state of Para. Alcan owns 24 per cent of this operation.

Developments in Brazil were also affected by recessionary factors but Nippon Amazon Aluminium Co. Ltd. (Nalco), a consortium of 31 Japanese companies, agreed in May to increase its investment in the Brazilian alumina/aluminum complex of Alumina do Norte do Brasil SA (Alunorte) and Aluminio Brasileiro SA (Albras), to be completed in 1989. This involves financial participation in contructing the Alunorte 800 000 tpy alumina refinery and the companion 320 000 tpy Albras primary aluminum smelter, near Belém. Brazil's high inflation rate has increased projected capital costs by 73 per cent to $2.6 billion in two years. The state mining company, Companhia Vale do Rio Doce (CVRD), has a 51 per cent interest in the smelter and a 60 per cent interest in the refinery. The latter will supply alumina to the local Albras smelter and to the Valesul Aluminio S.A. smelter near Rio de Janeiro. The Brazilian government has accepted a bid by Vereinigte Aluminium-Werke AG to build a 220 000 tpy smelter at Alune near Recife in northeast Pernambaco state. A feasibility study has started for an initial 110 000 t plant planned for completion in the late 1980s at a cost of $US 500 million. Of the three new smelters presently under construction, the 86 000 tpy smelter at Santa Cruz, 50 km west of Rio de Janeiro, began initial operations in May. The plant is expected to produce 37 000 t in 1982. The project has been under construction for more than three years by Valesul, a consortium of CVRD, Billiton Metals and Reynolds International Inc.

Brazil attained aluminum self-sufficiency in 1981, producing 5 per cent more primary aluminum than it consumed; however, consumption fell by 15 per cent during the year while production remained steady.

The Japanese aluminum industry continued to have problems resulting from higher energy costs, excessive aluminum imports and a decline in domestic consumption. For the first time at least in the past 10 years, secondary production (839 623 t) exceeded primary production (770 602 t). Imports of primary aluminum in 1981 reached a record 1 129 322 t of which 266 325 t were supplied by the United States. Canada supplied 124 631 t of ingot and 14 845 t of scrap. Total production plus imports minus exports of unwrought metal exceeded consumption by 312 916 t, and inventory levels rose. Consequently, the Japan Light Metal Stockpiling Association continued to purchase primary ingot from Japanese aluminum producers and the Japanese government agreed to purchase 17 000 t for the national stockpile. In addition, the government proposed a tariff-quota scheme in 1981 under which specified amounts of aluminum ingot could be imported duty free under long-term arrangements, while additional imports would be subject to import duties. Levies on direct imports by domestic consumers would have provided funding to subsidize the remaining domestic smelting industry. However, this proposal was abandoned near year-end, partly because of objections from the United States. That country exports aluminum to Japan, mainly as spot or short-term sales, and these would have been the most adversely affected by the tariff-quota scheme. It was replaced by a provision whereby domestic smelting firms may import specified amounts of ingot free at the normal 9 per cent duty, for sale to domestic customers over a three-year period beginning April 1982. As aluminum prices are higher in Japan than elsewhere, this plan would generate over $50 million annually to help finance industry restructuring. The Japanese industry, faced with uneconomically high electric power rates, is undergoing a major restructuring program which will result in a reduction of smelter capacity from 1.6 million t in 1979 to 700 000 t by 1982. Accordingly, domestic aluminum requirements will be met increasingly from imports, especially from overseas plants in which Japanese producers have equity investment in countries such as Australia, New Zealand and South America and from other sources under long-term purchase contracts. In addition, Japanese companies are participating in the construction of a 225 000 tpy primary aluminum smelter in North Sumatra - Indonesia's first smelter. This project, which is planned to start-up in 1982, is scheduled for completion in 1984. And an international consortium, including Japanese participation, is conducting a feasibility study on a 150 000-200 000 tpy smelter to be built at Banana in Zaire at a cost of about $690 million. Electricity would be supplied from the already completed Inga hydroelectric power plant on the Congo River.

India consumed 37 000 more t of primary aluminum than it produced in 1981, even though rated capacity at 321 000 t is 51 per cent greater than the amount produced. Imports are necessary to cover this aluminum shortfall caused by an inadequate power supply. At least one company, Hindustan Aluminum Corp. Ltd. (Hindalco), is relying on its own power station in order to expand its Renukoot smelter capacity from 100 000 tpy to 120 000 tpy by late 1982. Bauxite deposits are relatively widespread and, in recent years, large deposits containing an estimated 2.0 billion t were discovered in the eastern states of Orissa and Andhra Pradesh. Construction has started on an aluminum complex at Barmanjodi, Orissa, by Pechiney Ugine Kuhlmann in partnership with the National Aluminium Company. This $1.5 billion complex is expected to be completed in five years, and will have the capability to produce 2.4 million t of bauxite, 800 000 t of alumina and 218 000 t of aluminum annually. Another refinery of similar capacity may be built with Russian help in Andhra Pradesh.

In western Europe the yearly increase in the amount of primary aluminum produced was stalled in 1981 by the effects of the recession, as consumption decreased by 9.6 per cent (Table 7). However, the aluminum industry of most European countries weathered the recession remarkably well, although cutbacks were initiated toward the end of the year as demand continued to weaken. Vereinigte Aluminium-Werke AG reduced production at its Lippe smelter in West Germany by 5 000 t to a rate of 33 000 tpy at year-end. In France, Pechiney Ugine Kuhlmann cut the operating rate at its St. Jean de Maurienne smelter by 14 000 t, which reduced production to 93 per cent of capacity. British Aluminium Co. Ltd. at year-end closed its 100 000 tpy smelter at Invergordon, Scotland, because of high electricity costs and the fall in demand for aluminum. The company's two other smelters at Lochaber and Kinlochleven will continue to produce at full capacity and the company will buy aluminum externally. Constrution of Ireland's 800 000 tpy alumina plant at Aughinish, in which Alcan has a 40 per cent interest, is more than half complete, and production should start in 1983. Bauxite will be imported from Guinea and Brazil.

Expansion projects in Europe are continuing but completion dates may be delayed until international markets strengthen. In West Germany, capacities of both the Norf and Voerde smelters are being increased by 55 000 tpy and 114 000 tpy respectively, while the addition of new furnaces to the smelter of Toeging, Bavaria is expected to reduce unit power requirements by 20-25 per cent. The 142 000 tpy expansion project under way in Yugoslavia is expected to raise smelter capacity to 467 000 tpy by 1983. This includes a new 85 000 tpy smelter at Mostar, that came into production in 1981.

Production of primary aluminum in Spain increased 2.6 per cent in 1981 to a record 397 000 t. The largest of five smelters currently in operation, the San Ciprian smelter owned 55 per cent by Empresa Nacional del Aluminio SA (Endasa), reached its designed capacity of 190 000 tpy during the year. However, two other Endasa smelters with 126 000 tpy combined capacity are threatened by production cuts because of weak European aluminum demand as well as high energy costs. The government promised some relief through a 20 to 22 per cent decrease in electricity rates to aluminum producers effective January 1, 1982.

In the Middle East, primary aluminum production rose by one third in 1981 to 406 000 t. Much of this increase resulted from Dubai Aluminium Co. Ltd. expanding production at its new smelter from 35 000 t in 1980 to 106 000 t in 1981 and, at year-end production was at a 142 000 tpy rate compared with the rated capacity of 135 000 tpy. Further expansion is proposed for this smelter on the Arabian Gulf and for the Nag Hammadi smelter in Egypt. The massive expansion of the aluminum industry in the Middle East to 1 million tpy capacity, proposed by the Gulf countries and based on the availability of natural gas-fired electric power, must wait until world economic conditions improve.

Primary aluminum production in China is derived mostly from small plants, although one smelter has a capacity of 120 000 tpy. At year-end, completion of the first phase of an 80 000 tpy smelter at Guiyang (Guizhou) helped to boost China's primary aluminum capacity to about 400 000 tpy. A plan to construct a huge 600 000 tpy smelter at Guangxi is under active study. The only producing smelter of this size is located in Russia.

The aluminum industry is truly multi-national, comprising 126 smelters in 45 countries. High energy costs in recent years have led to a shift in smelter construction to countries such as Australia and Brazil, which enjoy both energy potential and sources of raw material. The developing countries in Africa, Asia and the rest of Latin America are significant growth areas for the aluminum industry. In Ghana, for example, an 800 000 tpy alumina refinery, based on the Kibi bauxite deposits (280 million t), is under review. The country already has a 200 000 tpy smelter. The Philippine government has been attempting to interest aluminum producers in building a 140 000 tpy smelter, based on low-cost power from the Polangui River. In addition, significant bauxite discoveries have been made in two areas of the Philippines.

PRICE AND STOCKS

The U.S. producer list price of primary aluminum ingot remained unchanged at 76 cents a pound throughout the year. However, as a result of high inventories, the U.S. market price fell from a monthly average of 68 cents per pound in March to 49 cents in November, but then rose slightly to 50.6 cents in December.

Producer stocks of primary metal, as reported by the International Primary Aluminium Institute, increased steadily from 2 238 000 t in January to 3 115 000 t at the end of December, which is double the July 1980 level and very close to the historical high reached in early 1976. Inventories have risen despite a cut in the average western world smelter operating rate to 87 per cent of capacity by November from 92 per cent at the beginning of 1981. By year-end the U.S. operating rate was down to 73 per cent and the rate in Japan was less than 50 per cent of capacity. However, both Europe and Canada maintained output at 95 per cent of capacity during the year.

OUTLOOK

The current recession is expected to adversely affect the aluminum industry well into 1982 or beyond. At present, aluminum stocks are high but with the reduction of production, especially in the United States and Japan, these stocks should eventually fall to a manageable level. As inflation and interest rates ease, additional smelter construction already in the planning stage, will resume to satisfy the expected increase in demand in the mid-80s. At that time, the price of aluminum should approach $1.35 a pound to compensate for the cost of new smelter construction. Production capacity is expected to grow at a slower rate than demand if expansion plans are delayed due to escalating costs of plant construction and the risks involved in a period of uncertain growth. Consequently an undersupply of aluminum and rising metal prices can be anticipated later in the 1980s with the result that other materials could replace aluminum to some extent.

Packaging, electrical power transmission, and transportation equipment will account for an increasing share of aluminum consumption, while use in construction will grow more slowly due to competition from other materials. Recycled aluminum will continue to be an important source of supply since recycling uses less than 20 per cent of the energy required to produce primary aluminum. The use of recycled metal is expected to increase from a current 25 per cent of aluminum consumption in major markets to 30 or 35 per cent during the next few years.

TARIFFS

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	.8¢	5¢	na
35302-1	Aluminum bars, rods, plates, sheets, strips, circles, squares, discs and rectangles	free	2.3	7.5¢/lb	free
35303-1	Aluminum channels, beams, tees and other rolled, drawn or extruded sections and shapes	free	11.4	30	free
35305-1	Aluminum pipes and tubes	free	11.4	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)

	1981	1982	1983	1984	1985	1986	1987
				(%)			
32910-1							
35301-1	.8¢	.6¢	.5¢	.4¢	.3¢	.1¢	free
35302-1	2.3	2.3	2.3	2.2	2.2	2.1	2.1
35303-1	11.4	10.8	10.3	9.7	9.1	8.6	8.0
35305-1	11.4	10.8	10.3	9.7	9.1	8.6	8.0
92820-1							

TARIFFS (cont'd)

UNITED STATES (MFN)		1981	1982	1983	1984	1985	1986	1987
					(%)			
Item No.								
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	3.1	3.0	2.9	2.8	2.8	2.7	2.6
618.02	Other unwrought aluminum, excluding alloys, per pound	0.7¢	0.6¢	0.5¢	0.3¢	0.2¢	0.1¢	free
618.04	Aluminum silicon, per pound	2.4	2.4	2.3	2.3	2.2	2.2	2.1
618.06	Other aluminum alloys, per pound	0.7¢	0.6¢	0.5¢	0.3¢	0.2¢	0.1	free
618.10	Aluminum waste and scrap, per pound[1]	2.0	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 1981, USITC Publication 1111; U.S. Federal Register Vol. 44, No. 241.

[1] Duty on waste and scrap temporarily suspended.

na Item does not qualify under the General Preferential Tariff.

Antimony

J.J. HOGAN

The antimony market felt the impact of the continuing worldwide recession and high interest rates in 1981. Consumption and production were both lower than the previous year. Some of the producers reduced output to help ease an over-supply situation and Canada's only antimony mine exhausted its developed ore reserves. The price of antimony declined steadily during the year. Initiated by Bolivian producers, action has been taken, initially by four antimony producing countries, to form an international producers group to promote a viable antimony industry. In late 1981, the United States Congress authorized the sale of 2 721 t declared surplus to its strategic needs.

CANADIAN DEVELOPMENTS

Antimony produced in Canada in 1981 was obtained from one antimony mine which closed in May. Antimony was also recovered as a byproduct of a lead smelting operation that treats lead concentrates containing antimony. The value of antimony contained in ores and concentrates produced in 1981 was $2,876,000 (Table 1), 56.7 per cent lower than in 1980. The value of the antimony content of primary antimonial-lead alloy produced in 1981 was $262,000, sharply lower than 1980 value. Antimony contained in the antimonial lead produced was 50 000 kg in 1981. Lower demand for antimonial lead because of changes in the technology of lead-acid batteries was responsible for the lower output.

Imports of antimony oxide in 1981 totalled 936 000 kg compared with 944 000 kg in 1980. The United Kingdom supplied 58.0 per cent, the United States, 23.0 per cent and France, 16.9 per cent.

Consolidated Durham Mines & Resources Limited operated Canada's only antimony mine at its Lake George property near Fredericton, New Brunswick. Ore from the producing zone was exhausted and mining and milling operations ceased in May, although concentrate sales from inventory will continue into the first quarter of 1982. During the fiscal year ending June 30, 1981, the company reported that the concentrator treated 35 762 t of ore averaging 3.54 per cent antimony and produced 2 480 t of concentrate averaging 66.37 per cent antimony. In fiscal year 1980 the concentrator treated 90 244 t of ore averaging 3.09 per cent antimony and produced 3 463 t of concentrate averaging 66.86 per cent antimony. The concentrates were of premium quality and were exported to the United States and Europe.

An extensive diamond drilling program to search for more ore at deeper horizons has outlined an antimony bearing zone containing an estimated 774 000 t averaging 4.15 per cent antimony. This zone appears to be the downward extension of the mined zone and it can be mined by extending the present inclined shaft. A feasibility study is under way on the production from this zone and, if the decision is favourable, it should take about a year to bring the mine back into production.

Construction of the leach plant at the Sam Goosly antimony-silver-copper property of Equity Silver Mines Limited, 37 km south of Houston in British Columbia, to remove impurities in the concentrates, was completed in 1981. It will recover an estimated 1 700 tpy of antimony. Leaching of the concentrate on a trial basis began toward the end of the year and the plant is expected to be in full operation in the second quarter of 1982.

Cominco Ltd., which operates a lead smelter and refinery at Trail, British Columbia, produces a primary antimonial-lead product. It can produce antimonial lead with

TABLE 1. CANADA, ANTIMONY PRODUCTION AND IMPORTS 1980 AND 1981 AND CONSUMPTION, 1979 AND 1980

	1980		1981P	
	(kilograms)	($'000)	(kilograms)	($'000)
Production				
Antimonial lead alloy	78 654	416	50 000	262
Antimony in ores and concentrates	..	6,643	..	2,876
Total	..	7,059	..	3,138
Imports				
Antimony oxide				
United Kingdom	558 780	2,583	543 000	2,746
United States	312 843	1,295	215 000	885
Belgium-Luxembourg	52 481	206	158 000	549
France	19 958	78	20 000	78
Total	944 062	4,162	936 000	4,258

	1979	1980
	(kilograms)	
Consumption[1]		
Antimony used for, or in the production of:		
Antimonial lead	329 733	235 056
Babbit	19 487	18 854
Solder	14 500	7 000
Type metal	11 889	7 962
Other commodities	87 814	100 860
Total	463 423[r]	369 732
Held by consumers on December 31[2]	39 976	42 389

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

[1] Antimony content of primary and secondary antimonial-lead alloys. [2] Available data, as reported by consumers.
P Preliminary; .. Not available due to confidentiality; [r] Revised.

an antimony content ranging up to 23 per cent, depending on customer requirements. Antimony contained in antimonial-lead alloy produced by Cominco was reported to be 50 000 kg in 1981, compared with 79 000 kg in 1980. Secondary smelters recover antimonial lead from scrap metal but no recent statistical data are available concerning this production.

Most of the antimonial lead produced at Trail is a byproduct of lead concentrates obtained from Cominco's Sullivan mine at Kimberley, British Columbia. Other sources are lead-silver ores and concentrates shipped to Trail from other Cominco mines and from custom shippers. The lead bullion produced from the smelting of these ores and concentrates contains about 1 per cent antimony, which collects in anode residues from the electrolytic refining of the lead bullion and in furnace drosses. These residues and drosses are treated to yield antimonial-lead alloy, to which refined lead may be added to produce marketable products of the required grade.

TABLE 2. CANADA, CONSUMPTION AND CONSUMERS' STOCKS OF ANTIMONY[1], 1970, 1975-80

	Consumption			On hand at end of year	
	Antimony Metal	Antimonial-lead alloy[2]		Antimony Metal	Antimonial-lead alloy[2]
			(kilograms)		
1970	518 007	635 212		131 501	91 563
1975	454 164	723 155		116 760	170 478
1976	437 998	1 038 234		30 338	224 664
1977	370 867	1 204 416		27 932	132 262
1978	347 906	1 000 732		101 814	91 049
1979	463 423	931 990		39 976	87 473
1980	369 732	643 983		42 389	51 405

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

[1] Available data, as reported by consumers. [2] Antimony content of primary and secondary antimonial-lead alloys.

WORLD REVIEW

World mine production of antimony was estimated by the American Bureau of Metal Statistics to be 64 430 t in 1981 compared with 65 177 t in 1980 (Table 3).

The world's major primary antimony producers in decreasing order of output in 1981, as shown in Table 3, were Bolivia, Republic of South Africa, China and the U.S.S.R. In 1981, these four countries accounted for 69 per cent of the world total. Smaller producers were Mexico, Thailand, Canada, Morocco, Turkey, Yugoslavia and Australia.

Consolidated Murchison Limited operates the world's largest antimony mine, near Gravelotte in northern Transvaal, Republic of South Africa. The company processed 388 950 t of ore averaging 2.81 per cent antimony in 1981 compared with 512 320 t averaging 2.70 per cent in 1980. In the second half of 1980, mine production was drastically lowered to a monthly rate of 30 000 t because of the depressed antimony market. In the middle of 1981, an improvement in the market resulted in the monthly mill rate being increased to 35 000 t. Antimony concentrates and cobbed ore production in 1981 totalled 16 599 t averaging 58.72 per cent compared with 22 372 t averaging 58.43 per cent in 1980. Mill recovery of 87.1 per cent was about the same as in 1980. Working costs per t milled increased by about 34 per cent to R43.76 with a corresponding increase in cost per t of antimony produced, mainly because of the reduced tonnage milled and continuing inflationary pressure. Sales of antimony concentrates and cobs in 1981 were 16 212 t, an increase of over 27 per cent over 1980 sales. Stocks of concentrates and cobbed ore at year-end were 16 946 t, a slight increase.

In 1981, approximately 63 per cent of antimony concentrates produced was treated at the nearby plant of Antimony Products (Proprietary) Limited, owned 25 per cent by Consolidated Murchison, for the production of crude antimony trioxide. About 70 per cent of Murchison's output is exported to the United States, United Kingdom and Europe.

Bolivia was the world's largest producer of antimony in 1981. Production was estimated at 15 422 t, slightly below the 1980 output. In 1980, the Bolivian antimony producers established Comité Bolivian de Productores de Antimonio (CBPA), an organization formed to define trading and pricing policies and to research and promote antimony uses. The intent was to expand the organization into an international producers group. In late October 1981, representatives of four countries - Bolivia, Peru, Thailand and Turkey - met in La Paz, Bolivia to discuss methods to ensure a viable antimony industry and to review a report prepared by Batelle Memorial Institute for the Bolivian organization. At the meeting, it was decided to form the Organizacion International de Antimonio (OIA). The Bolivian committee was given the responsibility of drafting a constitution for the new inter-

TABLE 3. WORLD MINE PRODUCTION OF ANTIMONY, 1979-81

	1979	1980	1981[e]
		(tonnes)	
Bolivia	14 420	15 465	15 420
Republic of South Africa	11 614	13 073	10 890
People's Republic of China[e]	10 000	10 000	9 980
U.S.S.R.[e]	7 500	7 000	8 170
Mexico[1]	2 872	2 903	2 900
Thailand	2 935	3 550	2 810
Canada[2]	2 954	2 141	2 100
Morocco	850	549	1 810
Turkey	495	2 153	1 810
Yugoslavia	2 037	1 560	1 810
Australia[3]	1 538	1 389	1 130
Peru	763	769	770
Guatemala	639	700	730
Italy	950	713	700
United States	655	311	530
Czechoslovakia[e]	530	530	270
Other countries	2 863	2 371	2 600
Total	63 615	65 177	64 430

Sources: Non-Ferrous Metal Data 1981, American Bureau of Metal Statistics Inc.

[1] Antimony content of ores for export plus antimony content of antimonial lead and other smelter products produced. [2] Estimated on the basis of value of production. [3] Antimony content of antimony ore and concentrates, lead concentrates, and lead and zinc middlings.
[e] Estimated.

national group. It will be submitted at the second annual meeting scheduled to take place at La Paz in October 1982.

ASARCO Incorporated announced in May that it had increased its antimony oxide plant capacity by a third, to about 2.27 million kg a year by installing a 498 950 kg/mo kettle at its Omaha lead refinery. ASARCO produces three grades of antimony oxide - high tint, the lowest price; low tint and ultra pure, the highest price. For the past two years, ASARCO has been marketing its production itself rather than selling through agents.

In the latter part of the year, Bernuth, Lembcke Co., Inc. brought a new 1 360 tpy antimony oxide and sodium antimoniate plant into production in Tennessee, United States. A leach process is being used.

TABLE 4. INDUSTRIAL CONSUMPTION OF PRIMARY ANTIMONY IN THE UNITED STATES BY CLASS OF MATERIAL PRODUCED, 1979-81

	1979	1980	1981P
	(tonnes, antimony content)		
Metal Products			
Ammunition	229	328	371
Antimonial lead	1 179	679	202
Bearing metal and bearings	213	202	143
Cable covering	15	28	23
Castings	13	9	1
Collapsible tubes and foil	22	16	7
Sheet and pipe	33	26	27
Solder	181	122	40
Type metal	34	19	6
Other	90	67	42
Total	2 009	1 496	862
Nonmetal Products			
Ammunition primers	21	18	15
Fireworks	5	4	3
Flameproofing chemicals and compounds	5 518	5 166	3 367
Ceramics & glass	1 022	1 182	802
Pigments	362	453	328
Plastics	1 433	1 484	563
Rubber products	165	295	65
Other	127	97	-
Total	8 653	8 699	5 143
Total reported	10 662	10 195	6 005
Grand Total	10 662	10 195	9 382[1]

Source: U.S. Bureau of Mines: Mineral Yearbook 1980 for 1979, Mineral Industry Surveys for 1980 and 1981.
[1] Estimated 100 per cent coverage based on reports from respondents that consumed 63 per cent of the total antimony in 1979.
P Preliminary.

Consumption of primary antimony in the United States, the non-communist world's largest consumer, as reported by the United States Bureau of Mines (USBM) was 10 516 t in 1981, about 13 per cent of the world's primary production. Consumption in 1980 was 10 196 t. The United States depends on imports, mainly from Bolivia and Mexico for ores and concentrates, Bolivia for antimony metal and the Republic of South Africa, Bolivia, the People's Republic of China and France for antimony oxide. Bolivia was the largest overall U.S. supplier in 1981 with 6 393 t, followed by South Africa and the People's Republic of China with 3 382 t and 1 805 t, respectively.

Recovery from secondary material is an important source of antimony. In 1981, the United States production was 10 170 t, mostly from antimonial lead. As antimonial lead for use in automobile batteries is phased out, secondary recovery should decline.

Antimony in the United States National Defense stockpile at the end of 1981 was 36 948 t. The stockpile goal for antimony is 32 659 t, leaving a surplus of 4 289 t. The Omnibus Budget Reconciliation Act of 1981 authorized the disposal of 2 721 t of antimony at the rate of 907 tpy, effective October 1, 1981. No sales by the General Services Administration (GSA) were made in 1981.

The antimony content of industrial stocks in the United States at the end of 1981 was 7 509 t.

USES

Antimony is used principally as an alloy and in the form of oxides. Sulphide forms are used to a lesser extent.

Antimony hardens and strengthens lead and inhibits chemical corrosion. These characteristics created a large use for the metal in antimonial-lead storage batteries. However, the introducton of the low antimonial-lead battery and the lead-calcium battery has drastically lowered its use in this application in North America. Antimony's largest use, as antimony trioxide or trichloride, is as a fire retardant in products such as automotive upholstery, carpets and carpet underlays, as well as in plastics, insulation for electrical equipment and fibreglass boats.

The trioxide is also a glass-former and is sought for its ability to impart hardness and acid resistance to enamel coverings for bathtubs, sinks, toilet bowls and refrigerators. Sodium antimonate is used in the production of high-quality glass and has a growing use in the manufacture of television screens. The pentasulphide (Sb_2S_5) is used as a vulcanizing agent by the rubber industry. Burning antimony sulphide creates a dense white smoke that is used in visual control, in sea markers and in signaling.

Antimonial-lead alloys are also used for power transmission and communications equipment, type metal, solder, ammunition, chemical pumps and pipes, tank linings, roofing sheets and antifriction bearings. Antimony increases hardness, minimizes shrinkage, permits sharp definition and lowers the melting point of type metal. In antifriction bearings, antimony with tin forms hard tin-antimony crystals that increase bearing life.

Antimony trioxide is valuable for paint formulation because of its high hiding power and, along with various chemical compounds, it produces a wide range of pigments. High-purity metal is used in the production of indium-antimony and aluminum-antimony intermetallic alloys for semiconductors.

PRICES

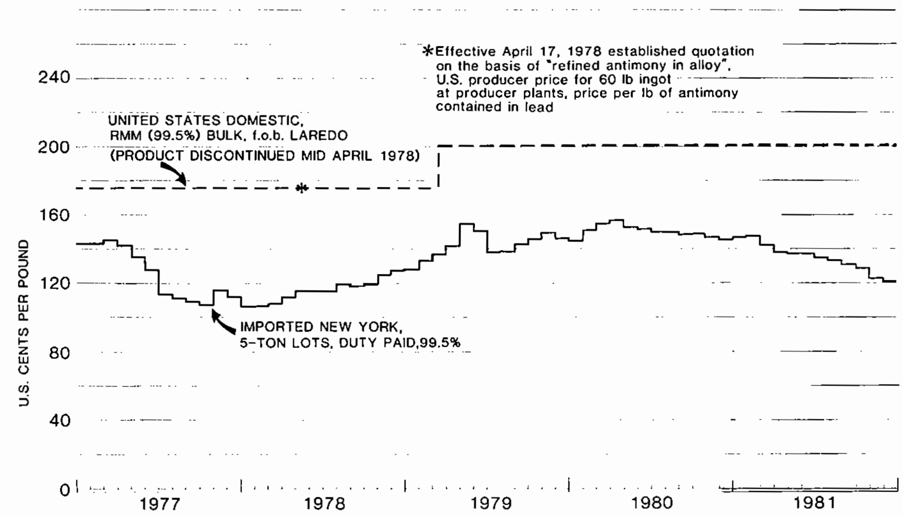
Producer prices for antimony contained in antimony-lead alloy, in 60 pound ingots fob producer plants, as quoted in **Metals Week** remained unchanged for the year 1981 at $US 2 per pound.

The New York dealer price for antimony metal opened the year 1981 at $US 1.47-1.51 per pound, reached a high of $1.48-1.52 by mid-January and declined steadily to close the year at $1.20-1.24 per pound. The poor worldwide economic performance and high interest rates were largely responsible for the price decline.

The European free market metal price for 99.6 per cent antimony, cif Europe as quoted in **Metal Bulletin,** opened the year 1981 at $US 3,170 to $3,250 per t. The price trend paralleled that of the United States and declined steadily throughout the year closing at $2,430 to $2,560 per t.

The price for lump sulphide antimony ore, 60 per cent antimony, for the year 1981, as quoted in **Metal Bulletin,** was $US 23.50 to $25 per t unit until Febraury 20 when it was reduced to $21 to $23. It remained at this level until the end of November, when it was reduced to $20 to $22 per t.

ANTIMONY METAL PRICES



Most United States producers of antimony trioxide quoted their price at $US 1.80 per pound during 1981 but ASARCO quoted a variable price. Its price was quoted at $1.50 per pound until May when it was increased to $1.60 per pound. The price was lowered in August to $1.55, in September to $1.45 and again in November to $1.40 per pound. Reportedly, sales by other producers are being discounted to compete with ASARCO and imports of antimony trioxide.

OUTLOOK

The general worldwide recession, especially in the automotive and durable goods industry, is expected to continue to depress the use of antimony in batteries and flame retardant applications in 1982. However, in the medium-term a small increase in consumption could occur in flame retardant chemicals, plastics and glass but it would be offset, in part at least, by the continuing reduction in the use of antimony in automobile batteries in the United States and the adoption of the maintenance free batteries for use in European and Japanese automobiles which reportedly is now being introduced on some automobiles.

It appears that there will be adequate antimony metal and oxide available to satisfy world demand in 1982 and no marked change in the price is foreseen in the near future. Restraint by producers in making antimony available to the market could have a positive influence on price. The forthcoming sale of 2 721 t by the GSA over a three-year period will be a deterring factor in any price increase.

In the medium- to longer-term the supply of antimony will be able to meet demand. South Africa and Bolivia have curtailed output and if the need arises these cutbacks could readily be reversed. China has large reserves of antimony and production could, if necessary, be increased to meet demand.

TARIFFS

CANADA

Item No.		British Preferential	General Preferential	Most Favoured Nation	General
			%		
33000-1	Antimony or regulus of, not ground, pulverized or otherwise manufactured	free	free	free	free
33502-1	Antimony oxides	free	free	9.4	25

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

Item No.	1981	1982	1983	1984	1985	1986	1987
			%				
33502-1	9.4	7.8	6.3	4.7	3.1	1.6	free

UNITED STATES

Item No.		1981	1982	1983	1984	1985	1986	1987
				(¢ per pound)				
601.03	Antimony ore	Remains free						
632.02	Antimony metal unwrought etc. (Duty on waste and scrap temporarily suspended)	0.8	0.6	0.5	0.4	0.3	0.1	free

EUROPEAN ECONOMIC COMMUNITY (MFN)

Item No.		1981	Base Rate	Concession Rate
			%	
26.01	Antimony ore	free	free	free
81.04	1. Antimony unwrought waste and scrap	free	free	free
	2. Antimony, other	8	8	8

Sources: The Customs Tariff and Commodities Index, January 1981, Revenue Canada; Schedules of the United States Annotated 1981, USITC Publication 1111; U.S. Federal Register Vol. 44, No. 241; Official Journal of the European Communities, Vol. 23, No. L315, 1980.

Arsenic

J.J. HOGAN

Arsenic occurs as a minor constituent of complex ores which are mined primarily for their copper, lead, zinc, silver and gold content, although globally, copper ores are the main source of arsenic. It is collected in the form of impure arsenic trioxide in dusts and residues from the roasting of these ores. Approximately 96 per cent of arsenic is consumed in the form of arsenic trioxide and other arsenic compounds. Only about 4 per cent is consumed as metallic arsenic. In the literature, arsenic trioxide is commonly referred to as arsenic.

A limited supply and increasing demand from the agricultural and wood perservative sectors created a tight market for arsenic trioxide during 1981. The world's major consumers of arsenic trioxide have been placed on an allocation system by the producers. World production declined from an estimated 63 939 t in 1970 to 38 700 t in 1981. Factors responsible for this decrease include environmental regulations pertaining to arsenic trioxide emissions from smelters, lower recovery rates, labour problems and a lower arsenic content of some ores.

CANADIAN DEVELOPMENTS

Few data are available on arsenic in Canada, particularly in recent years. Minor production of arsenic trioxide was recorded for 1970 and 1971 (Table 1) from the roasting of arsenic-bearing silver ores from the Cobalt district. The cobalt refinery closed in early 1972. In 1976 Canadian Smelting & Refining (1974) Limited brought a new silver refinery into production to treat the arsenical silver-cobalt ores, using a hydrothermal process that does not recover arsenic trioxide.

Dust and residues collected during the roasting of arsenious gold ores at two gold mines, Campbell Red Lake Mines Limited in the Red Lake district of Ontario and Giant Yellowknife Mines Limited in the Northwest Territories, have a high arsenic content. Both these operations use similar recovery technology, including electrostatic precipitation of dust, the cooling of the arsenic-containing gases and the collection of arsenic trioxide in a baghouse.

In 1981 Giant Yellowknife, which had been storing arsenic-containing residues underground, shipped 1 093 t of impure arsenic trioxide to a United States purchaser. To handle these shipments a storage silo and loading facilities were completed early in 1981. Campbell Red Lake also ships impure arsenic trioxide to the United States.

Cominco Ltd. is constructing an arsenic trioxide recovery plant at its Con gold mine near Yellowknife, Northwest Territories, for the production of 99.5 per cent pure marketable arsenic trioxide from arseniferous sludge accumulated during the period in which Con ores were roasted to obtain maximum gold recovery. The capacity of the plant is 15 tpd of arsenic trioxide and its cost is estimated to be about $13 million. The plant is expected to be in operation in 1983. Plant feed reserves are estimated to be about 65 000 t which will be fed to the plant at about 32 tpd. Gold and silver will be recovered from the plant residue.

Cominco officially opened its gallium arsenide plant at Trail, British Columbia, in mid-1981. It is the latest unit in the company's electronic materials division. The plant produces gallium arsenide crystals 5 to 7 centimetres in diameter and 50 cm in length which are sliced into half a millimetre wafers and polished. The wafers are used in certain electronic applications and for light emitting diodes.

No recent Canadian statistics are available for either domestic consumption of or international trade in arsenic or its compounds. Major uses are believed to be wood preservatives and agricultural chemicals.

PRICES

Arsenic trioxide prices have risen sharply since the mid-1970s, and the rising trend continued in 1981, reflecting strengthening demand in the face of restricted supply (Table 3).

The producer price, imported in steel drums, minimum 95 per cent arsenic trioxide, cif major United States ports, was quoted at 77.16 cents per kilogram (kg) at the beginning of 1981 and increased to 99.21 cents per kg on February 20, where it remained for the remainder of the year.

The Laredo price for refined 99.31 per cent arsenic trioxide in carload lots fob, Texas (Mexican arsenic) was quoted at $1.21 per kg at the beginning of the year and increased to $1.54 per kg on April 3. On June 5, the price was increased to $1.72 per kg, which held for the balance of the year.

The Tacoma price for crude 95 per cent arsenic trioxide in carload lots, fob Tacoma, Washington, which was quoted at 70 cents per kg on February 20, was increased to 75.5 cents per kg on April 24 and to 77.2 cents per kg on September 4. It remained at this level for the balance of the year. In the first part of 1981 the quoted price of 89.8 cents per kg was for arsenic trioxide shipped in drums and not bulk.

In July 1975, Metals Week quoted metallic arsenic (99 per cent arsenic content), at $US 3.53 per kg ($1.60 per pound). The price increased to $3.86 per kg in 1976 and to $4.19 in 1977. This was the price in August 1979 when regular quotes were discontinued. In July 1981, ASARCO reduced its metal price from $7.16 per kg to $6.94 ($3.15 per pound) for 907.2 kg lots fob Tacoma.

The United Kingdom price for black lump arsenic (metal) at the end of 1981, as quoted in Metal Bulletin, was £3,500 per t.

OUTLOOK

Arsenic trioxide is in tight supply and only a slight increase in production is expected in the short term. Recent developments in Canada, Chile and Peru will raise output. Environmental regulations pertaining to arsenic emissions could affect output by restricting the treatment of arsenic-bearing ores but measures to control emissions, although costly, could also lead to increased output. The recent sharp price increases for arsenic trioxide should encourage new production or an increase in secondary recovery.

TABLE 3. ARSENIC TRIOXIDE PRICES (UNITED STATES) 1970-1981[1]

	Producer Price imported as per cent arsenic trioxide	Laredo Price fob Texas, 99.5 per cent arsenic trioxide	Tacoma Price fob Washington 95 per cent minimum arsenic trioxide
		cents US/kg	
1970	13.8	13.2	10.4
1971	13.8	13.2	10.4
1972	13.8	13.2	no quote
1973	nominal	16.5	" "
1974	28.7	23.1	" "
1975	44.1	36.4	" "
1976	44.1	37.5	28.9
1977	44.1	41.9	28.9
1978	61.7	59.5	51.3
1979	70.5	66.1	53.5
1980	77.2	101.4	89.8[2]
1981	99.2	172.0	77.2

Source: Metals Week.
[1] Price indications near year-end. [2] Price for arsenic trioxide shipped in drums not bulk.

Asbestos

G.O. VAGT

SUMMARY

Shipments of asbestos fibre declined in 1981, primarily as a result of a continued slowdown in the construction industry which was hit by record high interest rates and general recessionary conditions. Preliminary figures indicate that total 1981 shipments were 1 133 000 tonnes valued at $589.2 million, compared with 1980 shipments of 1 323 053 t valued at $618.5 million. Exports, generally comprising about 95 per cent of production, were proportionally lower.

Adverse publicity, often more sensationalist than informative, and concern by some regulatory groups that health hazards may still be present even with today's strict inplant and outside emission regulations, have also contributed to weaker demand and high inventories.

CANADIAN SCENE

Quebec's shipments amounted to an estimated 984 000 t in 1981. Quebec's annual production consistently represents from 85 to 90 per cent of total Canadian production and exports of asbestos from Canada account for approximately 65 per cent of total world exports.

Johns-Manville Canada Inc., the western world's largest asbestos producer, was forced in little over a year to reduce its number of employees from 2,200 to about 1,500 at the Jeffrey mine. Asbestos Corporation Limited suspended operations for two, 3-week periods during 1981 and during the final three months of the year intermittent shutdowns, accounting for about one-half of the working time, affected 1,500 employees. Other companies also laid off employees or reduced operating schedules. A list of companies appears in Table 2.

Advocate Mines Limited, managed by Johns-Manville Canada Inc, announced in September that a decision effective December 31, 1981 was reached to close its asbestos mine and mill at Baie Verte, Newfoundland. The Advocate board of directors cited financial difficulties resulting from cash flow problems as the reason for the decision. Several companies individually expressed interest in taking over the operation, possibly with government assistance.

Judicial disputes between the Quebec Crown Corporation, la Société nationale de l'amiante (SNA) and General Dynamics Corporation (GDC) of St. Louis, Missouri for control of Asbestos Corporation Limited (ACL) culminated on March 5, 1981 when an Appeals Court decision upheld a Quebec Superior Court ruling that expropriation legislation (Bill 121) introduced by the Government of Quebec in 1978, was constitutional. Based on a decision announced November 8, 1981, the Quebec government negotiated a 51 per cent controlling interest in Asbestos Corporation Limited. Under the terms of the agreement signed on February 12, 1982 and following an initial investment by Quebec of $16 million for control of General Dynamics Corporation (Canada) Limited, Quebec can, with the approval of General Dynamics in the third year following the agreement, start buying the U.S. parent company's 1,550,010 common shares of ACL for $C 42 each ($65.1 million total) to be calculated at 16 per cent interest compounded annually.

The Ontario government's Royal Commission formed in 1980 to investigate the health effects of exposure to asbestos fibres and to recommend safety standards, conducted an intensive series of public hearings that will extend into 1982. Research programs deemed necessary to improve under-

TABLE 1. CANADA, ASBESTOS PRODUCTION AND TRADE, 1980 AND 1981

	1980		1981P	
	(tonnes)	($000)	(tonnes)	($000)
Production (shipments)[1]				
By type				
Crude, groups 1, 2 and other milled	-	-	..	..
Group 3, spinning	19 710	22,114	..	..
Group 4, shingle	476 424	359,648	..	..
Group 5, paper	194 359	107,696	..	..
Group 6, stucco	220 933	70,198	..	..
Group 7, refuse	411 627	58,837	..	..
Group 8, sand	-	-	-	-
Total	1 323 053	618,493	1 133 000	589,163
By province				
Quebec	1 150 842	495,526	984 000	471,443
British Columbia	100 089	77,816	92 000	78,390
Newfoundland	72 122	45,151	57 000	39,330
Total	1 323 053	618,493	1 133 000	589,163
Exports				
Crude				
Turkey	-	-	10	26
Total	-	-	10	26
Milled fibre (groups 3, 4 and 5)				
United States	62 248	49,056	64 640	56,260
Mexico	32 295	25,783	33 441	29,088
France	48 664	35,366	33 948	28,618
India	29 175	24,765	32 892	28,530
United Kingdom	40 016	34,454	26 438	24,608
Japan	40 446	25,666	30 741	22,600
West Germany	118 740	82,134	28 283	21,763
Italy	28 879	23,965	21 007	19,159
Belgium-Luxembourg	16 716	12,343	18 545	16,490
Australia	14 682	12,229	15 466	14,778
Spain	12 726	9,729	16 426	14,383
Malaysia	21 099	15,451	16 582	14,129
Other countries	187 672	144,730	181 368	152,714
Total	653 358	495,671	519 777	443,120
Shorts (groups 6, 7, 8 and 9)				
United States	262 173	53,462	265 080	49,195
Japan	91 708	27,459	69 523	20,654
West Germany	31 842	8,217	56 919	13,273
United Kingdom	29 973	6,464	26 210	5,352
France	20 154	4,683	15 743	4,095
India	6 202	1,939	10 435	3,887
Mexico	9 369	2,144	13 057	3,568
Taiwan	8 335	2,980	8 200	3,270
Thailand	5 780	2,070	5 289	1,922
Nigeria	7 710	1,920	4 926	1,657
Venezuela	4 243	1,114	5 410	1,570
Switzerland	4 882	1,436	4 352	1,441
Belgium-Luxembourg	8 414	2,603	4 020	1,369
South Korea	2 114	517	3 937	1,356
Argentina	7 484	1,936	3 915	1,092
Other countries	63 996	16,502	45 386	17,867
Total	564 379	135,446	542 402	131,568
Grand total crude, milled fibres and shorts	1 217 737	631,117	1 062 189	574,714

TABLE 1. (cont'd)

	1980		1981P	
	(tonnes)	($000)	(tonnes)	($000)
Manufactured products				
Asbestos cloth, dryer felts, sheets				
United States		3,610		2,654
United Kingdom		674		485
Japan		14		192
Venezuela		6		153
Nigeria		7		78
Taiwan		90		68
Other countries		343		387
Total	..	4,744	..	4,017
Brake linings and clutch facings				
United States		2,453		5,516
Australia		261		253
Hong Kong		201		133
Mexico		-		87
France		65		78
Ecuador		37		63
West Germany		56		35
Uruguay		27		18
Guatemala		15		13
Other countries		120		56
Total	..	3,235	..	6,252
Asbestos and asbestos cement building materials				
United States		11,978		12,542
Australia		193		880
United Kingdom		894		529
Iraq		-		494
Singapore		342		411
South Africa		-		403
Malaysia		-		258
Thailand		1,184		218
Venezuela		122		211
Other countries		1,823		927
Total	..	16,536	..	16,873
Asbestos basic products, nes				
United States		11,643		7,732
West Germany		659		1,033
Australia		270		109
Taiwan		73		68
Venezuela		140		61
Other countries		455		438
Total	..	13,240	..	9,441
Total exports, asbestos manufactured	..	37,755	..	36,583
Imports				
Asbestos, unmanufactured	1 156	889	934	687
Asbestos, manufactured				
Cloth, dryer felts, sheets, woven or felted		2,422		1,910
Packing		3,211		3,535
Brake linings		6,626		8,342

TABLE 1. (cont'd)

	1980		1981P	
	(tonnes)	($000)	(tonnes)	($000)
Imports (cont'd)				
Clutch facings		1,634		1,502
Asbestos-cement shingles and siding		58		52
Asbestos-cement board and sheets		840		470
Asbestos building materials, nes		3,530		2,214
Asbestos basic products, nes		5,153		3,547
Total asbestos, manufactured	..	3,474	..	21,572
Total asbestos, unmanufactured and manufactured	..	24,363	..	22,259

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

standing of the issues presented include topics such as asbestos in public buildings, sampling and measurement, technical feasibility and cost of controlling asbestos fibres in the workplace, and workers compensation.

There were no changes in federal emission regulations pursuant to the Clean Air Act as defined by Environment Canada. These regulations 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. Quebec in-plant regulations, based on recommendations made in 1976 by the Beaudry Study Committee, are determined by the level of total respirable dust, asbestos content of the total respirable dust and the number of fibres greater than five microns in length. The average concentration of fibre is restricted to 2 fibres/cm^3 or lower in order to satisfy the maximum, never-to-exceed limit of 5 fibres/cm^3.

To focus on a scientific perspective of the controversial health issues of asbestos, a World Symposium on Asbestos sponsored by the Governments of Canada and Quebec and by the Commission of the European Communities will be held in Montreal in May, 1982.

Representation at the Symposium is expected to be balanced by current points of view from the medical science, labour, government and industry sectors.

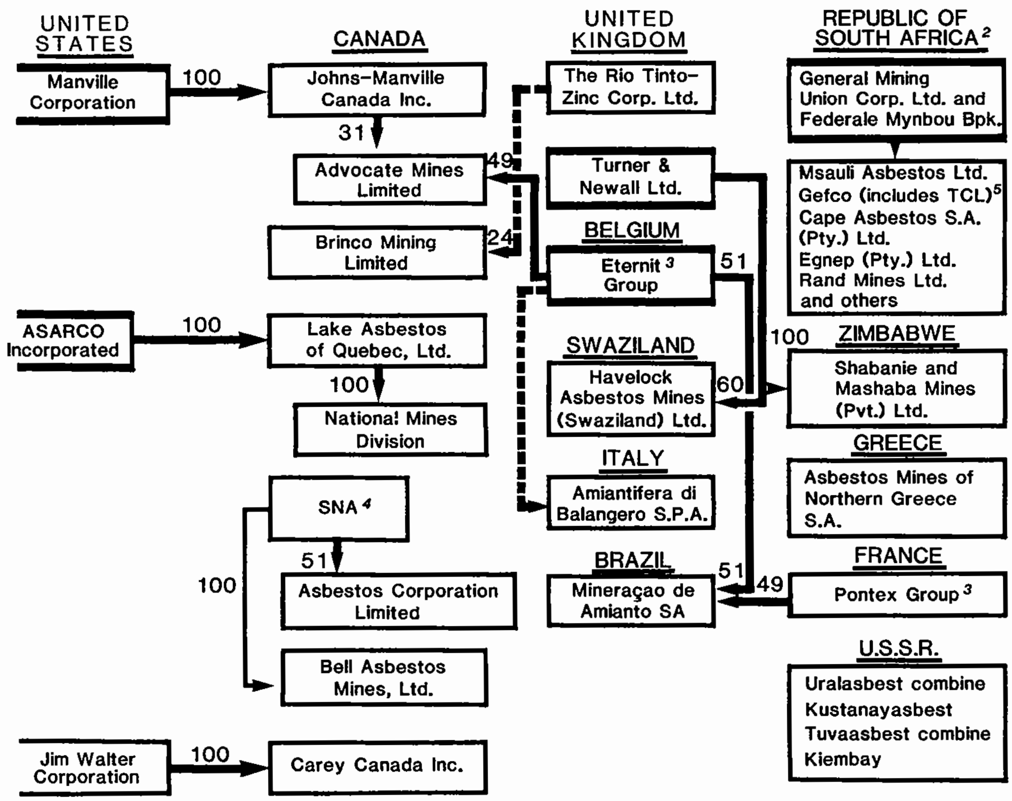
WORLD SCENE

Based on an estimated 1981 world production of 4.7 million t of fibre, major world producers and their approximate percentage share of production are: U.S.S.R., 45; Canada, 24; Republic of South Africa, 6; Zimbabwe, 5; China, 3; Italy, 3; and others, 14. Worldwide there have been many recent changes in the ownership of mining and milling assets, as indicated in Figure 1.

Expansions to production facilities 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 250 000 to 300 000 t of asbestos. South Africa's production comprises about 50 per cent crocidolite, 30 per cent chrysotile and 20 per cent amosite.

The new mine-mill complex of Asbestos Mines of Northern Greece SA near Kozani, Greece was inaugurated in April, 1981 and full-scale operation at 100 000 tpy is expected in the near future. Most of the output will be in grades 5 and 6 with grades 4 and 7 providing about 15 per cent and 10 per cent of the total, respectively. About 80 per cent of the output will be exported. Proven ore reserves are 90 million t with an average fibre recovery of 2.63 per cent.

MAJOR INTERNATIONAL ASBESTOS MINING GROUPS[1]



1. Most major groups have manufacturing interests
2. Production breakdown (approximate): crocidolite 50%, amosite 30%, chrysotile 20%.
3. Primarily have international manufacturing interests
4. Société nationale de l'amiante, a Quebec Crown corporation
5. Griqualand Exploration & Finance Co. Ltd. including Transvaal Consolidated Land & Exploration Co. Ltd.

100 — Major shareholder and percentage

24 — Minor shareholder and percentage

TABLE 2. CANADIAN ASBESTOS PRODUCERS AND PROSPECTIVE PRODUCERS, 1981

	Mine Location	Mill Capacity (tonnes) ore/day	fibre/year	Remarks
Producers				
Advocate Mines Limited	Baie Verte, Nfld.	6 600	80 000	Open-pit. Produces groups 4 and 6.
Carey Canada Inc.	East Broughton, Que.	6 800	210 000	Open-pit. Mainly produces groups 6 and 7.
Asbestos Corporation Limited				World's major independent asbestos producer.
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 by Quebec government.
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.
Prospective Producers				
United Asbestos Inc.	Matachewan, Ont.	3 600	100 000+	Inactive. Operated from late 1975 to March, 1977.
Abitibi Asbestos Mining Company Limited	Amos, Quebec	11 800		Feasibility study has been undertaken.
McAdam Mining Corporation Limited	Chibougamau, Que.	4 500		Feasibility study has been undertaken.

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

TABLE 3. CANADA, ASBESTOS PRODUCTION AND EXPORTS, 1970, 1975-81P

	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
1976	27	681 003	855 061	1 536 091
1977	1	762 186	755 173	1 517 360
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
1981P	..	..	..	1 133 000
Exports				
1970	91	747 814	669 509	1 417 414
1975	183	570 418	514 997	1 085 598
1976	83	725 197	777 154	1 502 434
1977	1	705 832	709 649	1 415 482
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
1981P	10	519 777	542 402	1 062 189

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

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

OUTLOOK

Capital expenditure programs by companies have been somewhat reduced as a result of weaker demand, however emphasis remains on the expansion of open pits, on feasibility studies to assure continued large supplies of fibre and on improving environmental control.

In the United States, the focus is on deregulation and re-examination of past regulatory action. Stricter asbestos health regulations are apparently not a top priority at present and increasing emphasis is being placed on the use of cost-benefit analyses in developing new regulations.

Studies indicate that the manufacture of asbestos-based products is less energy intensive than for plastic or metals, however the rate of growth of the Canadian asbestos industry will be mainly dependent on the degree to which world public opinion regards asbestos as a current health problem. If public acceptance of asbestos-based products is low, then even those products characterized by asbestos that is non-friable and locked-in, and from which it cannot easily escape during normal end-use, will be downgraded in commercial importance by manufacturers. An excessively strict approach that could lead to effectively banning the use of certain products in the major industrialized countries would result in an overall zero or negative growth rate in demand for asbestos. However, other countries offer very good potential demand, particularly for asbestos-cement products that may be locally manufactured to improve water and sanitation systems and to provide low-cost housing materials. The demand for asbestos in the less industrialized countries comprises 20 to 30 per cent of Canada's total exports, and based on growth during most of the previous decade, annual requirements in this segment of the market may exhibit an average annual increase of three to four per cent during most of the 1980s.

PRICES

Canadian asbestos prices quoted in **Asbestos** December, 1981[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.

Quebec asbestos producer list prices were increased about 11 per cent effective January 1, 1981, however these were not maintained. Cassiar Resources Limited, which amalgamated with Brinco Mining Limited, increased prices similarly. With record high inventories and the serious decline in demand price discounting continued into 1982.

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	11.4	11.4	25	7.5
31205-1	Asbestos in any form other than crude, and all manufactures thereof, when made from crude asbestos of British Commonwealth origin, nop	free	11.4	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	7	7	25	4.5
31220-1	Asbestos woven fabric, wholly or in part of asbestos for use in manufacture of clutch facings and brake linings	11.4	11.4	30	7.5
31225-1	Asbestos felt, rubber impregnated for use in manufacturing floor coverings	free	free	25	free

MFN REDUCTIONS (effective January 1 of year given)

	1981	1982	1983	1984	1985	1986	1987
				(%)			
31200-1	11.4	10.8	10.3	9.7	9.1	8.6	8.0
31205-1	11.4	10.8	10.3	9.7	9.1	8.6	8.0
31215-1	7.0	6.8	6.5	6.3	6.0	5.8	5.5
31220-1	11.4	10.8	10.3	9.7	9.1	8.6	8.0

UNITED STATES

Item No.		
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

UNITED STATES (cont'd)

		1981	1982	1983	1984	1985	1986	1987
					(%)			
518.21	Asbestos, yarn, slivers, rovings, wick, rope, cord, cloth, tape and tubing	3.0	2.5	2.0	1.5	1.0	0.5	free
518.51	Asbestos articles nop	3.4	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 1981, USITC Publication 1111. 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 1981 were valued at $4.39 million, while imports of barium carbonate, one of the most important barium chemicals derived from barite, amounted to 3 209 t valued at $1,080,000.

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. Witherite ($BaCO_3$) was formerly of importance but it has been found in relatively large quantities only in the north of England. The major western world producers of barite are: the United States, Peru, India, Ireland, Mexico and Morocco.

CANADIAN SCENE

Production

Barite was produced during 1981 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 for well drilling commenced in late 1981 on a seasonal basis at the Buchans mine, Newfoundland. The barite is marketed by Baroid of Canada, Ltd. under separate agreements made with Abitibi-Price Inc. and ASARCO Incorporated which own respectively 51 per cent and 49 per cent of the mine. Barite reserves are estimated to be more than one million t contained in tailings. A $2 million expansion supported by a federal government grant to process about 3 million t of tailings containing 40 per cent barite will presently allow an annual production up to 10 000 t of barite.

Nystone Chemicals Ltd. commenced production of 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. Earlier work led to a development program under the federal Program for Advancement of Industrial Technology (PAIT). The financing for a plant to produce about 2 000 tpy of product located at the Debert Air Industrial Park near Truro, was assisted by the Department of Regional Economic Expansion and The Nova Scotia Resources Development Board.

Consumption

In 1980, consumption of barite in Canada was an estimated 139 000 t with over 90 per cent utilized in drilling muds.

TABLE 1. CANADA, BARITE PRODUCTION AND TRADE, 1980 AND 1981 AND CONSUMPTION, 1979 AND 1980

	1980		1981P	
	(tonnes)	($000)	(tonnes)	($000)
Production (mine shipments)	..	4,380	..	4,386
Imports				
United States	44 930	4,130	10 962	1,141
Ireland	-	-	5 000	118
Netherlands	54	11	254	72
Other	173	74	62	24
Total	45 157	4,215	16 278	1,355
Exports				
United States	645	212	405	196
Total	645	212	405	196
	1979		1980P	
Consumption[1]				
Well drilling[e]	91 992		135 359	
Rubber goods	1 058		915	
Paint and varnish	2 440		1 567	
Glass and glass products[2]	7		121	
Other[3]	818		867	
Total[e]	96 315[r]		138 829	

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

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

TABLE 2. CANADA, BARITE PRODUCTION TRADE AND CONSUMPTION, 1970, 1975-81

	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
1976	1,852,254	18 097	60 297	58 066
1977	2,836,241	5 979	69 421	53 508
1978	2,656,672	15 635	56 783	58 191
1979	1,953,000	20 765[r]	2 038	96 315[r]
1980	4,380,000	45 157	645	138 829
1981P	4,386,000	16 278	405	92 000

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Mine shipments.
[P] Preliminary; [r] Revised; [e] Estimated.

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 is not available.

WORLD SCENE

World production of barite in 1981 was about 7.5 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:

TABLE 3. WORLD PRODUCTION OF BARITE 1979-81 AND RESERVES, 1981

	Mine production			Reserves
	1979	1980P	1981e	1981e
	(000 tonnes)			
United States	1 916	2 037	2 585	50 000
China, P.R.	500	680	771	9 000
U.S.S.R.	500	500	500	9 000
Peru	444	415	409	6 000
India	387	345	354	27 000
Morocco	287	320	327	3 000
Mexico	151	269	318	9 000
Thailand	378	305	300	9 000
Ireland	328	260	260	8 000
Chile	227	226	224	..
France	170	227	209	5 000
Canada	67	86	82	15 000
Other free-world countries	1 270	1 215	1 137	31 000
Communist countries	442	435	430	12 000
World totals	7 067	7 320	7 906	193 000

Sources: United States Bureau of Mines, Mineral Commodity Summaries, 1982. U.S. Bureau of Mines Preprint, 1981.
P Preliminary; e Estimated; .. Not available.

Baroid Division of N L Industries, Inc.; Dresser Industries, Inc.; Milchem, Inc.; and Imco Drilling Services, a division of Halliburton Company.

The United States is by far the world's largest producer of barite and its mines produced an estimated 2.2 million t in 1981, 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 U.S. during 1980 and 1981 were 1.68 and 1.72 million t respectively. Following the United States, which accounted for 28.9 per cent of the total world production were India, 4.8; Peru, Mexico and Ireland, each with 4.2; Morocco, 3.6; Thailand, France and Italy, each with 3.0; West Germany, 1.8; Canada, 1.2; Yugoslavia, 0.6; other market economy countries 14.5; U.S.S.R., 6.6 and other central economy countries, 16.4.

The United States, the principal consumer of barite, used an estimated 3.8 million t in 1981. Imports into the United States for the years 1977 to 1980, inclusive, came from the following countries, by per cent: Peru, 23.5; Mainland China, 14.5; Ireland, 12; Morocco, 10; Chile, 10; and other 30.

In the United States, three new grinding plants were completed and the capacity of another was expanded. Two new mills were completed at other locations and construction of another was under way. In Chile a new mine development was under way and in Peru a new plant will concentrate stockpiled ore from previous operations.

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. When barite is used in highly pigmented distemper or latex paints, a degree of light scattering is attributed to the barite, therefore 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 call for 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 ore 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 1981, 7,200 wells or 8.2 million m were drilled according to preliminary statistics, compared to 1980 when 9,200 wells or 10.3 million m were drilled. In 1982 drilling activity is expected to be about 30 per cent lower than in 1981. Factors such as government taxation policies, the seriousness of jurisdictional disputes over ownership of offshore rights, the relative amount of drilling activity in the conventional and offshore regions and the outlook for exports of natural gas will be important to determining 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 where there is drilling activity, however, increasing rail transportation rates in North America may provide additional incentives to overseas suppliers. 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 increased about 20 per cent in 1981.

United States prices of barite as reported in Engineering and Mining Journal[1], of December 1981.

	($ per short ton)
Unground	
Chemical and glass grade:	
Hand picked, 95% $BaSO_4$, not over 1% Fe	72.00
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	32.00-61.00
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	95.00-115.0
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	10	11.3	25	7.5
92818-1	peroxide				
92842-1	Barium carbonate	10	14.4	25	9.5
93207-5	Lithopone	free	12	25	free

MFN REDUCTIONS UNDER GATT (effective January 1 of year given)

	1981	1982	1983	1984	1985	1986	1987
				(%)			
92818-1	11.3	9.4	7.5	5.6	3.8	1.9	free
92842-1	14.4	14.1	13.8	13.4	13.1	12.8	12.5
93207-5	12.0	11.8	11.5	11.3	11.0	10.8	10.5

UNITED STATES (MFN)

Item No.		
	Barium carbonate:	
472.02	Natural, crude (witherite)	free
476.06	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	4.9%

		1981	1982	1983	1984	1985	1986	1987
					(%)			
472.04	Barium carbonate, natural ground (witherite)	5.6	5.3	5.1	4.9	4.7	4.4	4.2

Sources: The Customs Tariff and Commodities Index, January 1981, Revenue Canada; Tariff Schedules of the United States Annotated (1981), USITC Publication 1011; 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 1981 was approximately 22 800 t valued at $1.7 million. From a 1978 base, demand for strontium in the U.S. 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 25, 1981

	($ per short ton)
Strontium carbonate glass grade, bags, truckload, works	560.00-575.00
	($ 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.		1981	1982	1983	1984	1985	1986	1987
					(%)			
Strontium metal:								
473.19	Chromate	4.7	4.5	4.4	4.2	4.0	3.9	3.7
632.46	Unwrought, waste and scrap	4.7	4.5	4.4	4.2	4.0	3.9	3.7
632.68	Alloys	6.4	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	5.6	5.3	5.1	4.9	4.7	4.4	4.2
421.74	Nitrate	5.6	5.3	5.1	4.9	4.7	4.4	4.2
421.76	Oxide	5.6	5.3	5.1	4.9	4.7	4.4	4.2
421.82	Sulfate, mineral (celestite)			Remain free				
421.84	Sulfate, other	4.7	4.5	4.4	4.2	4.0	3.9	3.7
421.86	Other	4.7	4.5	4.4	4.2	4.0	3.9	3.7

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

Cadmium

M.J. GAUVIN

Cadmium is a relatively rare element in the earth's crust, occurring most commonly as the sulphide, greenockite (CdS) which is found associated with zinc sulphide ores, particularly sphalerite ((Zn, Fe)S). There are no known commercial orebodies of cadmium; reserves at any time are a function of zinc reserves and specifically the cadmium content of those reserves.

Cadmium metal is recovered as a by-product of zinc smelting and refining. Since secondary sources are considered negligible in terms of total supply, cadmium production is a function of zinc metal production which bears little or no relationship to the demand for cadmium. Consequently, the cadmium market can be quite volatile.

PRODUCTION AND CONSUMPTION

Canada, in 1981, was the non-socialist world's third largest producer of cadmium metal following Japan and the United States. The next two largest producers were the Federal Republic of Germany and Belgium. Production of cadmium in the non-socialist world, as reported by the World Bureau of Metal Statistics decreased in 1981 to 13 315 t from 14 403 t in 1980.

TABLE 1. CANADIAN PRIMARY CADMIUM STATISTICS, 1979-81

	1979	1980	1981P
		(tonnes)	
Mine production	1 210	1 033	1 274
Metal production	1 455	1 303	1 293
Metal capacity	1 800	1 800	1 800
Metal shipments:			
Domestic	121	88	131
Exports	1 293	1 096	1 453

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

Consumption of refined cadmium in Canada as reported by consumers to Statistics Canada increased 25 per cent in 1980 to 61 t from that reported in 1979. Data for 1981 were not available at time of writing. Domestic shipments as reported by primary producers were reported at a very low 88 t in 1980 but increased to a more normal 132 t during 1981.

TABLE 2. CANADA, CADMIUM METAL CAPACITY, 1981

Company and Location	Annual Capacity
	(tonnes)
Cominco Ltd.	
Trail, British Columbia	640
Canadian Electolytic Zinc Limited	
Valleyfield, Quebec	550
Kidd Creek Mines Ltd.	
Hoyle, Ontario	450
Hudson Bay Mining and Smelting Co., Limited	
Flin Flon, Manitoba	160
Total Canada	1 800

Source: MR 195 **Mining and Mineral Processing Operations in Canada,** 1980, Energy, Mines and Resources, Canada.

TABLE 3. CANADA, CADMIUM PRODUCTION AND EXPORTS 1980 AND 1981, AND CONSUMPTION 1979-81

	1980		1981P	
	(kilograms)	($)	(kilograms)	($)
Production				
All forms[1]				
Ontario	778 000	5,701,000	850 000	4,241,000
British Columbia	92 000	677,000	186 000	929,000
Quebec	98 000	719,000	97 000	508,000
Newfoundland	30 000	218,000	88 000	441,000
Manitoba	24 000	177,000	42 000	208,000
Saskatchewan	6 000	39,000	11 000	57,000
Nova Scotia	5 000	37,000	-	-
Total	1 033 000	7,568,000	1 274 000	6,384,000
Refined[2]	1 302 955	..	1 293 265	..
Exports				
Cadmium metal				
United States	782 939	4,951,000	912 595	5,125,000
United Kingdom	312 420	1,904,000	531 377	2,617,000
Italy	-	-	4 999	24,000
West Germany	11	6,000	20	13,000
Netherlands	21	9,000	2 513	12,000
Ivory Coast	-	-	1 000	6,000
Other countries	434	25,000	400	4,000
Total	1 095 825	6,895,000	1 452 904	7,801,000

	1979	1980	1981
		(kilograms)	
Consumption			
Cadmium metal[3]			
Plating	24 558	21 405	..
Solders	6 568	22 931	..
Other uses[4]	17 620	16 675	..
Total	48 746	61 011	..

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Production of refined cadmium from domestic ores, plus recoverable cadmium content of ores and concentrates exported. [2] Refined metal from all sources and cadmium sponge. [3] Available data reported by consumers. [4] Mainly chemicals, pigments and alloys other than solder.
P Preliminary; - Nil; .. Not available.

TABLE 4. CANADA, CADMIUM PRODUCTION, EXPORTS AND DOMESTIC SHIPMENTS, 1970, 1975-81

	Production		Exports	Producers'
	All Forms[1]	Refined[2]	Cadmium Metal	Domestic Shipments
			(kilograms)	
1970	1 954 055	836 745	702 630	157 307
1975	1 191 674	1 142 508	637 797	98 820
1976	1 313 723	1 387 805	1 555 772	135 354
1977	1 185 446	1 369 447	869 684	84 944
1978	1 151 298	1 264 804	1 259 290	141 579
1979	1 209 459	1 454 954	1 292 515	120 926
1980	1 033 000	1 302 955	1 095 825	88 232
1981P	1 274 000	1 293 265	1 452 904	131 175

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Production of refined cadmium from domestic ores plus recoverable cadmium content of ores and concentrates exported. [2] Refined metal from all sources and cadmium sponge.
P Preliminary.

USES

Cadmium is a soft, ductile, silver-white electropositive metal. It is used for electroplating iron and steel products to protect them against oxidation. A cadmium coating, like a zinc coating, protects metals that are lower in the electromotive series by physical enclosure and by sacrificial corrosion, and this is the largest use for cadmium. Cadmium-plated parts are used in automobiles, household appliances, aircraft, radios, television sets and electrical equipment.

The second-largest use according to the Statistics Canada survey is in the manufacture of pigments and chemicals. Cadmium sulphides give yellow-to-orange colours and cadmium sulphoselenides give pink-to-red and maroon. Cadmium is a valuable alloying metal and has applications in cadmium-silver solders and in cadmium-tin-lead-bismuth fusible or low-melting-point alloys for automatic sprinkler systems, fire-detection apparatus and valve seats for high-pressure gas containers. A growing application is in the production of nickel-cadmium storage batteries. These batteries are considerably more expensive than the standard lead-acid battery, but have a longer life and higher peak-power output, are smaller and are superior in low-temperature operation.

TABLE 5. CADMIUM METAL PRICES, 1981

	Average Monthly Prices		
	Northern Miner[1]	Metals Week	
Month	Cominco	U.S. Producer	New York Dealer
	($Cdn/lb)	($US/lb)	
January	3.00	2.324	1.900-2.050
February	2.50	2.000	1.800-1.900
March	2.50	2.000	1.750-1.950
April	2.50	2.000	1.700-1.950
May	2.50	2.000	1.800-2.000
June	2.50	2.000	1.650-1.850
July	2.50	1.875	1.550-1.750
August	2.50	1.875	1.550-1.700
September	2.50	1.750	1.550-1.650
October	2.50	1.614	1.350-1.650
November	2.00	1.600	1.300-1.400
December	2.00	1.400	1.250-1.350
Average	2.46	1.927	1.596-1.767

Sources: **Northern Miner, Metals Week.**
[1] Northern Miner list price suspended February 1981 (quotations per Cominco).

TABLE 6. WESTERN WORLD CADMIUM METAL PRODUCTION, 1979-81

Continent and Country	1979	1980	1981P
		(tonnes)	
Europe			
Austria	34	36	56
Belgium	1 440	1 527	1 065
Finland	590	581	618
France	792	792	660
West Germany	1 266	1 194	1 073
Italy	527	568	489
Netherlands	416	455	506
Norway	115	130	118
Spain	222	309	303
United Kingdom	424	375	278
Yugoslavia	170	190	168
	5 996	6 157	5 334
Africa			
Algeria	185	150	180
Namibia	81	70	-
Zaire	212	168	240
Zambia	-	1	-
	478	389	420
Asia			
India	166	89	111
Japan	2 597	2 174	2 036
Turkey	12	10	12
South Korea	50	365	360
	2 825	2 638	2 519
America			
Canada	1 455	1 303	1 293
Mexico	732	722)	815
Peru	190	174)	
United States	2 058	1 949	1 871
Other America	57	59	36
	4 492	4 207	4 015
Australia	804	1 012	1 027
Western World	14 595	14 403	13 315

Sources: World Metal Statistics; Energy Mines and Resources Canada.
P Preliminary; - Nil.

PRICES

Published producer prices in the United States were $2.50 a pound at the beginning of the year. In mid-January, they were reduced to $2 a pound and to $1.75 in early July. Further reductions in October and December lowered the price to $1.40 where it remained at year-end.

OUTLOOK

The long-term outlook for cadmium is that it will continue to follow the trends established by the zinc industry. During periods of oversupply, greater usage in its traditional markets and possible new uses would gradually absorb the excess supply.

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
32900-1	Cadmium in ores and concentrates	free	free	free	free
35102-1	Cadmium metal, not including alloys, in lumps, powders, ingots, or blocks	free	free	25	free

UNITED STATES

Item No.		
601.66	Cadmium in ores and concentrates	free
632.14	Cadmium metal, unwrought, waste and scrap	free
632.86	Cadmium alloys, unwrought containing by weight 96% or more but less than 99% of silicon	9%

		1981	1982	1983	1984	1985	1986	1987
					(%)			
632.88	Cadmium alloys, unwrought, other	8.1	7.7	7.3	6.8	6.4	5.9	5.5
633.00	Cadmium metal, wrought	8.1	7.7	7.3	6.8	6.4	5.9	5.5

EUROPEAN ECONOMIC COMMUNITY (MFN)

Item No.		1981	Base Rate	Concession Rate
			(%)	
26.01	Cadmium in ores and concentrates	free	free	free
81.04	Cadmium metal, unwrought, waste and scrap	4	4	4
	Cadmium metal, other	6	6	6

JAPAN (MFN)

Item No.		1981	Base Rate	Concession Rate
			(%)	
26.01	Cadmium in ores and concentrates	free	free	free
81.04	Cadmium metal:			
	Unwrought	7.3	10	5.1
	Waste and scrap	7.2	10	4.8
	Powders and flakes	7.5	10	5.8
	Cadmium metal, other	10.6	15	6.5

Sources: The Customs Tariff and Commodities Index, January, 1981. Revenue Canada; Tariff Schedules of the United States Annotated 1981, USITC Publication 1111; U.S. Federal Register, Vol. 44, No. 241; Official Journal of the European Communities, L 315, Vol. 3; Customs Tariff Schedules of Japan, 1981.

Calcium

A.G. JOHNSTON

The effects of world recession on the metal fabricating industry combined with reduced sales of U.S. automobiles continued to restrict the demand for calcium metal. During 1980-81, imports by the United States declined significantly due to lowered demand for the "maintenance-free" (MF) lead-calcium storage battery; however, imports by Japan, chiefly for the steel industry, were at an all-time high. Canada, continued to find new export markets for calcium metal although the United States market remained the most significant.

Calcium is the fifth most abundant element in the earth's crust. It occurs 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 makes four main grades of calcium: Grade 1, chemical standard, 99.7 per cent calcium, with up to 0.2 per cent magnesium and minor amounts of other elements; Grade 2, nuclear quality, 99.4 per cent calcium, with a maximum magnesium content at 0.5 per cent; Grade 3, battery grade, 98.5 per cent calcium, with a maximum of 0.5 per cent magnesium, 0.15 per cent nitrogen and 0.45 per cent aluminum; and Grade 4, commercial crowns, 98.0 per cent calcium, 0.5 to 1.5 per cent magnesium, 0.15 per cent maximum nitrogen and 0.45 per cent maximum aluminum.

Canadian exports to the United States, Canada's major customer, have declined in recent years but exports to Mexico and Australia have increased. In addition, some calcium metal was exported in 1981 to the Netherlands, Spain, the United Kingdom, Ireland and Japan.

WORLD MARKETS

Annual world production of calcium metal in recent years, as estimated by the United States Bureau of Mines, has ranged from 635 t to 726 t. Canada, is the leading producer with about 40 per cent of this total, followed by the U.S.S.R. and the United States. The other producers in the non-communist world are: Planet-Wattohm S.A., a subsidiary of Compagnie de Mokta, in France; Charles Pfizer and Co. Inc. in the United States; and Furukawa Magnesium Company in Japan.

A record 360 600 kg of calcium was imported by the United States in 1979 but U.S. imports declined to 98 400 kg in 1981. This decline was mainly due to reduced demand for lead-calcium storage batteries as U.S. automobile sales weakened. Since 1979, more calcium has been used in debismuthizing lead than in the manufacture of batteries. As the economic recession intensified, overall United States demand for calcium decreased, including its use in the metals manufacturing industry.

Although the U.S.S.R. produces substantial amounts of calcium metal (estimated at 450 000 kg annually), and supplied 64 per cent of U.S. imports in 1979, calcium metal exports during the 1980-81 period were nil. However, The Peoples Republic of China began exporting calcium metal to the United States in 1981.

Japanese imports of calcium metal in 1981, estimated at 150 000 kg, reached an all-time high, up 50 per cent from the previous year. Nearly 97 per cent was supplied by the United States, mainly for use in the steel industry. Japanese domestic production of calcium metal began in 1981, when Furukawa Magnesium started producing the metal in October. Production capacity is 10 000 kg per month. Exports of calcium-bearing steel products remained buoyant, especially high-tensile steel for oil and gas pipelines in overseas markets. In addition, the amount used in pharmaceuticals, chiefly as an ingredient of Vitamin B, has been increasing. Calcium demand by the battery industry did not grow as expected, because the price of calcium remained 20 to 30 per cent above the price of antimony, and the "maintenance free" battery has been slow to catch on in Japan. The steel industry consumed 75 to 80 per cent of the calcium metal imported by Japan in 1981, with the remainder shared almost equally by the pharmaceutical and battery industries.

PRICES

Calcium metal prices, in United States currency as published by Metals Week, increased from \$1.89 per lb in 1979 for commercial grade full crowns (20,000 lb lots) to \$2.47 per lb in 1980, and to \$3.05 per lb in October 1981. During the same period the price of calcium-silicon alloy (28 to 32 per cent calcium on 40,000 lb lots) in U.S. funds increased from \$0.71 per lb in 1979 to \$0.76 per lb in 1980, and to \$0.82 per lb by February 1981. Prices were unchanged for the remainder of the year.

USES

Calcium's powerful reducing properties make it valuable in the manufacture of many of the less common metals such as columbium, tantalum, chromium, titanium, thorium, uranium, 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

Since world economic conditions are not expected to improve before late 1982, near-term demand for calcium metal will remain weak. However, given general economic recovery, a high growth rate is predicted for the use of calcium metal in the battery and metal manufacturing industries. Research continues into new uses for calcium metal, particularly as an additive in the development of high quality steels.

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
92805-1	Calcium Metal	10	13.6	25	9

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

	1981	1982	1983	1984	1985	1986	1987
				(%)			
92805-1	13.6	12.8	12.1	11.4	10.7	9.9	9.2

UNITED STATES (MFN)

Item No.		1981	1982	1983	1984	1985	1986	1987
					(%)			
632-16	Calcium, unwrought, waste and scrap	6.4	5.8	5.3	4.7	4.1	3.6	3.0
633-00	Calcium, wrought	8.1	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

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

Total cement shipments from Canadian plants in 1981 changed only slightly from 1980 with market distribution being similar to 1979. The Atlantic, Quebec, Ontario and Prairie regions consumed less than the year before while British Columbia again provided an offsetting increase. The Canadian portland cement industry has undergone major changes in recent years such that production capacities are distributed across the country by region in response to existing and expected regional demand. Also, growth by the major companies has been accomplished through acquisition of producing plants, grinding plants or distribution facilities in the United States and through integration into the concrete products and construction fields in Canada. New plant construction would cost about $250 per t of annual production under current financial conditions and the acquisition route to growth could be much less expensive.

Exports of cement and of clinker to the United States have played a great part in the successful development and expansion of the Canadian portland cement industry. Record amounts were exported during 1979, principally to the States of New York, Michigan, Vermont and Washington, and the Canadian industry has been lamenting the fact that these amounts have not been duplicated since that time because of the recessionary conditions in the United States. Exports of cement were reduced by about 7 per cent in 1981, while clinker exports, principally to Canadian-owned grinding subsidiaries in the United States, were down more than 25 per cent.

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.

Table 3 has been altered in this review to illustrate clinker production capacity as of the end of 1981 from published information released by The Canadian Portland Cement Association. A plant generally has a slightly greater capacity to grind clinker than it has to produce clinker.

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 used over 450 000 t of cement in 1981, up 3.4 per cent from 1980 and representing 5.9 per cent of total Canadian consumption.

In the **Quebec region** the five clinker-producing plants have 25.6 per cent of the Canadian total in an area that has 26.6 per cent of Canadian population and which, in 1981, consumed about 1.6 million t

TABLE 1. CANADA, CEMENT PRODUCTION AND TRADE, 1980 AND 1981

	1980		1981p	
	(tonnes)	($)	(tonnes)	($)
Production[1]				
By province				
Ontario	3 397 000	163,056 000	3 620 000	200,115,000
Alberta	1 155 000	97,000,000	1 400 000	135,409,000
Quebec	2 765 000	128,999,000	2 527 000	128,973,000
British Columbia	1 351 000	90,881,000	970 000	81,546,000
Manitoba	510 000	34,680,000	650 000	50,904,000
Saskatchewan	370 000	30,200,000	398 000	37 413,000
Nova Scotia	..	18,379,000	..	26,323,000
New Brunswick	..	11,762,000	..	12,516,000
Newfoundland	..	6,415,000	..	7,388,000
Total	10 274 000	581,372,000	10 368 000	680,587,000
By type				
Portland	9 953 000	..	10 007 000	..
Masonry[2]	321 000	..	361 000	..
Total	10 274 000	581,372,000	10 368 000	680,587,000
Exports				
Portland cement				
United States	1 451 838	62,266,000	1 513 404	65,695,000
Saudi Arabia	68 946	2,472,000	60 002	2,561,000
St. Pierre and Miquelon	469	49,000	1 634	160,000
Other countries	6 230	279,000	3 644	271,000
Total	1 527 483	65,066,000	1 578 684	68,687,000
Cement and concrete basic products				
United States	..	37,997,000	..	34,237,000
Other countries	..	2,008,000	..	1,351,000
Total	..	40,005,000	..	35,588,000
Imports				
Portland cement, standard				
United States	124 247	8,958,000	469 651	32,508,000
Japan	284	37,000	-	-
Italy	17	2,000	-	-
Total	124 548	8,997,000	469,651	32,508,000
White cement				
United States	4 938	479,000	4 716	386,000
Japan	890	123,000	477	83,000
France	19	1,000	50	6,000
Total	5 847	603,000	5 243	475,000
Aluminous cement				
United States	10 489	2,732,000	14 251	2,833,000
South Africa	-	-	8	11,000
United Kingdom	184	63,000	-	-
Total	10 673	2,795,000	14 259	2,844,000

TABLE 1. (cont'd)

	1980		1981P	
	(tonnes)	($)	(tonnes)	($)
Cement, nes				
United States	80 536	6,499,000	189 258	19,175,000
United Kingdom	182	47,000	1 330	85,000
Italy	888	101,000	124	15,000
West Germany	32	4,000	76	10,000
France	31	11,000	4	1,000
Switzerland	14	3,000	1	..
Total	81 683	6,665,000	190 793	19,286,000
Total cement imports	222 751	19,060,000	679 946	55,113,000
Refractory cement and mortars				
United States		10,864,000		14,474,000
Ireland		329,000		1,552,000
West Germany		198,000		200,000
United Kingdom		1,169,000		75,000
Austria		34,000		50,000
Other countries		17,000		1,000
Total	..	12,611,000	..	16,352,000
Cement and concrete basic products, nes				
United States		2,616,000		3,016,000
United Kingdom		55,000		11,000
Japan		-		8,000
France		21,000		7,000
Other countries		9,000		3,000
Total	..	2,701,000	..	3,045,000
Cement clinker				
Japan	-	-	22 600	975,000
United States	446	28,000	18 336	831,000
United Kingdom	-	-	334	156,000
Italy	50	2,000	-	-
Total	496	30,000	41 270	1,963,000

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.

of portland cement or 20 per cent of total consumption, down only 1.1 per cent from 1980. The depressed construction markets have led CCL to close its Hull, Quebec terminal and to forego the rehabilitation of its Montreal East plant. Miron Inc. is supplying a major share of the portland cement requirements to the James Bay Development Corporation hydroelectric project. The company has undertaken 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. expects significant cost savings as a result of conversion to coal in their kilns at Joliette and at Beauport. The company closed its Kingston, New York plant and further integrated into the concrete products field with the purchase of two Ontario based ready-mix operations.

Ciment Québec Inc. continued through 1980 with the installation of a Fuller

TABLE 2. CANADA, CEMENT PRODUCTION, SHIPMENTS, TRADE AND CONSUMPTION, 1970, 1975-81

	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
1976	9 898 024	9 515 452	921 031	314 680	8 909 101
1977	9 933 135	9 639 679	1 274 652	257 812	8 622 839
1978	10 472 724	10 558 279	1 634 583	219 925r	9 143 621r
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
1981P	10 152 199	10 368 000	1 578 684	679 946	9 469 262

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; r Revised.

suspension preheater with a precalciner flash furnace system of 2 000 tpd capacity to replace the existing wet plants.

Portland cement consumption was down some 7 per cent in the **Ontario region** to only 32 per cent of total Canadian consumption. The region has nearly 50 per cent of the nation's clinker producing capacity. The highly integrated Canada Cement Lafarge Ltd. experienced prolonged strikes at many of its plants during the latter third of 1980 and extending into the first quarter of 1981. The company 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.

Lake Ontario Cement Limited continued to integrate into the concrete products and construction field in Canada during 1981. The company exported significantly less cement and clinker into western New York state and Michigan than in 1980.

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.

Medusa Products Company of Canada, Limited, Paris, Ontario grinds a white clinker imported from the Medusa plant at York, Pennsylvania. The white cement is sold mainly in Ontario.

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

TABLE 3. CEMENT PLANTS, APPROXIMATE ANNUAL GRINDING CAPACITY, END OF 1981

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
Medusa Products Company of Canada, Limited	Paris[1]					
St. Lawrence Cement Inc.	Clarkson	W,P	C,O,G	3	1 986	2 000
St. Marys Cement Limited	Bowmansville	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,P	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,P	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, 1976-81

	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	9 898 024	645 377	10 543 401	70
1977	22	49	14 885 000	9 933 135	775 145	10 708 280	72
1978	24	51	15 985 000	10 472 724	1 077 274	11 549 998	72
1979	24	51	15 985 000	11 765 248	1 530 537	13 295 785	83
1980	23	47	16 363 000[5]	10 274 000	726 087	11 000 087	67
1981	23	48	16 771 000[5]	10 368 000[6]	524 006	10 892 006	65

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. [5] Adjusted to agree with PCA information. [6] Preliminary figure.

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 27.6 per cent of clinker producing capacity, excluding 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 will increase capacity by about 1.3 million tpy through 1981.

Canada Cement Lafarge Ltd., Canada's largest cement producer, completed expansion of its Exshaw, Alberta plant and a new 600 000 tpy kiln was fired in March 1981.

The company owns two plants in Alabama, at Demopolis and Birmingham, and during 1981 arranged for the purchase of the Dallas, Texas-based General Portland Inc for $US 325 million.

Genstar Cement Limited completed an expansion program at its Edmonton cement plant in late-1980, and through 1981 continued a $26 million project to increase the productive capacity at its Cadomin limestone property. 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 plant at Richmond.

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. The Edmonton plant is supplied from Cadomin, Alberta using a 4 500 t unit train and an automated materials-handling system. Genstar's Vancouver plant on Tilbury Island, after experiencing start-up difficulties, produced satisfactorily during 1980 until closed by strike action in November. Negotiations carried well into 1981 and the closure contributed to cement shortages despite the reduced export market. Limestone for Tilbury is barged from Texada Island.

A typical feature of the cement-manufacturing industry is its diversification and vertical integration into related construction material 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.

TABLE 5. CANADA, DISTRIBUTION OF DOMESTIC CEMENT SALES[1] FROM PRODUCERS' PLANTS, 1977-1981

	1977	1978	1979	1980	1981
			(tonnes)		
Quebec					
Portland	1 991 607	1 818 456	1 817 792	1 609 900	1 580 769
Masonry	89 899	80 672	78 617	68 564	66 785
Total	2 081 506	1 899 128	1 896 409	1 678 464	1 647 554
Ontario					
Portland	2 920 972	2 819 248	2 734 519	2 537 150	2 507 932
Masonry	182 809	171 622	173 507	144 394	150 835
Total	3 103 781	2 990 870	2 908 026	2 681 544	2 658 767
Other Provinces					
Portland	3 369 219	3 720 725	3 875 740	3 815 150	3 669 306
Masonry	70 709	63 273	66 698	59 470	56 269
Total	3 439 928	3 783 998	3 942 438	3 874 620	3 725 575
Canada					
Portland	8 281 798	8 358 429	8 428 051	7 962 200	7 758 007
Masonry	343 417	315 567	318 822	272 428	273 889
Total	8 625 215	8 673 996	8 746 873	8 234 628	8 031 896
Exports					
Portland	1 071 889	1 390 243	1 817 243	1 626 502	W
Masonry	24 887	38 595	43 158	25 349	W
Total	1 096 776	1 428 838	1 860 401	1 651 851	1 964 962
Clinker[2]	775 195	1 077 274	1 530 537	726 087	524 006
Total Sales					
Portland	9 353 687	9 748 672	10 245 294	9 588 702	W
Masonry	368 304	354 162	361 980	297 777	W
Total cement	9 721 991	10 102 834	10 607 274	9 886 479	9 996 858
Total clinker[3]	775 195	1 077 274	1 530 537	726 087	524 006

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 for 1977. Statistics Canada for 1978 to 1981. [3] Interplant shipments are not reported for 1978 to 1981.
W - Withheld to avoid disclosing confidential company data.

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 1981 capital and repair expenditure on construction was about 54 billion, up 15 per cent over expenditures in 1980. Housing starts in 1981 were 177,973, down from 158,601 starts in 1980. Expectations are that demand for single detached units will decrease because of high interest rates in 1982 and that total starts of all types will be less than 160,000 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

TABLE 6. CAPACITY CHANGES DURING 1981

Company	Plant Location	Net Change in Clinker Capacity (tpy)	Remarks
Ontario			
St. Lawrence Cement Inc.	Clarkson	459 000	Converted one preheater kiln to a precalciner.
Prairie Region			
Canada Cement Lafarge Ltd.	Exshaw, Alta.	510 000	Removed one dry kiln, added one dry kiln. (Actually became operative in late November 1980).
Genstar Cement Limited	Edmonton, Alta.	676 000	Total expenditures on plant expansion approximately $144 million for a new dry kiln, grinding and storage facilities.

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 1981 issue of Rock Products, a **publication of MacLean-Hunter Publishing Corp., Chicago, Illinois.**

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 1970s. The opportunity for the United States to import energy in the form of cement clinker, while also avoiding the environmental problems associated with kiln operations, could become attractive.

TRADE

Higher imports of portland cement into Canada in 1981 can be attributed, at least in part, to the fact that the industry in British Columbia was not producing for such an extended period.

TABLE 7. PLANNED CAPACITY CHANGES AS OF END OF 1981

Company	Plant Location	Net Capacity Change Compared With Table 3 (tpy)	Expected Date of Completion	Remarks
Quebec				
Ciment Quebec Inc.	St. Basile	430 000	1982	Replacing existing 2-kiln, wet process plant with 735 000 tpy suspension preheater, flash calciner system.

TABLE 8. CANADA, HOUSE CONSTRUCTION, BY PROVINCE, 1980 AND 1981

	Starts			Completions			Under Construction		
	1980	1981	% Diff.	1980	1981	% Diff.	1980	1981	% Diff.
Newfoundland	3 845	3 210	-16.6	2 956	3 936	31.8	3 736	2 966	-20.6
Prince Edward Island	475	203	-57.3	692	320	-53.8	179	48	-73.2
Nova Scotia	3 895	3 715	- 4.6	4 512	4 374	- 3.1	2 762	2 052	-25.7
New Brunswick	2 646	2 188	-17.3	3 258	2 477	-24.0	1 318	978	-25.3
Total (Atlantic Provinces)	10 864	9 316	-14.2	11 448	11 107	- 3.0	7 995	6 044	-24.4
Quebec	29 186	29 645	1.6	33 560	30 691	- 8.5	14 639	12 815	-12.5
Ontario	40 127	50 161	25.0	54 021	45 557	-15.7	31 187	34 071	9.3
Manitoba	2 597	2 824	8.7	4 503	4 515	0.3	2 694	764	-71.6
Saskatchewan	6 250	5 972	- 4.4	7 763	8 085	4.1	6 022	3 864	-35.8
Alberta	32 031	38 470	20.1	34 717	34 755	.1	20 378	22 960	12.7
Total (Prairie Provinces)	40 878	47 266	15.6	46 983	47 355	0.8	29 094	27 588	- 5.2
British Columbia	37 546	41 585	10.8	30 156	40 286	33.6	22 865	22 311	- 2.4
Total Canada	158 601	177 973	12.2	176 168	174 996	- 0.7	105 780	102 829	- 2.8

Source: Canada Mortgage and Housing Corporation.

TABLE 9. CANADA, VALUE OF CONSTRUCTION[1] BY PROVINCE, 1980-82

	1980			1981			1982		
	Building Construction	Engineering Construction	Total	Building Construction	Engineering Construction	Total	Building Construction	Engineering Construction	Total
	(thousands of dollars)								
Newfoundland	443 916	406 244	850 160	443 529	507 551	951 080	423 573	690 893	1 114 466
Nova Scotia	631 654	551 663	1 183 317	760 986	739 683	1 500 669	756 979	1 143 079	1 900 058
New Brunswick	539 095	418 957	958 052	557 600	450 986	1 008 586	643 761	524 621	1 168 382
Prince Edward Island	98 322	77 677	175 999	84 931	66 585	151 516	100 200	67 522	167 722
Quebec	4 949 915	4 402 459	9 352 374	5 812 142	4 865 982	10 678 124	5 961 929	5 144 329	11 106 258
Ontario	8 347 796	4 089 665	12 437 461	9 329 979	5 237 744	14 567 723	9 688 874	6 398 642	16 087 516
Manitoba	882 855	514 989	1 397 844	883 939	697 113	1 581 052	876 595	733 599	1 610 194
Saskatchewan	1 237 980	1 040 434	2 278 414	1 226 220	1 530 801	2 757 021	1 258 552	1 671 868	2 930 420
Alberta	5 033 629	6 659 848	11 693 477	6 252 396	7 566 664	13 819 060	7 074 819	9 577 830	16 652 649
British Columbia, Yukon and Northwest Territories	4 374 953	3 624 755	7 999 708	5 919 000	4 023 461	9 942 461	5 854 103	4 965 945	10 820 048
Canada	26 540 115	21 786 691	48 326 806	31 270 722	25 686 570	56 957 292	32 639 385	30 918 328	63 557 713

Source: Statistics Canada.

[1] Actual expenditures 1980, preliminary actual 1981, intentions 1982.

TABLE 10. CANADA, VALUE OF CONSTRUCTION[1] BY TYPE, 1980-82

	1980	1981	1982
		(millions of dollars)	
Building Construction			
Residential	13 872	16 360	16 397
Industrial	3 005	3 425	3 524
Commercial	5 912	7 163	7 945
Institutional	2 157	2 451	2 751
Other building	1 594	1 872	2 023
Total	26 540	31 271	32 640
Engineering Construction			
Marine	269	336	419
Highways, airport runways	3 731	4 313	4 429
Waterworks, sewage systems	1 997	2 127	2 396
Dams, irrigation	202	257	336
Electric power	4 297	4 981	5 900
Railway, telephones	1 851	2 165	2 612
Gas and oil facilities	6 709	7 718	9 675
Other engineering	2 731	3 789	5 151
Total	21 787	25 686	30 918
Total construction	48 327	56 957	63 558

Source: Statistics Canada.

[1] Actual expenditures 1980, preliminary actual 1981, intentions 1982.

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 production, based on 1974 calculations. In 1981 the average plant consumption of energy of all types was 5,247 mega joules a tonne, a 15.6 per cent fuel saving over 1974.

A change in the fuel mix from 1974 to 1981 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 1981 natural gas usage was 42.7 per cent of the total energy requirements while petroleum products were 17.9 per cent and coal and coke rose to 39.4 per cent.

In Canada in 1981 eight plants used coal as primary fuel, seven used oil and eight used natural gas. Seven plants had a capability to used oil as an alternate fuel while six could convert to natural gas usage and one plant could use either oil or gas as alternatives - nine plants had no alternate fuel capability.

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

GOVERNMENT INITIATIVES

Portland cement used in Canada should conform to the specifications of CAN 3-A5-M77, 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-M77.

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).

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.

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.

USES

Cement has little use alone but, when combined with water, sand, gravel, crushed stone or other aggregates in proper 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.

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.

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 outlook for 1982 is uncertain. At best, housing starts will be something less than 160,000. Non-residential building construction will likely decrease in volume and if interest rates remain high and wages increase, even engineering construction will show but a slight gain in volume.

The Canadian portland cement industry has reduced its energy consumption per t of production by over 15 per cent since 1974. With rising energy costs, fuel now accounts for nearly 50 per cent of total input costs. Although price increases for cement are justified on the basis of energy costs, the industry is devoting itself and its resources to further reduce its energy usage in co-operation with federal government programs.

Growth in construction spending will undoubtedly be greatest in Alberta and British Columbia during 1982. The major cement producers expect continued growth in construction with modest gains in the short-term and, as in the past two or three years, also expect activity to range from promising through cautious. There is a good possibility that construction expenditures could increase in Atlantic regions as a result of offshore drilling activity.

Plant shutdowns for extended periods through the early months of 1982 are a possibility. Under good conditions winter months are slow, under existing conditions full operation will be difficult to justify. Labour disputes a year ago affected the industry in varying degrees from Quebec and Ontario to British Columbia. Genstar's

Vancouver plant was struck for about eight months, ending in July 1981.

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	4	3.9	8	2 2/3

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

	1981	1982	1983	1984	1985	1986	1987
	(cents per hundred pounds)						
29005-1	3.9	3.9	3.9	3.8	3.8	3.7	3.7

UNITED STATES (MFN)

Item No.		
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

		1981	1982	1983	1984	1985	1986	1987
		(% ad valorem)						
511.25	Other concrete mixed, per cubic yard	6.9	6.5	6.2	5.9	5.6	5.2	4.9

Sources: The Customs Tariff and Commodities Index, January 1981, Revenue Canada; Tariff Schedules of the United States Annotated 1981, USITC Publication 1111; 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. Chromite ore imports increased substantialy during 1981 to 47 626 t from 28 373 t in the previous year. At the same time, however, imports of ferrochromium dropped nearly 25 per cent to 31 573 t, reflecting the depressed state of the Canadian stainless and speciality steel industries.

Notwithstanding large resources of chromite in the Bird River area of Manitoba and the Eastern Townships of Quebec, Canada does not mine chromite ore.

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. While the Bird River deposits have in the past been considered uneconomic, mounting concern about the supply of strategic materials, such as chromite has led to increased activity in the area. Dynamic Mining Exploration Ltd. has optioned two deposits in the area, while 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 are held by many independant land owners.

WORLD DEVELOPMENTS

South Africa remained the world's largest producer of chromite with an estimated output of 3.1 million t of chromite ore. While this production is down from the previous year, South Africa remains well placed to resume higher production levels should the demand for chromium increase. By example, Rand Mines Limited, a subsidiary of Barlow Rand Limited, has 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.

In Zimbabwe, the Great Dyke contains the world's largest reserves of high grade chromite ore with a Cr:Fe ratio of over 2.8. Chromite production dropped somewhat, to an estimated 526 000 t during 1981 from 554 000 t in 1980, mainly as a result of lower demand. Union Carbide (Pvt.) Ltd., the country's largest ferrochromium producer, announced plans to increase the production capacity of its high-carbon ferrochromium complex at Que Que in the midlands of Zimbabwe by adding two 18 MW furnaces with combined capacity of 74 000 tpy. One came on-stream in mid-1981, the other is planned to start-up in 1982, at which time the capacity will total 210 000 tpy of ferrochromium. Meanwhile, Rhodall Ltd., Zimbabwe's second largest producer of ferrochromium products, has shelved plans that would have added three new furnaces at its Gwelo refinery complex. Increased production costs and higher wages were cited as the main reasons for the decision.

Inco Limited announced plans to restart the chromite operation at Tiebaghi, New Caledonia. The mine was operated by Union Carbide Corporation until 1962 when Inco purchased the property. Tiebaghi is expected to have an annual capacity of 85 000 t of chromite concentrate produced from 110 000 t of run of mine ore. Inco will hold 55 per cent interest in the project, the

TABLE 3. WORLD CHROMITE MINE PRODUCTION AND RESERVES, 1980 AND 1981

Country	Mine Production 1980	1981[e]	Reserves[e]
	(000 tonnes, gross weight)		
Republic of South Africa	3 415	3 090	2 268 000
Philippines	572	540	3 000
Zimbabwe	554	530	998 000
Turkey	399	370	5 000
Finland	175	160	25 000
Other market economy countries	1 038	930	13 000
Central economy countries	3 576	3 360	20 000
World total	9 729	8 980	3 300 000

Source: U.S. Bureau of Mines, Mineral Commodity Summaries, 1982.

[e] Estimated.

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 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

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. It 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, is being commercially developed by steelmakers.

The United States Bureau of Mines has developed a recycling technology to recover chromium from spent etching solution. 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 as 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, 1980	December 31, 1981
	($US)	
Chrome ore, dry basis, fob shipping point		
Transvaal 44% Cr_2O_3, no ratio (per tonne)	51.00-55.00	51.00-55.00
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)	9.37	8.27
	(¢US)	
Ferrochrome, fob shipping point (per kg Cr content)		
High carbon 66-70% Cr, 5.0-6.5% C	106.92-114.64	114.64-119.05
Imported 60-65% charge chrome	101.41-110.23	105.82-109.13
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	5	5	free
92821-1	Chromium oxides and hydroxides	free	14.4	25	free
	With the following exceptions: For use in the manufacture of artificial resins and plastics	free	free	25	free
	For use in the manufacture of additives for heating, lubricating and fuel oils	free	5	25	free
92821-2	Chromium trioxide for use in the manufacture of galvanized and tin plated steel	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)

TARIFFS (Cont'd.)

Item No.		1981	1982	1983	1984 (%)	1985	1986	1987
37506-1		5 0	4.8	4.7	4.5	4.3	4.2	4.0
92821-1		14.4	14.1	13.8	13.4	13.1	12.8	12.5

UNITED STATES

Item No.		
473.10-20	Chrome colours	4.7%
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%

		1981	1982	1983	1984 (%)	1985	1986	1987
420.98	Chromate and dichromate	2.8	2.7	2.7	2.6	2.5	2.5	2.4
531.21	Chrome refractory and heat insulating bricks	11.0	10.3	9.6	8.8	8.1	7.3	6.6
606.22	Ferrochromium, not containing over 3% by weight of carbon	4 0	3.9	3.7	3.6	3.4	3.3	3.1

		1981	1982	1983	1984 (%)	1985	1986	1987
632.18	Chromium metal, unwrought (duty on waste and scrap suspended)	4.7	4.5	4.4	4.2	4.0	3.9	3.7
632.88	Chromium alloys, unwrought, not otherwise specified	8.1	7.7	7.3	6.8	6.4	5.9	5.5

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

[1] Temporarily increased to 4.625¢ per pound on or before November 11, 1981.

Coal and Coke

J.A. AYLSWORTH

Canada's coal industry experienced growth and development in 1981. Final figures indicate that production of coal increased by 9 per cent over 1980. For the first year Canada became a net coal exporter and coal production reached a record level of 40 million t. Four new mines and two major additions to existing mines destined to serve export markets were under construction during the year as the coal industry prepared to meet new overseas demands for Canadian coking and thermal coals.

Domestic coal utilization increased to a record level of 38 million t in 1981 based on growing thermal coal use. Two new coal-fired thermal generating units became operational while other units completed their first full year of operation. A number of new coal-fired thermal power stations in both eastern and western Canada were under construction or in the planning phase during 1981, while studies of new coal based technologies, including coal liquefaction and coal slurry pipelines, were under way in widely separated regions of the country. Work was under way to expand one existing coal terminal facility south of Vancouver while final arrangements for a major new export coal facility near Prince Rupert were completed late in the year. Attention was focused on the western Canada rail system during 1981, where growing resource developments and the prospect of greatly increased coal export movements will necessitate expanded rail system capacity. Exploration programs in western and eastern Canada continued in 1981 as the coal industry prepared for the forecast expansion of domestic and export coal demand in the 1980s and 1990s.

NEW MINE DEVELOPMENTS

Early in the year separate agreements were signed with Quintette Coal Limited, Teck Corporation and Gregg River Resources Ltd. for nearly 10 million t of coal for Japanese coking and thermal coal markets. The contracts with Quintette Coal and Teck Corporation represent one of the largest agreements ever completed for coal exports. The agreements provide for the annual sale of nearly 7 million t of coking and 1 million t of thermal coal, to be developed from two new mines in northeastern British Columbia. The 2 million t of coking coal from the Gregg River mine near Hinton, Alberta, along with the coal from northeastern British Columbia, is scheduled to begin moving through west coast ports in late 1983 or early 1984.

In order to produce coal from the mines in northeastern British Columbia, nearly $3 billion worth of private and public sector investment will be required in mines, railways, a townsite and port infrastructure. A new townsite, called Tumbler Ridge, will be developed near the minesites, and a multi-million-dollar railway spur is now under construction to connect with the existing British Columbia Railway line at Anzac, north of Prince George. The Canadian National Railway line between Prince George and Prince Rupert will also be upgraded to facilitate this new coal movement. In late 1981 it was announced that the federal government had approved a joint undertaking between the National Harbours Board (NHB) and Federal Commerce and Navigation Ltd. (FEDCOM) for the construction and operation of new coal handling facilities at Ridley Island near Prince Rupert. The formation of this new consortium, with the NHB assuming a 90 per cent equity position and FEDCOM the remaining 10 per cent, and the conclusion of agreements with the coal shippers, signaled the completion of agreements between industry and governments for the infrastructure required for this coal development. The new coal port will have an initial annual throughput capacity of 12 million t, with the first shipments scheduled to begin in late-1983. Ultimate capacity of the port could be double this initial capacity.

TABLE 1. SUMMARY OF COAL SUPPLY BY TYPE AND VALUES, 1977-81

	1977		1978		1979		1980		1981	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
DOMESTIC[1]										
Bituminous										
Nova Scotia	2 164	81,733	2 650	116,322	2 157	103,279	2 726	132,750	2 539	133,226
New Brunswick	278	6,168	395	10,042	310	10,260	439	17,269	524	23,308
Alberta	4 274	191,026	5 115	212,616	5 349	190,059	6 830	246,771	6 895	272,238
British Columbia	8 585	339,686	9 061	379,489	10 616	466,801	10 156	457,959	11 781	590,935
Total	15 301	623,613	17 142	718,469	18 432	770,399	20 151	854,749	21 739	1,019,707
Sub-bituminous										
Alberta	7 902	29,962	8 278	36,135	9 569	43,562	10 542	55,402	11 551	42,559
Lignite										
Saskatchewan	5 478	20,762	5 058	21,520	5 012	21,770	5 971	32,381	6 798	55,305
Total	28 681	674,337	30 477	776,124	33 013	835,731	36 664	942,532	40 088	1,117,571
IMPORTED[2]										
Bituminous & Anthracite Briquettes	15 439	772,000	14 119	789,704	17 524	1,033,703	15 860	953,998	14 836	991,994
Total Coal Supply	44 120	1,446,337	44 596	1,565,828	50 537	1,869,434	52 524	1,896,530	54 924	2,109,565

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

[1] fob mines; [2] Value at US ports of exit.

TABLE 2. CANADA, COAL PRODUCTION BY TYPES AND PROVINCES 1980 AND 1981

	1980			1981		
	Surface	Underground	Total	Surface	Underground	Total
	(000 tonnes)					
Bituminous						
Nova Scotia	152	2 574	2 726	294	2 245	2 539
New Brunswick	439	-	439	524	-	524
Alberta	6 058	772	6 830	6 206	689	6 895
British Columbia	9 648	508	10 156	11 015	766	11 781
Sub-Total	16 297	3 854	20 151	18 039	3 700	21 739
Sub-bituminous						
Alberta	10 542	-	10 542	11 551	-	11 551
Lignite						
Saskatchewan	5 971	-	5 971	6 798	-	6 798
Total production	32 810	3 854	36 664	36 388	3 700	40 088

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

In southeastern British Columbia one new mine was under construction in 1981 and two existing mines were expanding their productive capacities. The Line Creek mine of Crows Nest Resources Limited was in the final stages of construction and initial thermal coal shipments were expected to begin in 1982, with coking coal shipments scheduled to start in 1983. Expansion of existing productive capacity is under way at B.C. Coal Ltd.'s (formerly Kaiser Resources Ltd.) Greenhills site, and at Fording Coal Limited's operations near Elkford. Major markets for these operations include Japan, South Korea and other Asian customers although Canadian coal is also developing new markets in Europe and Latin America.

In Alberta several existing operations are also expanding output potential to satisfy both domestic and export markets. During 1981 work was under way to expand the capacity of Canada's largest mine, the Highvale mine of Manalta Coal Ltd. west of Edmonton. Productive capacity at this operation will be increased to 11 million t annually, all of which will be consumed at local mine mouth power generation facilities. Luscar Sterco Ltd.'s Coal Valley mine, which currently supplies bituminous coal to Ontario Hydro and to a European utility, is also in the process of expanding its output potential. During 1981, Forestburg Collieries Limited began coal production from its new Paintearth mine, to replace declining output from the nearby Diplomat Mine. This coal will be used to supply the Battle River power generating station.

In Saskatchewan the new Poplar River mine near Coronach completed its first full year of operation in 1981. When it achieves full production in 1982/83 output will be approximately 1.5 million t. All of this coal will be consumed at the Poplar River thermal generating station.

In eastern Canada output from the new Salmon Harbour operation of N.B. Coal Ltd. combined with output from the Minto-Chipman area resulted in a significant increase in coal output in New Brunswick in 1981. Throughout the year drilling was carried out in the Coal Creek area in an ongoing program to firm up additional reserves.

In Nova Scotia funding was approved for a second exploratory tunnel at the Donkin-Morien development mine on Cape Breton Island. This proposed mine could nearly double provincial coal output by the mid-1980s. In addition, the Cape Breton Development Corporation (DEVCO) approved a major capital budget of nearly $100 million to upgrade its coal mining and transportation facilities throughout the 1980s.

Some of the other coal projects in the pre-developmental stage include the Obed Marsh property of Union Oil Company of

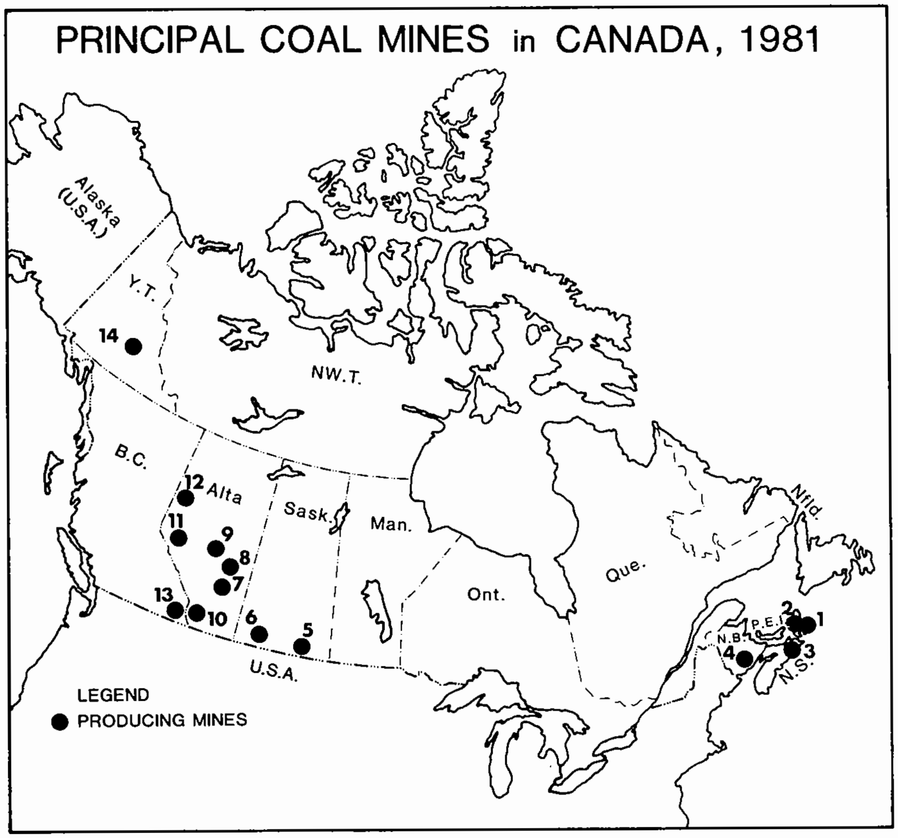


FIGURE 1

Canada Limited; the McLeod River property of Manalta Coal Ltd.; the Shaughnessy project of Fording Coal Limited; the Monkman property of Petro Canada; the Sage Creek Coal property of Rio Algom Limited, the Bowron River project of Norco Resources Ltd., the Quinsam Coal Ltd. project on Vancouver Island and many others. A number of these properties are in advanced stages of market development and several new mines are forecast to be in production in western Canada by 1990.

COAL INFRASTRUCTURE DEVELOPMENTS IN WESTERN CANADA

The large number of new Canadian coal mines forecast to come on-stream to serve growing international coal markets in the 1980s and 1990s spurred governments and private industry to action during 1981, to provide new transportation and port infrastructure. In addition to the new rail and port facilities under construction to serve northeastern British Columbia coal

TABLE 3. PRINCIPAL COAL PRODUCERS IN 1981

Company and Mine Location (Numbers refer to locations Figure 1)	1981 Raw Coal Production (000 tonnes)	Coal Rank	Chief Markets	Remarks
Nova Scotia				
1. Cape Breton Development Corporation (DEVCO)				
Lingan Mine, Lingan	1 510	Hvb A	Power generation	Underground
No. 26, Glace Bay Colliery	718	Hvb A	Metallurgical, Industrial, Domestic	Underground
Prince Mine, Point Aconi	471	Hvb A	Power generation	Underground
Novaco Limited, Point Aconi	184	Hvb A	Power generation	Surface
Thomas Brogan Limited Florence	57		Power generation Residential	Surface
Selminco Inc. Sydney	54	Hvb A	Power generation Residential	Surface
2. Evans Coal Mines Limited St. Rose	36	Hvb B	Power generation Residential	Underground
3. Thorburn Mining Limited Stellarton	27		Power generation Residential	Underground
New Brunswick				
4. N.B. Coal Limited Minto, Chipman areas	518	Hvb A	Power generation Paper mills	Surface
Saskatchewan				
5. Manitoba and Saskatchewan Coal Company (Limited) M&S Mine, Bienfait	1 141	Lig A	Power generation Industrial	Surface
5. Boundary Dam Mine, Estevan	1 422	Lig A	Power generation	Surface
5. Manalta Coal Ltd. Klimax Mine, Estevan	738	Lig A	Power generation Industrial	Surface
5. Manalta Coal Ltd. Utility Mine, Estevan	2 397	Lig A	Power generation	Surface
5. Saskatchewan Power Corporation Souris Valley Coal Mine, Estevan	302	Lig A	Power generation	Surface
6. Saskatchewan Power Corporation Poplar River Mine, Coronach	798	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. Roselyn Mine, Sheerness	69	Sub C	Power generation	Surface
8. Manalta Coal Ltd. Vesta Mine, Halkirk	1 110	Sub C	Power generation Residential	Surface
8. Forestburg Collieries Limited Diplomat Mine, Forestburg	1 038	Sub C	Power generation Residential	Surface
9. Manalta Coal Ltd. Whitewood Mine, Wabamun	1 447	Sub A & B	Power generation	Surface
Highvale Mine, Sundance	7 832	Sub C	Power generation	Surface
Bituminous Mines				
10. Coleman Collieries Limited Tent Mountain, Coleman	-		Japan for coke-making	Surface
11. Cardinal River Coals Ltd. Cardinal River Mine, Hinton	1 500	Mvb	Japan for coke-making	Surface
11. Luscar Sterco Ltd. Coal Valley Mine, Hinton	4 974	Mvb	Ontario Hydro and West Germany	Surface mine opened in 1978
12. McIntyre Mines Limited Smoky River Mines, Grand Cache	3 205	Lvb	Japan for coke-making	Surface and underground
British Columbia				
13. B.C. Coal Ltd. Michel Colliery, Natal Harmer Ridge, Sparwood	9 051	Lvb	Japan for coke-making	Surface and underground (hydraulic mining)
13. Fording Coal Limited Fording Mine, Fording Valley	5 825	Lvb	Japan for coke-making	Surface
13. Byron Creek Collieries Limited, Corbin Coal Mountain	530	Mvb	Ontario and Europe for steam generating	Surface
Yukon				
14. Cyprus Anvil Mining Corporation, Carmacks Coal Mine, Carmacks	21	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.

developments, upgraded and expanded port and railway facilities are being constructed to serve coal mines in southeastern British Columbia and south-central Alberta.

The existing Westshore Terminals Ltd. at Roberts Bank, along with Neptune Bulk Terminals (Canada) Ltd. and Pacific Coast Terminals Co. Ltd. in the port of Vancouver currently have the capacity to export nearly 20 million t of coal annually. The new Phase II coal terminal now under construction at Roberts Bank will add approximately 10 million t of coal throughput capacity by mid-1983. Further expansion of coal port facilities has been approved at Roberts Bank based on demand projections which indicate a more than three-fold increase in coal exports from western Canada by 1990.

In light of the large increases forecast for coal and other commodities on Canada's western rail system, an Action Meeting on Canada's Crisis in Rail Transportation Capacity was held in Vancouver in August 1981. Over 50 organizations representing commodity shippers in western Canada along with observers from provincial and federal governments were in attendance. Documents presented at this meeting outlined the scope of traffic growth predicted for the western rail system and the consequent need to expand rail system capacity. Coal, already the largest export commodity in terms of volume on the western rail system, was forecast to grow by significant amounts, both in absolute and relative terms so that by the end of this decade approximately half of all export commodities moving on the western rail system could be coal. A Task

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

Destination	Originating Province					
	Nova Scotia	New Brunswick	Saskat-chewan	Alberta	British Columbia	Canada
	(000 tonnes)					
Newfoundland	2	-	-	-	-	2
Prince Edward Island	8	-	-	-	-	8
Nova Scotia	1 777	-	-	103	-	1 880
New Brunswick	46	524	-	-	-	570
Quebec	8	-	-	-	-	8
Ontario	-	-	604	1 743	268	2 615
Manitoba	-	-	611	37	39	687
Saskatchewan	-	-	5 583	67	-	5 650
Alberta	-	-	-	11 734	-	11 735
British Columbia	-	-	-	7	208	215
Total Canada	1 841	524	6 798	13 691	515	23 370
United States	-	-	-	-	67	67
Japan	-	-	-	3 091	7 467	10 486
Others	579	-	-	1 121	3 452	5 152
Total shipments	2 420	524	6 798	17 831	11 502	39 075

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, 1971-81

Year	CANADA PRODUCTION				IMPORTS				
	Bituminous	Sub-Bituminous	Lignite	Total	Anthracite	Bituminous	Total Available	Domestic Consumption	Exports
				(million tonnes)					
1971	9.7	4.0	3.0	16.7	0.4	15.7	32.8	25.3	7.0
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

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

TABLE 6. CANADA, COAL PRODUCTION, IMPORTS, EXPORTS AND CONSUMPTION, 1976-81

	Production	Imports	Exports	Domestic Consumption
	(000 tonnes)			
1976	25 475	14 622	11 857	28 220
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

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

Force was set up with the aim of working with governments and others to facilitate the required expansion in rail system capacity.

PROVINCIAL COAL PRODUCTION AND MARKETS

In Nova Scotia, coal production and consumption was down in 1981 compared with 1980 because of a four-month strike at the Cape Breton Development Corporation (DEVCO) mines. Output from this organization accounts for over 90 per cent of all Nova Scotian coal production and in 1981 DEVCO's three mines, No. 26 Colliery, Lingan and Prince, produced 2.2 million t of saleable coal. Coal production in Nova Scotia will increase over the next few years as some new smaller mines begin production and as

TABLE 7. SUMMARY OF COAL DEMAND, 1977-81

	1977	1978	1979	1980	1981
	(000 tonnes)				
DEMAND					
Thermal Electric					
Canadian Coal	13 870	13 931	16 104	19 314	20 998
Imported Coal	8 572	8 984	8 857	8 468	8 815
Total	22 442	22 915	24 961	27 782	29 813
Metallurgical					
Canadian Coal	938	1 195	1 272	961	784
Imported Coal	5 726	5 714	6 593	6 279	5 593
Total	6 664	6 909	7 865	7 240	6 377
General Industry					
Canadian Coal	691	766	963	1 190	962
Imported Coal	914	922	751	955	1 044
Total	1 605	1 688	1 714	2 145	2 006
Space Heating					
Canadian Coal	163	199	200	166	171
Imported Coal	22	27	24	-	-
Total	185	226	224	166	171
Exports					
Canadian Coal	12 387	14 000	13 698	15 269	15 705
Total					
Canadian Coal	28 049	30 091	32 237	36 900	38 620
Imported Coal	15 234	15 647	16 225	15 702	15 452
Total Coal Demand	43 283	45 738	48 462	52 602	54 072

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

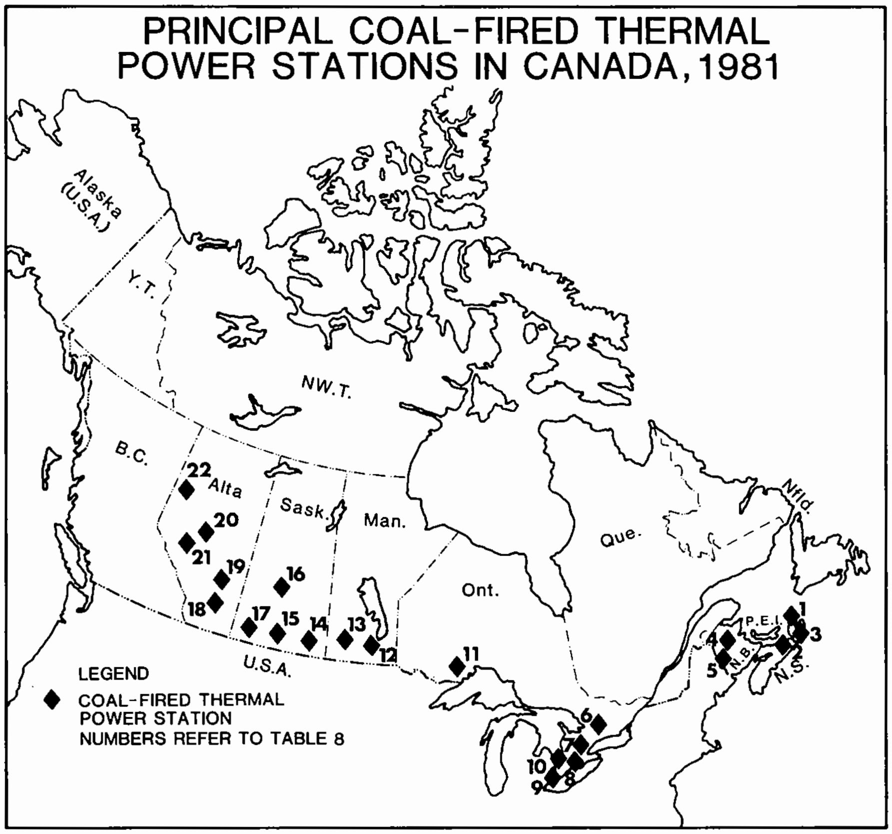


FIGURE 2

capital investments are completed in No. 26 Colliery and at the Prince Mine. Production from the other smaller mines in Nova Scotia totalled 314 000 t in 1981.

DEVCO sells the majority of its coal production to domestic consumers and in 1981 a record 1.4 million t of provincially produced coal was consumed by Nova Scotia Power Corporation stations to generate electricity. This allowed the province for the first time in many years to generate more electricity from coal than from oil.

There are currently three coal-fired generating stations in Nova Scotia, one at Lingan on Cape Breton Island, and others at Trenton and Glace Bay. Further increases in provincial thermal coal consumption was assured in 1981 with the start of construction of units 3 and 4 at Lingan. Lingan 3 is currently scheduled to come on-stream in 1984 and Lingan 4 in 1985. Each of these 150 MW units will consume 400 000 t of Nova Scotian coal annually. Other markets for DEVCO coal included exports of coking quality coals to Italy, Holland, West

TABLE 8. PRINCIPAL COAL-FIRED THERMAL POWER STATIONS IN CANADA, 1981

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	40 161	
2. Nova Scotia Power Corporation	Maccan	25 000	1 968	
2. Nova Scotia Power Corporation	Trenton	210 000	314 397	
3. Nova Scotia Power Corporation	Lingan	300 000	769 335	Two new 150-MW units to come on-stream in 1984 and 1985.
New Brunswick				
4. New Brunswick Electric Power Commission	Dalhousie	200 000	287 880	
5. New Brunswick Electric Power Commission	Grand Lake	85 000	227 364	
Ontario				
6. Ontario Hydro	Richard L. Hearn	1 222 500	191 574	
7. Ontario Hydro	Lakeview	2 422 500	1 693 996	
8. Ontario Hydro	Nanticoke	4 022 500	5 772 685	
9. Ontario Hydro	J. Clark Keith	271 500	93 117	
10. Ontario Hydro	Lambton	2 022 500	3 282 575	
11. Ontario Hydro	Thunder Bay	277 300	427 519	One new 149-MW unit began operation in 1981. Second unit scheduled to begin operation in early 1982.
Manitoba				
12. Manitoba Hydro	Selkirk	155 800	10 941	
13. Manitoba Hydro	Brandon	237 000	321 168	
Saskatchewan				
14. Saskatchewan Power Corporation	Estevan	70 000	354 799	
15. Saskatchewan Power Corporation	Boundary Dam	875 000	3 874 628	
16. Saskatchewan Power Corporation	Queen Elizabeth	232 000	94 880	
17. Saskatchewan Power Corporation	Poplar River	300 000	610 674	One new 300-MW unit to come on-stream in 1982.
Alberta				
18. Alberta Power Limited	Drumheller	15 000	1 924 580	
19. Alberta Power Limited	Battle River	737 000		
20. TransAlta Utilities Corp.	Wabamun	582 000	1 470 418	
21. TransAlta Utilities Corp.	Sundance	2 100 000	7 480 212	
22. Alberta Power Limited	H.R. Milner	150 000	569 037	

Source: Energy, Mines and Resources Canada.

Germany, Sweden and Brazil. In addition, the Sydney Steel Corporation (Sysco) steel operations utilized 400 000 t of local coal while approximately 200 000 t was sold to residential and commercial markets.

Coal production by N.B. Coal Limited was up by 20 per cent in 1981 over 1980 as provincial demand for thermal coal grew. Bituminous coal output totalled 524 000 t compared with 439 000 t in 1980. Virtually all of this coal was sold to the New Brunswick Electric Power Commission for use in its coal-fired power stations. Forecasts for 1982 suggest that output will remain at about the same level as 1981 and by the mid-1980s output is expected to level off at about 550 000 t annually. Throughout 1981 drilling was carried out in the Coal Creek area in an ongoing program to firm up additional reserves.

While Ontario produces no coal it is currently Canada's largest coal consuming province. In 1981 nearly 18 million t of thermal, metallurgical and general industry coal was utilized in Ontario and the 1982 figure will be at least equal to this record level. Ontario Hydro consumed 11.5 million t of coal, with approximately 2.5 million t coming from mines in British Columbia, Alberta and Saskatchewan and the remainder from mines in the United States. In September 1981, a new 150 MW unit at Thunder Bay was brought into service and another 150 MW unit is scheduled to begin operation in 1982. Annual coal requirements for these two units when run at full capacity will be approximately 1 million t, all of which will come from existing lignite coal mines in Saskatchewan. Approximately 250 000 t of lignite was received from Saskatchewan in 1981.

Work was also under way on Ontario Hydro's other new coal-fired thermal generating station under construction at Atikokan west of Thunder Bay. During 1981 site service facilities were completed and work on the powerhouse foundation and installation of the coal bunkers was under way. Initial start-up of this 200 MW station is currently scheduled for 1984.

Importation of coking coal by Ontario's three steel companies decreased by almost 1 million t in 1981 primarily because of a strike at one of the steel mills reducing that operation's coal requirements. Imports totalled 5.3 million t, all from mines in the United States. Consumption of coal by general industry and other consumers in Ontario remained unchanged at 1.1 million t in 1981.

TABLE 9. COAL USED BY THERMAL POWER STATIONS IN CANADA, BY PROVINCES, 1963-81

	Nova Scotia	New Brunswick	Ontario	Manitoba	Saskatchewan	Alberta	Total Canada
				(000 tonnes)			
1963	484	97	2 547	60	956	528	4 672
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

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

Production of coal increased by 14 per cent in 1981 in Saskatchewan as exports of thermal coal to Manitoba doubled and increased nearly sevenfold to Ontario. Production approached the 7 million t level for the first time in 1981 in Saskatchewan although provincial thermal coal consumption remained unchanged at just under 5 million t. Unit 1 of the Poplar River Generating Station came on-stream in late 1981 and the second 300 MW unit is now scheduled for first firing in late 1982. Forecasts of thermal coal use in Saskatchewan suggest that consumption could exceed 6 million t in 1982 and approach 8 million t in 1983.

Production and consumption of coal also increased in Alberta in 1981 in response to increases in electricity demand. One new coal-fired thermal generating unit began operation during the year at Alberta Power Limited's Battle River station near Forestburg. Total coal consumption at Alberta Power's two stations was 2.5 million t in 1981, up approximately 20 per cent over the previous year.

Coal utilization at TransAlta Utilities Corporation's (formerly Calgary Power Ltd.) Wabamun and Sundance power stations reached a record level of just under 9 million t in 1981, up approximately 7 per cent over 1980. Coal consumption at this corporation's power stations is forecast to increase by over 10 per cent in 1982 and continue to grow as twin 375 MW units at the new Keephills generating station come on-stream in 1983 and 1984.

Similar sized new generating units have been approved at a site near Sheerness, northeast of Calgary, for 1985 and 1986, while applications for two more 375 or 400 MW units to be located near Edmonton are under consideration for the 1986-88 period.

While very little coal is consumed within British Columbia, it is Canada's second-largest coal producing province and the largest producer of coal for export. Output in 1981 from the three operating mines in the southeastern corner of the province approached 12 million t with a value of nearly $600 million. The volume of production in British Columbia could double by 1985 based on the number of new mines now under construction or consideration and the expansions to existing operations already under way. In addition several other coal projects are under study and forecasts indicate that production in this province could increase almost threefold by 1990.

TABLE 10. EXPORT DEMAND FOR CANADIAN COAL, 1980 AND 1981

Country	1980		1981	
	(000 t)	($000)[1]	(000 t)	($000)[1]
Japan	11 123	686,844	10 486	680,953
United States	1	15	67	4,344
Denmark	252	9,526	319	20,281
Chile	159	9,541	248	16,169
Korea	1 296	79,217	1 733	113,999
Germany	603	27,708	608	32,276
Sweden	192	10,141	261	17,091
Mexico	28	1,793	272	19,186
Pakistan	25	1,536	73	4,832
Belgium	21	1,397	56	5,699
Brazil	633	40,414	874	62,534
Argentina	45	3,099	76	5,817
Italy	48	3,015	71	5,022
Taiwan	216	13,193	315	20,782
Spain	48	2,921	54	4,204
India	263	16,098	117	7,675
Netherlands	-	-	75	5,010
Total	15 269	923,267	15 705	1,025,874

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

CANADIAN TRADE

Canadian coal trade entered a new era in 1981 as Canada became a net coal exporter for the first time. Exports exceed imports by nearly 1 million t as exports increased and imports decreased in relation to 1980 volumes.

Exports grew by 3 per cent to nearly 16 million t in 1981 based on increased thermal coal shipments. Although still small relative to coking coal exports, thermal coal sales to overseas markets grew by 52 per cent in 1981 to just under 2 million t. Increased sales to Japan was the primary factor behind this growth as both utilities and cement plants in that country turned to coal in an attempt to reduce use of higher-priced oil.

Although still the largest segment in the Canadian export market, coking coal shipments fell by 2 per cent in 1981 to just under 14 million t. Small decreases in exports to Japan accounted for the overall decline in exports, although shipments to South Korea and Brazil, Canada's second and

TABLE 11. CANADA, COKE PRODUCTION AND TRADE, 1971-81

	Production		Imports		Exports	
	Coal Coke	Petroleum Coke	Coal Coke	Petroleum Coke	Coal Coke	Petroleum Coke
	(tonnes)					
1971	4 631 897	187 278	586 430	665 774	288 272	11 171
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

Source: Energy, Mines and Resources Canada.

third largest coking coal customers, increased during 1981. For the ninth consecutive year sales of coal to Japan exceeded the 10 million t level and in 1981 represented 67 per cent of all Canadian coal exports. Sales to South Korea grew to 1.7 million t or 11 per cent of exports while exports to Brazil totalled nearly 6 per cent of all overseas sales.

For the third year imports of coal declined from the 1979 record of 17.5 million t. The 1981 volume of imports fell by 1 million t to 14.8 million, down 6 per cent compared with 1980, primarily because of a strike in the United States coal industry and a strike at one of Canada's major steel plants. Imports of coking coal fell by 11 per cent to under 6 million t for the first time in three years. In spite of the decline in the volume of imports, the value increased by 4 per cent reflecting higher prices paid for both thermal and coking coal.

COAL STUDIES, RESEARCH AND DEVELOPMENT

A wide range of governments, private sector groups, universities and research organizations carry out coal research and development work within Canada. Activities range from studies looking at coal liquefaction opportunities to coal mining, testing, preparation and geological studies.

One example of a study of new coal technology initiated during 1981 involved six organizations setting up a consortium that along with the federal government, will spend up to $2.5 million on a "synfuels" techno-economic evaluation. The Scotia Coal Synfuels Project will evaluate technologies for the possible liquefaction of Nova Scotia coal at potential sites near Sydney and Point Tupper on Cape Breton Island. Other studies of potential coal liquefaction, coal-methanol production and coal slurry pipelines were under way in western Canada. Within the Government of Canada, the Canada Centre for Mineral and Energy Technology (CANMET) and the Geological Survey of Canada are responsible for the majority of the coal R&D work. Within CANMET the 1981 priorities for coal studies focused on clean coal burning technologies, removing pollutants prior to combustion and using coal as a supplementary source of energy or liquid fuels in the processing of tar sands bitumen. Other coal research activities concentrated on resource assessment, mining technology, coal preparation, carbonization, gasification, and on coal combustion. The Geological Survey of Canada is involved in resource assessment programs in several regions of Canada.

As a result of the National Energy Program priority has been given to work that evaluates the economic and technical feasibility of replacing oil with a coal-liquids mixture in some of Atlantic Canada's existing oil fired thermal generating stations and to work on developing new efficient and environmentally acceptable coal utilization

TABLE 12. COKE OVEN AND OTHER CARBONIZATION PLANTS IN CANADA, 1981

Company	Operating Batteries and No. of Ovens	Oven Type	Year Built	1981 Coal Feed	1981 Coke Production	Byproduct
				(000 tonnes/year)		
The Algoma Steel Corporation, Limited Sault Ste. Marie, Ontario	No. 5-86	Koppers-Becker	1943	1 860	1 382	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	1 974	1 400	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	67	38	Tars, gas, light oil
Dofasco Inc. Hamilton, Ontario	No. 1-25	Koppers-Becker Gun Type Comb.	1951	1 754	1 339	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. 6-6	Koppers-Becker Underjet	1949	567	398	Tars, light oil, gas
	No. 6-61	Koppers-Becker Underjet	1953			
B.C. Coal Ltd. Natal, British Columbia	16 Units	Curran-Knowles	1949	155	110	Crude tar, gas, coke breeze
	16 Units	Curran-Knowles	1952			
Manitoba and Saskatchewan Coal Company (Limited) Char Briquetting Div. Bienfait, Saskatchewan	2 Units	Lurgi Carbonizing Retort	1925	76	40)	All coal char
	2 Units	Salem Rotary Hearth Calciners	1974	224	89)	

Source: Energy, Mines and Resources Canada.

technologies. Toward this latter goal, construction of a test scale atmospheric fluidized-bed heating plant was under way at the Canadian Forces Base, Summerside, Prince Edward Island during 1981. Construction of another fluidized-bed test facility at Point Tupper, Nova Scotia is under consideration, while studies into the production and utility demonstration of the combustion of a pumpable coal-water fuel in small boilers was also under way in Atlantic Canada during 1981. Approximately $20 million of coal related R&D was budgeted by private and government groups for fiscal 1981.

OUTLOOK

Forecasts suggest that Canada's coal industry will grow throughout the 1980s and 1990s. The large number of new coal agreements signed in 1981, along with other new mining projects initiated during the year will result in a doubling of coking coal exports to nearly 30 million t by 1985. Growth in thermal coal exports could result in overall exports approaching the 35 million t level by the middle of the decade.

The domestic thermal market will also provide an important base for the future growth of Canada's coal industry in both western and eastern Canada in the 1980s. Alberta's consumption of coal for the generation of electricity will double to 20 million t by 1990, while Saskatchewan's utilization will likely achieve the same relative increase growing from 5 to 10 million t. Ontario is not forecasting large increases in thermal coal use in the 1980s but is developing two new stations that will be fueled with Saskatchewan lignite coal. Ontario may be consuming nearly 5 million t of Canadian thermal coal annually by the mid-1980s. In eastern Canada both New Brunswick and Nova Scotia are expected to increase coal utilization throughout the decade in the area of conventional coal-fired thermal electricity generation and through the commercialization of new coal-water technologies to replace oil in utility and industrial boilers.

Thermal coal is forecast to be the fastest growing sector of an expanding world coal market throughout the 1980s and 1990s as many nations try to reduce dependence on imported oil. Short term oil surpluses and falling prices may stretch out and somewhat reduce the overall rate of thermal coal demand in some countries but most experts forecast that thermal coal trade will increase in the 1980s and eventually surpass coking coal as the major coal trade commodity.

Cobalt

D.G. FONG

SUMMARIES

Canadian cobalt production in 1981 was at a record high of 2 436 t an increase of 61 per cent from the 1980 level. The increase was a result of markedly improved recoveries at a major Canadian producer. Output at two other producers was also at historically high levels, but these increases were mainly due to higher receipts of toll-refined ores, following the completed expansion of refinery capacities.

In 1981, western world cobalt consumption decreased 20 per cent to about 16 000 t. Production again surpassed consumption, resulting in a buildup of large inventories and a continuing decline in prices. Consumption declined in most major applications; those affected the most were the superalloys, permanent magnets and tool steels.

The 1981 cobalt production in the western world, estimated at 21 800 t, decreased by 12 per cent from 1980. Production increases in a number of operations were more than offset by a sharp reduction in Zaire and Zambia.

Cobalt markets will continue to be weak as long as producer inventories remain at a high level. On the other hand, substitution, a significant factor in the cobalt market during the last few years, has been tapering off. A continuing stable supply and moderate prices could lead to a reversal of the recent substitution trend in some major applications.

CANADA AND OFF-SHORE OPERATIONS OF CANADIAN PRODUCERS

Cobalt production in Canada increased by 61 per cent in 1981 to 2 436 t. Two companies, Inco Limited and Falconbridge Nickel Mines 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 feed.

Inco produced crude cobalt oxide at its Port Colborne, Ontario and Thompson, Manitoba plants. This product was then reprocessed at the company's Clydach, Wales refinery to obtain various oxide and salt compounds. In recent years, Inco has made process changes and modifications to its smelter operations to improve the recovery and increase the production of cobalt.

Work on Inco's Port Colborne electrolytic cobalt plant was progressing as planned. The $25 million plant, expected to come on-stream by the end of 1982 or in early 1983, will have a production capacity of 907 tpy of cobalt. Feed 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.

At Kristiansand, Norway, Falconbridge'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. Capacity at the plant was recently increased to 1 800 tpy of cobalt. On October 27, 1981 a fire broke out in the matte leach plant of the nickel refinery. The remainder of the refinery, where electrolytic cobalt, nickel and copper are produced, was not affected and the matte leach plant was expected to be back in operation by February, 1982.

Sherritt continued to expand its cobalt refining capacity at its Fort Saskatchewan, Alberta facility, which in 1981 was increased by 35 per cent to 820 tpy. The increase

TABLE 1. CANADA, COBALT PRODUCTION TRADE 1980 AND 1981 AND CONSUMPTION 1979 AND 1980

	1980		1981P	
	(kilograms)	($)	(kilograms)	($)
Production[1] (all forms)				
Ontario	1 685 948	106,900,856	1 569 000	88,096,000
Manitoba	432 206	27,847,070	247 000	13,857,000
Total	2 118 154	134,747,926	1 816 000	101,953,000
Exports				
Cobalt metal				
United States	227 697	13,750,000	624 726	25,428,000
Netherlands	64 136	3,375,000	26 989	919,000
Brazil	153	16,000	7 676	441,000
Switzerland	-	-	6 804	372,000
Mexico	5 443	353,000	3 729	250,000
Other countries	27 480	2,797,000	6 651	350,000
Total	324 909	20,291,000	676 575	27,760,000
Cobalt oxides and hydroxides[2]				
United Kingdom	1 066 000	40,384,000	601 000	27,532,000
Norway	25 000	1,195,000	-	-
Total	1 091 000	41,579,000	601 000	27,532,000
Consumption[3]	1979		1980	
Cobalt contained in:				
Cobalt metal	86 422		80 981	
Cobalt oxide	19 053		14 766	
Cobalt salts	9 131		9 478	
Total	114 606	..	105 225	..

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 AND 1975-81

		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
1976	1 356	523	471	-	96	160
1977	1 485	684	605	519	68	147
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
1981P	1 816	676	601	24	20	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Production from domestic ores, cobalt content. From 1967, production includes cobalt content of Inco and of Falconbridge Nickel Mines Limited shipments to overseas refineries, but prior years exclude Inco shipments to United Kingdom. [2] Cobalt content. [3] Gross weight.
[4] Consumption of cobalt in metal, oxides and salts.
P Preliminary; - Nil; .. Not available.

was fully committed for toll treatment arrangements. The company plans to raise annual capacity to 907 t of cobalt by 1983.

Two mining companies in Canada, Agnico-Eagle Mines Limited and Teck Corporation produced cobalt-bearing silver concentrates in the Cobalt area of Ontario. Concentrates from Agnico-Eagle were treated at the nearby silver refinery of Canadian Smelting & Refining (1974) Limited (CSR) while flotation concentrates from Teck were being shipped abroad for processing. The CSR plant did not recover cobalt. Precipitates and residues containing about 9 per cent cobalt were stockpiled with the intention of recovering the cobalt or selling the residues at some future date.

TABLE 3. PRODUCER SHIPMENTS OF COBALT BY MAJOR CANADIAN PRODUCERS 1979-81

	1979	1980	1981
	(tonnes)		
Inco	562	885	1 814
Falconbridge	606[r]	632[r]	622
Sherritt Gordon	264	196	379
Total	1 432[r]	1 713[r]	2 815

Source: Company annual reports.
[r] Revised.

WORLD DEVELOPMENT

World demand for cobalt in 1981 was again exceeded by production, resulting in a further buildup of producer stocks. At year-end, total inventories were estimated at 16 500 t of cobalt, with Zaire holding more than 12 000 t. Consumer stocks, on the other hand, continued to decline.

Western world cobalt production in 1981, estimated at 21 800 t, declined by 12 per cent from the previous year. Production in Zaire, the world's largest cobalt supplier, was about 11 150 t of cobalt, a significant drop from the 14 482 t of 1980.

Two important Zairian copper-cobalt projects, postponed in the 1970s, have been revived. GECAMINES (La Générale des Carrières et des Mines), the state-owned mining company, planned to complete the P2 smelter and refinery project, with construction work expected to start in 1983. Meanwhile, evaluation and planning work resumed at the Tenké Fungurumé copper-cobalt project of Société Minière de Tenké Fungurumé (S.M.T.F.). Annual output at the Tenké project, originally planned at 130 000 t of refined copper and 6 500 t of cobalt will be reduced to about one-third of the earlier predictions. The Shaba-Inga powerline, an important part of the Tenké project, is expected to be completed by the end of 1982.

Zambia's 1981 output was substantially lower, estimated at approximately 2 600 t compared with 3 310 t in 1980. The production drop in Zambia was partly due to production cutbacks and partly to labour unrest.

Construction of a new roast-leach-electrowinning plant in Zambia was under way at NCCM's (Nchanga Consolidated Copper Mines Ltd.) Rokana Division. The new plant, scheduled to be completed during early 1982 at a cost of $155 million, will raise NCCM's cobalt production capacity from 1 088 tpy to over 3 630 tpy. Also, RCM (Roan Consolidated Mines Ltd.) was installing a vacuum refining plant at the Chambishi refinery. Completion of the plant will add another 360 tpy of cobalt production capacity and bring the total Chambishi refining capacity to 2 720 tpy.

On May 15, 1981, Zambia announced a merger between NCCM and RCM, the country's two state-controlled mining companies. The new company, to be called Zambia Consolidated Copper Mines Ltd. (ZCCM), will be formed after a negotiating committee made up of government, mining company and central bank officials determines the terms of merger. The merger is expected to be completed in early 1982. The government hopes to achieve a better coordination between production and market requirements after the merger.

Morocco's Bou Azzer, located on the eastern edge of the Atlas Mountains, is a unique mine; it is the only primary cobalt producer in the world. Bou Azzer recovered cobalt concentrate from a cobalt-arsenide ore, while all other world producers produced cobalt as a byproduct or coproduct of copper or nickel mining. The concentrates produced at the 360 tpd Bou Azzer mill were sent to the Pechiney Ugine Kuhlmann's Pomblière plant in France for further processing.

Two companies in the United States, Noranda Mining Inc. and Anschutz Mining Corporation, announced delays in development at their respective cobalt deposits due to the poor market condition. Noranda had originally planned to bring the Blackbird mine in Idaho into production in 1985; Anschutz had scheduled its Madison mine in Missouri for full scale operation in early 1984.

The General Services Administration (GSA) announced on June 25, 1981 a commitment to purchase 2 359 t of cobalt for the national defense stockpile. The metal will be delivered under contract from Zaire at a price of $US 33 a kg. This contract represents the first major acquisition for the US stockpile in 20 years and will raise the cobalt stockpile holdings to 20 730 t, or about 54 per cent of the government's goal.

Major cobalt producers, at a meeting in Brussels in November 1981, agreed to establish a Cobalt Development Institute. The aims of the Institute are to provide a forum for exchange of information concerning the use of cobalt and to provide technical assistance to end users. Participating members are to include cobalt producers, refiners, distributors and consumers. The new Institute, located in Brussels, to be officially launched on January 1, 1982, is also to undertake promotional activities to support and develop the use of cobalt and its alloys.

USES

Cobalt is used in superalloys because it provides high strength, and wear and corrosion resistance 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.

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.

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.

TABLE 4. WORLD PRODUCTION OF RECOVERABLE COBALT^{e}, 1979-1981

	1979	1980	1981
	(tonnes)		
Zaire	14 100	14 482	11 150
Zambia	3 176	3 309	2 600
Canada	1 168	1 517	2 436
Finland	1 180	1 179	1 300
Morocco	960	998	1 000
Philippines	1 239	1 270	1 400
Australia	1 542	1 596	1 500
Other Western	480	580	450
Subtotal	23 845	24 931	21 836
U.S.S.R.	1 810	2 040	4 000[1]
Cuba	1 700	1 700	
Total	27 355	28 671	25 836

[1] U.S.S.R. and Cuba.
e Estimated.

TABLE 5. DISTRIBUTION OF WESTERN WORLD COBALT CONSUMPTION^{e}, 1981 BY MAJOR USE

	Per Cent
Superalloys	34
Magnetic alloys	17
Other alloys	21
Paints	12
Chemicals	13
Ceramics	3
Total	100

Source: Energy, Mines and Resources Canada
e Estimated.

PRICES

	Dec. 1980	Aug. 1981
	($)	
Cobalt metal, per lb.		
fob New York		
Shot, 99.5%, 250-kg drum	25.00	20.00[1]
Powder, 99%+		
300 and 400 mesh, 50-kg drums	27.92	22.92[1]
extra fine, 125-kg drums	35.25	27.26[1]

Source: **Metals Week.**
fob Free on board.
[1] Price list suspended, last quote week ending August 14, 1981.

The producer price for cobalt metal was reduced on March 2, 1981 to $US 44 per kg from $US 55, a price that had been in effect since February 1, 1979. On August 3, Zaire and Zambia, in an effort to compensate for the stronger US dollar, began making sales at a substantial discount from the posted price. Zambia offered cobalt at $US 38.58 per kg while Zaire's price was lowered to $US 38.05. These producer selling prices prevailed for the remainder of the year. Dealer prices, which started at $US 45.19 - $US 47.95 per kg at the beginning of 1981, dropped to $US 38.03 - $US 39.13 by the end of June, and to $US 20.94 - $US 22.60 in October as a result of large overhanging producer inventories and weaker markets.

OUTLOOK

Rare earth-cobalt magnets provide a promising market that could substantially increase cobalt consumption. Major potential uses for these high performance magnets are in components such as starter motors for automobiles and aircraft because of the advantages gained in reliability and weight reduction.

World cobalt consumption is forecast to have a low growth rate over the next few years because of the continuing sluggish world economy. Prices will be weak as long as producer inventories remain at abnormally high levels. The current oversupply condition is expected to prevail through 1982 and could last well into 1983. On the other hand, declining prices combined with ample supplies will stem the trend of substitution that developed during the last few years. Some market strengthening would likely result if the GSA acted to fulfill its stockpile goal.

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	9.2	25
92824-1	Cobalt hydroxides	10	7.5	11.3	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)

Item No.	1981	1982	1983	1984	1985	1986	1987
				(%)			
35110-1	9.2	8.8	8.4	8.0	7.6	7.2	6.8
92824-1	11.3	9.4	7.5	5.6	3.8	1.9	free
92824-2	10	10	10	10	10	9.9	9.2

TARIFFS (cont'd)

UNITED STATES

Item No.		1981	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	5.6	5.3	5.1	4.9	4.7	4.4	4.2
426.24	Cobalt salts, resinate	5.6	5.3	5.1	4.9	4.7	4.4	4.2
426.26	Cobalt salts, other	5.6	5.3	5.1	4.9	4.7	4.4	4.2
632.88	Cobalt metal alloys unwrought	8.1	7.7	7.3	6.8	6.4	5.9	5.5
633.00	Cobalt metal wrought	8.1	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.

Columbium (Niobium) and Tantalum

D.G. FONG

World production capacity of columbium increased significantly in 1981 with the completion of expansion programs at Brazilian and Canadian operations. On the other hand, global consumption of columbium during the year was about the same as in 1980. The demand for high-purity columbium products dropped drastically, especially in superalloys for the aircraft industry. However, strong demand for ferrocolumbium in plate and pipeline steelmaking offset the decline.

Prices for pyrochlore* (columbium concentrate) and standard grade ferrocolumbium were stable in 1981 although the weak market for high-purity columbium products resulted in a series of price cuts for the latter products.

The 1981 tantalum market softened markedly and prices plummeted. A combination of expanded supply, responding to buoyant markets in the late 1970s, and weak demand gave rise to large stocks overhanging the market. Demand for the metal was affected by the economic recession which had a negative impact on the production of capacitors and carbides, the two principal markets for tantalum. On the other hand, consumption in anti-corrosive applications and alloy additives remained strong during 1981.

Overall demand for tantalum will remain weak in the next two or three years. Most companies are expected to reduce their production of tantalite** concentrate until excessively high inventories are brought to more normal levels.

* Pyrochlore is a complex oxide of sodium, calcium and columbium ($NaCaCb_2O_6$). Pyrochlore concentrate is sold on the basis of 50 to 55 per cent columbium pentoxide (Cb_2O_5) contained.

COLUMBIUM

Canadian Developments

Columbium is produced in Canada by Niobec Inc., a company owned jointly by Société québécoise d'exploration minière (SOQUEM) and Teck Corporation. During 1981, Niobec produced about 2 810 t of columbium pentoxide (Cb_2O_5) in concentrates, a 17 per cent increase over 1980. The increase in output resulted from expansions completed at the mine and mill in February 1981. Production is expected to increase further in the next two years when mining operations will enter higher-grade ore zones.

SOQUEM continued to carry out metallurgical tests for the production of pure columbium and tantalum oxides at the Crevier property. Encouraging results from these tests could lead to a production decision by the company. The property contains a columbium - tantalum - uranium - zirconium deposit and is located about 55 km northwest of Girardville in the Lac St-Jean area of Quebec.

World developments

Columbium production in Brazil and Canada accounts for about 95 per cent of western world supplies and for nearly all the

** Tantalite and columbite, the natural oxides of tantalum, columbium, ferrous iron and manganese (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.

standard ferrocolumbium used in the steel industry. In 1981, Brazil's Companhia Brasileira de Metalurgia e Mineracao S.A. (CBMM), the largest columbium operation in the world, produced about 12 634 t of columbium pentoxide (Cb_2O_5) compared with 14 238 t in 1980.

CBMM, owned 52.65 per cent by Companhia Metropolitana de Comercio/ Participaçoes of Brazil and 47 per cent by Molycorp, Inc. of the United States, completed a $US 44 million columbium concentrate plant in October. When running-in of the 25 000 tpy plant is completed, the company will be able to mothball its existing 14 500 tpy plant. CBMM had originally planned to bring a second mill into operation at the end of 1981. However, due to current excess production capacity and rising inventories, completion of the second phase expansion has been postponed.

Brazilian exports of columbium concentrates (pyrochlore) were minimal during 1981 as CBMM adopted a policy to discontinue shipments of concentrates abroad. The company supplied standard-grade ferrocolumbium (about 66 per cent Cb) and high-purity columbium pentoxide, the up-graded product of pyrochlore. Due to the weak market, ferrocolumbium production in 1981 decreased to 11 483 t compared to 13 944 t in 1980. Other high-purity columbium products were reaching commercial production stage; marketing of these products could begin in 1982 or 1983.

High-purity columbium pentoxide production at CBMM's Araxa plant was limited to only 56 t in 1981 from a capacity of 1 360 tpy. The company began production of high-purity pentoxide in early 1980 using pyrochlore as a raw material. However, because of inventory buildup, the plant was shutdown in late 1981.

During the fourth quarter of 1981, CBMM began production of vacuum-grade ferrocolumbium and nickel-columbium, products used mainly in superalloys for the aircraft industry. The company also developed a process - and a plant was under construction - to produce special pure grades of columbium pentoxide for optical and electronic applications.

In the United States, Teledyne Wah Chang, Albany, of Albany, Oregon started

TABLE 1. CANADA, COLUMBIUM (NIOBIUM) AND TANTALUM PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975 AND 1977-81

	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
1977	2 508 909	139 757	W	W	7 043	2 407	757 090	132 449
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	272 155
1980	2 462 798	115 261	877	156	21 280	12 112	655 721	210 467
1981P	2 740 000	110 000	913	303	2 769	5 152	419 865	..

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.

large-scale production of high-purity columbium pentoxide from pyrochlore in 1980. Teledyne currently has a production capacity of 907 tpy of high-purity pentoxide and could readily expand to double this nominal capacity.

Nigeria recovered columbite from placer deposits in the Plateau Province near Jos, known mainly for its tin production. Historically, Nigeria has been an important supplier of columbite. However, due to its diminishing resources and the development of a new extraction process to produce high-purity pentoxide from the more-abundant pyrochlore, Nigeria's importance as a source of columbium supply has diminished.

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 manufacturing 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.

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

The price of pyrochlore concentrates and standard grade ferrocolumbium held steady throughout 1981. Niobec, the sole major supplier of pyrochlore concentrates after the discontinuance of concentrate exports from Brazil at the end of 1980, maintained its price at $7.17 a kg of contained Cb_2O_5. The price of standard grade ferrocolumbium remained steady at $US 13.71-$US 14.00 a kg of contained columbium. On the other hand, the price of high-purity columbium products declined substantially during the year. CBMM reduced its high-purity pentoxide price to $US 17.19 a kg from $US 20.19. The U.S. prices for high-purity ferrocolumbium dropped to $US 54.67 from $US 66.47 a kg.

OUTLOOK

Columbium appears to provide one bright spot in the gloomy outlook for many metals. During the next few years, the annual rate of consumption growth is forecast to be in the 7 to 8 per cent range, with strong demand anticipated for energy, automobile and construction-related applications. In this regard, specialty and carbon steels will continue to remain the dominant market for columbium. The recent development of a columbium-ruthenium catalyst for the selective oxidation of hydrocarbon in making synthetic fuels could, if proven commercial, provide a new market and add another dimension for columbium products.

TANTALUM

Canadian Development

Canada is the world's largest producer of tantalite ores, one of the major sources of tantalum. Tantalum concentrate is 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. The company's 1981 production of tantalum pentoxide (Ta_2O_5) contained in concentrate, estimated at 135 t, changed little from that of 1980.

In late 1980, TANCO completed construction of a flotation circuit and modifications to the gravity plant which raised plant capacity from 158 700 t to about 226 800 t of mill feedstock a year. The expansion has enabled the company to treat lower-grade ore and to reprocess tailings during the summer while maintaining the same annual level of tantalite output.

The large tonnage of tailings stockpiled at Bernic Lake has a tantalum pentoxide grade of about 0.07 per cent, compared to 0.12 per cent for typical underground ore. The retreatment of tailings by flotation recovered about 45 per cent of the contained tantalum and produced a 20 to 25 per cent tantalum pentoxide (Ta_2O_5) product. Standard concentrates from TANCO assay over 35 per cent Ta_2O_5.

Placer Development Limited continued its ore beneficiation tests during 1981 to develop an efficient extraction process for the Thor Lake tantalum-columbium deposit. The property, located about 100 km southeast of Yellowknife, N.W.T., was optioned by Placer from Highwood Resources Ltd. Drilling to year-end 1981 indicated an extensive deposit with encouraging mineralization of tantalum and columbium. Significant amounts of rare-earth metals were also reported and these could be produced as a byproduct if the property is brought into production.

World Developments

Western world tantalum production from all sources in 1981, estimated at 1 134 t tantalum pentoxide contained, was down 24 per cent from that of 1980. Canada, Australia and Brazil continued to be the most important suppliers of tantalite concentrates, while southeast Asia remained the largest source of tantalum supply. In Thailand, as well as in Malaysia, tantalum was recovered from tin slags, low-ratio columbite, and tantalum-bearing ilmenite (struverite) which together accounted for about one-half of the world's primary tantalum production in 1981.

In response to high prices and tight supply in the late 1970s, production capacity worldwide was being substantially increased. Greenbushes Tin N.L. announced an expansion at its Australian operation and a small mine was brought back into operation in Brazil, in addition to the Canadian mill expansion at Bernic Lake.

The most significant development was the Greenbushes project in Australia where construction of a treatment plant began in December, 1980. Initial production, which is expected in mid-1982, will be 68 tpy of Ta_2O_5 in concentrate. Full development with a total annual output of 340 tpy could be completed by 1986.

Ore reserves in the Greenbushes deposit are 21.8 million t grading 0.11 per cent tin, 0.044 per cent Ta_2O_5 and 0.031 per cent Cb_2O_5, based on a cutoff grade of 0.3 per cent tin equivalent. Complete development of the deposit could make it the largest producer of tantalum concentrate (tantalite) in the world.

In 1981, tantalum output from Brazil, estimated at 113 t contained Ta_2O_5, increased substantially compared with that of the mid-70s. The higher output reflected an increasing number of small mines (unregistered mines known as garimpeiros) brought on-stream and improved recoveries at existing mines during recent years. Brazil's tantalum production reached a high of 330 t in 1972 but dropped to a low of 83 t in 1974. The record-high prices in the late-70s spurred the large increase in tantalum output.

During the last two years, western world processors were also recovering tantalum from low-grade tin slags, which in 1980 accounted for about one-quarter of the year's total output. However, with the slump in prices during 1981, production from this source became uneconomical.

The United States General Services Administration (GSA) solicited potential suppliers in September to supply up to 27.7 t of Ta_2O_5 for the defence stockpile. GSA signed a contract in December with Norore Corporation to purchase 16.6 t Ta_2O_5 contained in concentrate at $US 81.23 a kilogram. This contract will raise total holdings to 1 174 t, which is about 2 614 t below the GSA goal.

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.

Due to the record high prices for tantalum during the last few years, manufacturers of capacitors have cut back on tantalum consumption by employing tantalum powder, which imparts a higher capacitance, and by using less expensive substitutes such as aluminum electrolytes and ceramics. In the United States, tantalum-columbium mixed carbides gained wider acceptance as a substitute for tantalum carbide in the manufacture of cutting tools.

Western world consumption in 1981 dropped 35-40 per cent from a year earlier while stocks of producers, processers and merchants rose to about 907 t, or about one year's supply. In addition to the effect of substitution, demand from manufacturers of capacitors and carbides was also affected by the economic recession. Capacitor production, which formerly accounted for two-thirds of tantalum consumption, was off by 7 per cent from the 1980 level, while cemented carbides, estimated to account for 25 per cent of the tantalum market, were seriously affected by the poor performance of the automobile industry.

PRICE

Weak demand and rising inventories had a negative impact on the tantalum market during 1981. Concentrate prices declined steadily after April 1980, when they reached a high of $US 264 a kilogram of contained tantalite on the spot market. The spot price late in 1981 was reported at $US 88 to $US 110 per kilogram. Likewise, producer prices were lowered by a large margin. TANCO and Greenbushes reduced their tantalite prices in the third quarter of 1981 to $US 187 and $US 176 respectively from $US 226 and $US 223 a kilogram.

OUTLOOK

The current downturn in demand for tantalum is expected to be temporary. With growing expenditures for defense purposes in the United States, the demand for tantalum is likely to rise in military applications in the long-run. Furthermore, usage is expected to expand in the chemical industry for anticorrosive applications, and in the aerospace industry where tantalum is being used in nickel and cobalt-based superalloys to make turbine blades for jet engines. However, the dominant use for tantalum will continue to be capacitors and carbide tools; the growth in consumption in the capacitor industry will be significantly lower compared with the 8 per cent annual rate in the past.

PRICES

The prices are in U.S. currency and were quoted in Metals Week and American Metal Market in December 1980 and 1981

	1980	1981
	($)	
Columbium ore		
Columbite, per kilogram of pentoxide, cif US ports	19.84 - 24.25	17.64 - 22.04
Brazilian pyrochlore, per kilogram Cb_2O_5 fob shipping point, contract only	5.62	(1)
Canadian pyrochlore, per kilogram, fob mine	7.17	7.17
Ferrocolumbium, per kilogram Cb, fob shipping port		
Low alloy	13.71 - 14.00	13.71 - 14.00
High purity alloy	66.47 - 68.12	54.67
Columbium metal, per kilogram 99.5-99.8%, fas shipping point		
Reactor ingot	99.21 - 132.28	77.16 - 88.18
Reactor powder	110.23 - 143.30	83.78 - 105.82

PRICES (cont'd)

	1980	1981
	($)	
Tantalum ore		
Tantalite, per kilogram of pentoxide, Tanco price	225.97	187.39
Tantalum metal, per kilogram, fob shipping point depending on size of lot		
U.S. powder	440.92 - 548.95	308.65 - 418.88
U.S. rod 99.9% Ta	507.06 - 685.64	315.26 - 473.99

(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, 1982)	free	free	25	free
37506-1	Ferrocolumbium, ferrotantalum, ferro-tantalum-columbium	free	5	5	free

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

Item No.	1981	1982	1983	1984	1985	1986	1987
			(%)				
37506-1	5.0	4.8	4.7	4.5	4.3	4.2	4.0

UNITED STATES

Item No.		
601.21	Columbium ore	free
601.42	Tantalum ore	free

		1981	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)	4.7	4.5	4.4	4.2	4.0	3.9	3.7
628.17	Columbium, unwrought alloys	6.9	6.5	6.2	5.9	5.6	5.2	4.9
628.20	Columbium metal, wrought	8.1	7.7	7.3	6.8	6.4	5.9	5.5

TARIFFS (cont'd)

		1981	1982	1983	1984	1985	1986	1987
					(%)			
629.05	Tantalum metal, unwrought and waste and scrap (duty on waste and scrap suspended to June 30, 1982)	4.7	4.5	4.4	4.2	4.0	3.9	3.7
629.07	Tantalum, unwrought alloys	6.9	6.5	6.2	5.9	5.6	5.2	4.9
629.10	Tantalum metal, wrought	8.1	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.

Copper

D. CRANSTONE

World copper consumption, which had dropped in 1980, rose slightly in 1981. The decline in copper prices that began in 1980 continued. By year-end, a significant number of mine closures had occurred in the United States, and the majority of world copper producers were operating at a loss. Further mine closures seemed likely in 1982 unless there was a revival of the world economy.

CANADA

With the opening of several copper mines in Canada in the last few months of 1980, Canadian copper production in 1981 would have been expected to have exceeded that for 1980. However, with depressed market demand and low prices, primary copper production in 1981 (718 082 t) remained about the same as the 716 363 t in 1980 (Table 1). Refined copper production in 1981 also dropped, amounting to 476 655 t in 1981 compared to 505 238 t in 1980. Demand for copper was weak owing to the depressed world economy, especially because of the low number of housing starts, and lower than normal North American automobile sales. However, world copper inventories did not grow significantly, probably because of high interest costs and production cuts.

The profitability of Canadian copper producers was down sharply from 1980, with a number of mines operating at a loss. More mine closures seem likely in Canada and the United States in 1982 unless there is a marked improvement in the copper price.

Atlantic provinces

Consolidated Rambler Mines Limited announced in September that its copper-gold mine at Baie Verte, Newfoundland would close about the end of November. It now appears that, provided metal prices do not drop further, the mine may be able to continue into the spring of 1982, at a reduced rate of production. Although the Buchans mine of ASARCO Incorporated had been expected to close in early 1981, some additional ore was discovered in 1981 and the mine is now expected to operate for another two or three years, but at a reduced rate.

Quebec

A corporate reorganization of Campbell Resources Inc. resulted in the transfer of Campbell's Quebec mining and mineral exploration assets to a related company, Camchib Resources Inc. Camchib continues to operate the mines at Chibougamau and during the year developed additional ore zones at the Cedar Bay and Henderson II mines. In conjunction with the partners in its joint venture, Camchib expects to have spent about $8 million by mid-1982 (most of this by the end of 1981) on an aggressive drilling or underground exploration program on 11 mining properties in northwestern Quebec. The company wants to increase mine production to utilize its idle concentrator capacity.

Corporation Falconbridge Copper experienced strikes at its Lake Dufault and Opemiska divisions in 1981. A strike that began at Lake Dufault on February 2 ended late that month, and the Opemiska Division was closed by a strike from May 4 to June 8. Corporation Falconbridge Copper reported promising diamond-drill intersections (some of high-grade) of copper-zinc-silver-gold bearing material at depths of over 1 300 m on a new deposit discovered on the Ansil property near Lake Dufault, about 5 km west of the company's former Norbec mine. The best intersection assayed 12.42 per cent copper, 21 g/t silver and 4 g/t gold over 39.5 m. Five drills are involved in the deep exploration program, which is expected to continue into 1982. As the existing Corbet mine is presently expected to be mined out by about 1986, this discovery is essential to continued operations at the Lake Dufault division.

TABLE 1. CANADA, COPPER PRODUCTION, TRADE AND CONSUMPTION, 1980 AND 1981

	1980		1981p	
	(tonnes)	($)	(tonnes)	($)
Production[1]				
British Columbia	264 675	687,080,809	309 265	684,064,000
Ontario	259 349	673,255,493	228 192	504,738,000
Quebec	97 728	253,696,274	89 499	200,477,000
Manitoba	64 751	168,090,610	57 776	127,795,000
New Brunswick	9 092	23,601,339	12 821	28,359,000
Yukon	10 433	27,082,436	9 129	20,192,000
Newfoundland	4 879	12,666,512	5 583	12,350,000
Saskatchewan	5 194	13,484,527	5 523	12,216,000
Northwest Territories	262	679,493	294	650,000
Total	716 363	1,859,637,493	718 082	1,590,841,000
Refined	505 238	..	476 655	..
Exports				
Copper in ores, concentrates and matte				
Japan	178 914	354,060,000	198 399	297,969,000
Norway	19 723	50,126,000	24 987	55,086,000
South Korea	5 153	9,297,000	19 819	27,382,000
Taiwan	10 628	19,032,000	11 117	19,724,000
Spain	13 587	10,490,000	4 904	7,063,000
West Germany	5 515	8,251,000	5 923	6,985,000
Turkey	-	-	2 915	6,334,000
Romania	6 445	11,692,000	2 786	4,426,000
Belgium-Luxembourg	6 088	4,020,000	2 779	4,091,000
United States	3 179	6,356,000	2 175	2,670,000
United Kingdom	532	1,138,000	691	1,651,000
Other countries	36 312	49,277,000	319	103,000
Total	286 076	523,739,000	276 814	433,484,000
Copper in slag, skimmings and sludge				
United States	306	37,000	763	189,000
Spain	17	7,000	339	523,000
Total	323	44,000	1 102	712,000
Copper scrap (gross weight)				
United States	13 939	30,893,000	17 604	31,300,000
Netherlands	589	1,387,000	541	1,048,000
Japan	450	779,000	597	989,000
South Korea	237	491,000	495	897,000
Spain	1 546	3,798,000	230	425,000
Taiwan	387	578,000	248	343,000
United Kingdom	123	124,000	174	308,000
India	215	444,000	118	239,000
Other countries	2 284	4,041,000	406	688,000
Total	19 770	42,535,000	20 413	36,237,000
Brass and bronze scrap (gross weight)				
United States	9 106	14,435,000	9 545	13,972,000
India	1 049	1,458,000	1 888	2,684,000
Belgium-Luxembourg	3 119	5,044,000	1 221	1,781,000
South Korea	56	93,000	528	746,000
Japan	526	816,000	360	559,000
Taiwan	298	399,000	390	518,000

TABLE 1. (cont'd.)

	1980		1981P	
	(tonnes)	($)	(tonnes)	($)
Brass and bronze scrap (gross weight) (cont'd)				
Brazil	49	77,000	214	318,000
Hong Kong	-	-	174	255,000
West Germany	693	1,370,000	165	237,000
Spain	393	773,000	122	182,000
Other countries	1 426	2,095,000	164	189,000
Total	16 715	26,560,000	14 771	21,441,000
Copper alloy scrap, nes (gross weight)				
United States	2 557	3,376,000	3 420	4,510,000
Belgium-Luxembourg	2 037	3,456,000	879	1,262,000
Taiwan	1 305	295,000	1 143	270,000
South Korea	18	7,000	143	209,000
Japan	26	44,000	76	102,000
Singapore	-	-	23	30,000
Other countries	435	617,000	17	26,000
Total	6 378	7,795,000	5 701	6,409,000
Copper refinery shapes				
United States	126 695	329,327,000	84 138	188,903,000
United Kingdom	74 558	193,876,000	74 378	155,262,000
West Germany	29 495	76,955,000	31 756	68,630,000
Belgium-Luxembourg	25 611	60,366,000	17 786	38,199,000
France	16 487	42,347,000	17 766	37,711,000
Italy	11 639	30,589,000	11 895	25,718,000
Sweden	7 564	19,375,000	9 275	19,714,000
Brazil	10 166	25,829,000	4 278	9,290,000
Netherlands	16 010	43,213,000	3 751	7,821,000
Japan	-	-	2 781	4,919,000
Greece	2 259	5,810,000	2 325	4,906,000
Portugal	2 249	5,761,000	1 378	2,899,000
Other countries	12 289	29,349,000	1 138	2,546,000
Total	335 022	862,797,000	262 645	566,518,000
Copper bars, rods and shapes, nes				
United States	7 870	23,502,000	6 517	18,961,000
Venezuela	1 980	5,949,000	2 455	6,275,000
Bangladesh	921	2,855,000	1 525	3,763,000
Pakistan	1 843	5,104,000	1 235	2,745,000
India	474	1,215,000	767	1,993,000
Nigeria	300	1,046,000	600	1,958,000
Cuba	480	1,178,000	700	1,789,000
Dominican Republic	773	2,277,000	453	1,093,000
United Kingdom	262	631,000	121	449,000
Other countries	601	1,635,000	448	1,013,000
Total	15 504	45,392,000	14 821	40,039,000
Copper plates, sheet and flat products				
United States	3 873	14,445,000	4 883	15,942,000
Venezuela	130	558,000	51	210,000
Australia	-	-	47	173,000
Other countries	30	129,000	13	52,000
Total	4 033	15,132,000	4 994	16,377,000

TABLE 1. (cont'd.)

	1980		1981P	
	(tonnes)	($)	(tonnes)	($)
Copper pipe and tubing				
United States	3 524	12,805,000	2 447	8,505,000
Spain	1 140	4,245,000	714	2,428,000
Netherlands	622	2,364,000	525	1,658,000
Israel	783	2,702,000	421	1,409,000
Netherland Antilles	-	-	165	642,000
West Germany	1 329	4,551,000	182	579,000
United Kingdom	324	1,307,000	80	359,000
India	3	13,000	18	127,000
Italy	137	377,000	5	36,000
Trinidad-Tobago	23	96,000	5	27,000
Other countries	834	3,291,000	15	102,000
Total	8 719	31,751,000	4 577	15,872,000
Copper wire and cable (not insulated)				
United States	211	357,000	142	523,000
United Kingdom	36	125,000	10	45,000
New Zealand	-	-	8	43,000
Venezuela	-	-	10	39,000
Other countries	31	111,000	35	113,000
Total	278	593,000	205	763,000
Copper alloy shapes and sections				
United States	7 021	23,419,000	10 352	32,727,000
Venezuela	22	84,000	64	234,000
Belgium-Luxembourg	6	24,000	88	189,000
United Kingdom	-	2,000	60	145,000
Ecuador	12	48,000	11	59,000
Denmark	-	-	18	39,000
Other countries	59	223,000	44	116,000
Total	7 120	23,800,000	10 637	33,509,000
Copper alloy pipe and tubing				
United States	2 329	9,693,000	2 080	7,615,000
Netherlands	19	107,000	17	90,000
Argentina	12	87,000	8	48,000
Taiwan	26	189,000	6	41,000
Ireland	-	-	5	18,000
Mexico	-	-	2	13,000
West Germany	77	300,000	-	-
U.S.S.R.	29	212,000	-	-
Other countries	125	595,000	-	1,000
Total	2 617	11,183,000	2 118	7,826,000
Copper alloy wire and cable, not insulated				
United States	114	567,000	141	689,000
New Zealand	18	102,000	14	87,000
Chile	-	-	11	71,000
Australia	-	-	9	40,000
Other countries	74	212,000	8	56,000
Total	206	881,000	183	943,000
Copper and alloy fabricated materials, nes				
United States	1 170	4,867,000	1 402	5,775,000
United Kingdom	153	453,000	148	483,000
Belgium-Luxembourg	108	1,046,000	70	157,000

TABLE 1. (cont'd.)

	1980		1981P	
	(tonnes)	($)	(tonnes)	($)
Copper and alloy fabricated materials, nes (cont'd)				
Puerto Rico	22	70,000	24	126,000
Taiwan	-	-	18	105,000
Australia	13	90,000	12	60,000
Other countries	245	958,000	32	261,000
Total	1 711	7,484,000	1 706	6,967,000
Insulated wire and cable[2]				
United States	13 880	55,428,000	15 240	60,600,000
Saudi Arabia	3 871	14,842,000	6 538	21,353,000
Pakistan	1 344	3,254,000	1 320	3,664,000
Kenya	-	-	1 681	3,409,000
Trinidad-Tobago	1 409	5,105,000	525	2,716,000
Egyptian A.R.	-	-	493	1,654,000
Cameroon	-	-	306	1,596,000
Singapore	142	515,000	414	1,252,000
Indonesia	31	109,000	257	1,159,000
United Kingdom	122	504,000	155	988,000
Other countries	4 029	20,918,000	1 959	10,015,000
Total	24 828	100,675,000	28 888	108,406,000
Total exports of copper and products	..	1,700,361,000	..	1,295,503,000
Imports				
Copper in ores and concentrates	12 744	21,437,000	19 505	23,976,000
Copper scrap	28 045	41,173,000	26 428	33,242,000
Copper refinery shapes	13 466	31,634,000	24 778	56,325,000
Copper bars, rods and shapes, nes	761	2,265,000	3 674	8,768,000
Copper plates, sheet strip and flat products	1 315	5,015,000	1 593	5,933,000
Copper pipe and tubing	2 619	10,413,000	3 301	12,772,000
Copper wire and cable, not insulated	980	4,017,000	1 597	6,157,000
Copper alloy scrap (gross weight)	7 006	8,250,000	11 546	10,921,000
Copper powder	387	1,124,000	306	880,000
Copper alloy refinery shapes, bars and sections	10 297	26,155,000	9 838	24,915,000
Brass plates, sheet and flat products	3 621	10,960,000	3 782	11,575,000
Copper alloy plates, sheets, strip and flat products	2 428	12,527,000	6 552	35,553,000
Copper alloy pipe and tubing	2 158	10,071,000	2 557	11,820,000
Copper alloy wire and cable, not insulated	797	2,945,000	909	3,529,000
Copper and alloy fabricated material, nes	2 293	11,056,000	2 486	12,910,000
Insulated wire and cable	..	52,530,000	..	65,986,000
Copper oxides and hydroxides	304	792,000	277	799,000
Copper sulphate	142	176,000	339	329,000
Copper alloy castings	636	2,276,000	453	2,408,000
Total imports of copper and products	..	254,816,000	..	328,798,000
Consumption[3]				
Refined	195 124	..	216 759	..

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.

Noranda Mines Limited announced that it has discovered copper mineralization beneath the town of Murdochville, Quebec, adjacent to its Gaspé Division, at a depth of about 700 m. Drilling has indicated mineralization sufficiently attractive to warrant the major expenditures required for mine development, but ore continuity between the existing drill holes has yet to be established. This discovery is important because the company's higher grade Needle Mountain mine will be exhausted by the late-1980s. Without a new source of good grade ore, copper production will drop if all ore has to come from the much lower grade Copper Mountain mine.

In October, Noranda announced that operations would be reduced at the Copper Mountain mine and concentrator, stating that the production cut, which would eliminate 200 jobs by the end of 1981, is aimed at offsetting operating losses foreseen for 1982 and 1983. At the same time, Noranda said it would expand its underground exploration program.

Brascade Resources Inc., a holding company owned 70 per cent by Brascan Limited and 30 per cent by the Caisse de Depôt et Placement du Québec (the Quebec pension fund), obtained a 37 per cent interest in, and effective control of, Noranda Mines Limited during the summer. In an agreement with Noranda, Brascade purchased a block of Noranda treasury shares for $500 million, and promised not to purchase more than 50 per cent of Noranda's shares. Although Brascade is to have representation on the Noranda board, its nominees are to comprise less than a majority of directors.

Patino, N.V. of The Netherlands agreed to sell all issued shares in Patino Mining Investments Limited to Northgate Exploration Limited of Toronto for $126.4 million. Patino Mining Investments owns Patino Mines (Quebec) Limited and Lemoine Mines Limited. If all options in the complex transaction are exercised, Northgate will acquire a 35 per cent interest in Patino, N.V. and a 34 per cent interest in Edper Equities Limited of Toronto. This would give Northgate an indirect 6 per cent interest in Brascan Limited.

Production began during the summer at the Les Mines Selbaie mine, 60 km north of Joutel, 66 2/3 per cent owned by Selco Inc. and 33 1/3 per cent owned by Hudson's Bay Oil and Gas Company Limited (HBOG). Production is from an underground mine in the B zone, an orebody with reserves of 3 450 000 t averaging 3.8 per cent copper, 0.5 per cent zinc, 35 g/t silver and 1.1 g/t gold.

Ontario

Texasgulf Canada Ltd. was renamed Kidd Creek Mines Ltd. and became a wholly-owned subsidiary of Canada Development Corporation (CDC) in November 1981. Kidd Creek owns and manages the Canadian mineral properties formerly held by Texasgulf Inc. and its subsidiaries in Canada, as well as non-petroleum mineral properties previously held by Aquitaine Company of Canada Ltd. (now Canterra Energy Ltd.) and by CDC Oil & Gas Limited. Kidd Creek will not be involved in Texasgulf's former Canadian hydrocarbon enterprises. This change in ownership was part of a deal negotiated during the summer in which Société Nationale Elf Aquitaine (SNEA) purchased Texasgulf shares from other Texasgulf shareholders, then traded Texasgulf's Canadian assets for CDC's 35 per cent of Texasgulf shares plus $450 million in cash. CDC also purchased, for an unspecified amount, a 75 per cent interest in Canterra Energy Ltd. from Elf Aquitaine.

Noranda Mines Limited brought its open pit "F"-Group copper-zinc-silver mine into production in early 1981. Ore from this mine and that from the Lyon Lake mine is being treated at the nearby concentrator of Noranda-controlled Mattabi Mines Limited, where an expansion of capacity is planned. Abitibi-Price Inc., the minority owner of Mattabi, is reported to have intersected 12 m of good grade zinc-copper-silver mineralization during deep drilling of a property located 4 km west of the Mattabi mine.

With low nickel and copper demand and prices, Inco Metals Company announced in December that it will put the Coleman mine at Sudbury on standby by March 1, 1982, will reduce operations at the Shebandowan mine west of Thunder Bay from two shifts to one, and will close all Sudbury district and Shebandowan operations in July, 1982 for a four-week period.

The South Bay mine of Selco Inc., at Confederation Lake, closed in May 1981 when ore reserves were exhausted.

Manitoba

Hudson Bay Mining and Smelting Co., Limited continued with the development of the Trout Lake mine near Flin Flon, the

TABLE 2. CANADA, COPPER PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975 AND 1977-81

	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
1977	759 423	508 767	279 583	294 490	574 073	18 821	203 382
1978	659 380	446 278	282 159	247 727	529 886	21 441	228 694
1979	636 383	397 263	315 211[r]	191 122	506 333[r]	32 540[r]	210 689
1980	716 363	505 238	286 076	335 022	621 098	13 466	195 124
1981[p]	718 082	476 655	276 814	262 645	539 459	24 778	216 759

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; [r] Revised.

Spruce Point mine at Reed Lake and the Rod mine at Snow Lake. As Hudson Bay will need copper concentrates for its Flin Flon smelter to replace concentrates from the company's Flin Flon and Whitehorse Copper mines, these new mines will be important sources for partial replacement of those copper concentrates.

Sherritt Gordon Mines Limited was unable to meet production targets at its Ruttan and Fox mines. These problems, combined with low metal prices, led to a Mining Division loss of $25.5 million in 1981. The company is to lay off close to 400 employees (almost one-third of its Mining Division personnel) at the two mines and at Lynn Lake in early 1982, because of the severe financial drain resulting from low copper prices.

British Columbia

Teck Corporation brought its Highmont copper-molybdenum mine in the Highland Valley into production. The first concentrator circuit had been put into operation in late December 1980 and the second in March 1981. By June the concentrator was handling 20 000 tpd of ore and a throughput of 22 680 tpd was expected by year-end.

Nearby, Lornex Mining Corporation Ltd. completed its expansion program on August 1. The milling rate should increase by 68 per cent, to between 67 000 and 72 600 tpd, depending on the hardness of the ore. The project was completed for slightly less than the original $160 million estimate.

Cominco Ltd. completed feasibility studies on the Lake Zone copper-molybdenum deposit, also in the Highland Valley. Cominco purchased complete ownership of Bethlehem Copper Corporation in 1981, so that it now completely controls the Lake Zone deposit. A decision on whether or not to proceed with this huge project is now expected in early 1982. Three years will be required to prepare the deposit for production once a production decision is made. The mining and milling rate for ore is expected to be about 80 000 tpd. This one mine will increase Canada's copper production by between 15 and 20 per cent.

Silver Standard Mines Limited announced that an extensive continuing exploration program on the Schaft Creek copper-molybdenum deposit in the Stikine River area has more than doubled the deposit size to one billion t (in a computer-designed open pit), with a copper-equivalent grade of 0.61 per cent and a waste-to-ore ratio for the pit of 1.2 to 1. Grades are 0.30 per cent copper, 0.0204 per cent molybdenum, 0.14 g/t gold, and 1.20 g/t silver.

Noranda Mines Limited continued with its $60 million development of the Goldstream copper-zinc deposit, 80 km north of Revelstoke. Initial production is scheduled for 1982.

TABLE 3. PRINCIPAL COPPER MINES IN CANADA, 1981 AND (1980)

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	0.80	8.95	5.31	-	92.91	0.72	68 946	1 145	25.76	295	10
Buchans	(1 100)	(0.85)	(9.38)	(5.42)	(-)	(102.51)	(0.82)	(75 296)	(1 324)	(24.79)	(588)	(10)
Consolidated Rambler	1 100	3.82	-	-	-	17.85	2.06	143 244	20 851	25.13	5 240	1
Mines Limited, Ming mine, Baie Verte	(1 100)	(3.51)	(-)	(-)	(-)	(18.55)	(2.09)	(164 281)	(22 184)	(24.96)	(5 537)	(1)
New Brunswick												
Brunswick Mining and	10 000	0.35	8.74	3.51	-	98	-	3 423 000	21 121	22.37	7 844	1
Smelting Corporation Limited, No. 6 and No. 12 mines, Bathurst	(9 100)	(0.31)	(8.80)	(3.56)	(-)	(97.37)	(-)	(1 848 036)	(10 344)	(22.35)	(3 804)	(1)
Heath Steele Mines	3 650	0.91	3.94	1.45	-	51.43	0.69	1 249 984	32 895	20.54	8 119	1
Limited, Newcastle	(3 650)	(0.84)	(4.34)	(1.45)	(-)	(55.20)	(1.03)	(1 252 406)	(26 894)	(21.21)	(7 430)	(1)
Quebec												
Camchib Resources	3 600	0.96	-	-	-	6.24	2.50	330 791	16 204	18.66	3 024	2
Inc., Cedar Bay, Henderson and Main and Gwillim mines Chibougamau	(3 600)	(0.99)	(-)	(-)	(-)	(6.86)	(2.78)	(390 981)	(17 894)	(19.77)	(3 538)	(2)
Corporation Falcon-	1 400	2.78	1.19	-	-	19.51	0.69	449 366	50 137	24.35	12 245	2
bridge Copper Millenbach and Corbet mines Noranda	(1 400)	(2.70)	(2.19)	(-)	(-)	(28.80)	(0.72)	(475 464)	(49 208)	(24.68)	(12 261)	(2)
Corporation Falcon-	2 900	1.64	-	-	-	12.72	1.13	843 300	57 853	22.70	13 133	2
bridge Copper Perry, Springer, Cooke mines, Chapais	(2 900)	(1.58)	(-)	(-)	(-)	(10.29)	(1.23)	(964 052)	(63 946)	(22.78)	(14 567)	(2)
Les Mines Selbaie	1 500	3.24	0.77	-	-	26.8	1.0[e]	94 917	11 373	25.79	2 933	2
Brouillan Twp.	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)

Louvem Mining Company Inc., (SOQUEM), Louvicourt	910 (910)	0.19 (0.15)	4.03 (3.89)	0.19 (0.11)	- (-)	29.49 (30.38)	0.96 (1.82)	32 276 (224 530)	95 (2 433)	15.90 (7.76)	15 (282)	10 (10)
Madeleine Mines Ltd., Ste. Anne des Monts	2 250 (2 250)	0.92 (0.94)	- (-)	- (-)	- (-)	5.14 (5.14)	- (-)	577 639 (564 738)	16 225 (15 710)	30.61 (31.59)	4 966 (4 963)	1 (1)
Noranda Mines Limited Mines Gaspé Division, Copper Mountain and Needle Mountain mines Murdochville	30 800 (30 800)	0.46 (0.52)	- (-)	- (-)	- (-)	3.62 (3.31)	0.06 (0.06)	11 533 642 (10 226 322)	177 148 (208 311)	25.09 (22.48)	44 454 (47 375)	1 (1)
Molybdenum grade of ore milled: 1981, 0.018% Mo												
Noranda Mines Limited Matagami Division Mattagami, Orchan, Norita and Radior No. 2 mines	4 100 (4 100)	0.75 (0.77)	4.85 (4.81)	- (-)	- (-)	19.58 (21.39)	0.62 (0.51)	1 203 722 (1 328 360)	30 304 (37 310)	22.68 (22.50)	7 651 (8 906)	2 (2)
Northgate Patino Mines Inc. Lemoine mine	300 (300)	3.70 (4.71)	8.47 (10.00)	- (-)	- (-)	69.60 (88.80)	4.08 (5.14)	84 967 (104 326)	12 124 (19 234)	24.59 (24.31)	3 025 (4 767)	2 (2)
Copper Rand, Copper Cliff Portage mines Chibougamau	3 085 (3 085)	1.64 (1.68)	- (-)	- (-)	- (-)	9.12 (9.22)	2.54 (2.95)	670 753 (615 035)	54 018 (52 264)	19.90 (19.29)	10 750 (10 082)	2 (2)
Ontario												
Corporation Falcon- bridge Copper Sturgeon Lake Joint Venture Sturgeon Lake	- (1 100)	- (1.46)	- (5.89)	- (1.05)	- (-)	- (131.66)	- (0.48)	- (371 623)	- (20 462)	- (21.49)	- (4 580)	- (2)
Falconbridge Nickel Mines Limited Falconbridge, East Onaping, Lockerby and Fraser Strathcona mines, Sudbury	10 300 (10 300)	1.01 (0.94)	- (-)	- (-)	1.25 (1.20)	3.43 (3.43)	0.07 (0.07)	2 754 690 (2 182 765)	.. (..)	.. (..)	26 247 (19 343)	3,4,5 (4,5)
Inco Metals Company, (Inco Limited) Clarabelle, Cole- man, Copper Cliff South, Creighton, Frood, Garson, Levack, Little Stobie, Stobie and McCreedy West mines	49 400[3] (49 400[3])	1.28 (1.30)	- (-)	- (-)	1.35 (1.39)	4.46[e] (4.46[e])	0.17[e] (0.17[e])	9 220 048 (10 608 827)	.. (..)	.. (..)	112 416 (130 844)	3 (3)

TABLE 3. (cont'd)

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)	
Ontario (cont'd)												
Kidd Creek Mines Ltd.	13 500	1.90	5.35	0.16	-	64.86	-	4 076 776	273 007	25.82	74 113	2,6
Kidd Creek mine Timmins	(9 100)	(1.83)	(5.78)	(0.15)	(-)	(86.36)	(-)	(3 899 575)	(256 835)	(24.96)	(67 826)	(2)
Mattabi Mines Limited	2 700	0.56	6.50	0.57	-	86.40	-	472 600	15 933[4]	19.92[4]	4 241[4]	2
Sturgeon Lake	(2 700)	(0.44)	(7.24)	(0.87)	(-)	(106.63)	(-)	(846 940)	(..)	(..)	(3 149)	(2)
Noranda Mines Limited	4 500	1.83	3.16	0.10	-	46.63	0.10	1 329 489	77 825	29.18	22 709	2
Geco Division Manitouwadge	(4 500)	(1.47)	(3.32)	(0.14)	(-)	(60.79)	(0.10)	(1 358 317)	(64 205)	(27.93)	(18 798)	(2)
Lyon Lake mine	-	0.95	6.83	0.72	-	118.62	..	325 649	..[5]	..[5]	..[5]	2
Sturgeon Lake	(-)	(0.86)	(5.48)	(0.61)	(-)	(98.4)	(-)	(92 000)	(..)	(..)	(520)	(2)
"F" Group mine	-	0.42	8.18	0.59	-	58.97	-	107 499	..[5]	..[5]	..[5]	
Sturgeon Lake	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	
Pamour Porcupine	2 700	0.23	-	-	-	4.46	2.29	808 923	6 735	23.24	1 565	2
Mines, Limited Schumacher Division mill Timmins	(2 700)	(0.25)	(-)	(-)	(-)	(2.85)	(2.19)	(845 982)	(7 494)	(23.05)	(1 727)	(2)
Selco Inc.	450	1.42	8.81	-	-	79.54	-	38 698	1 958	23.98	508	2
South Bay mine, Uchi Lake	(450)	(1.48)	(8.79)	(-)	(-)	(65.49)	(-)	(117 290)	(6 164)	(24.88)	(1 642)	(2)
Teck Corporation	250	0.60	-	-	0.25	240.00	-	78 397	-	-	21	-
Silverfields Division, Cobalt	(250)	(0.60)	(-)	(-)	(0.25)	(171.43)	(-)	(76 041)	(-)	(-)	(22)	(-)
Umex Inc.	3 600	1.16	-	-	0.12	7.89	0.17	1 088 622	40 049	28.38	11 366	2
Thiery mine Pickle Lake	(3 600)	(1.20)	(-)	(-)	(0.11)	(7.89)	(-)	(1 080 000)	(39 732)	(30.00)	(11 920)	(2)
Manitoba-Saskatchewan												
Hudson Bay Mining	10 700	2.01	2.34	0.14	-	16.66	1.17	1 754 032	173 774	18.58	32 285	7
and Smelting Co., Limited Anderson, Chisel, Flin Flon (including Saskatchewan portion), Ghost, Osborne, Stall, White Lake, Centennial and Westarm mines, Flin Flon and Snow Lake	(10 700)	(2.11)	(2.61)	(0.19)	(-)	(18.39)	(1.21)	(1 701 662)	(177 428)	(18.28)	(32 950)	(7)

Inco Metals Company,	12 700	0.13	-	-	1.77	2.74e	0.10e	1 801 223	..	..	2 035[6]	3
Pipe and Thompson	(12 700)	(0.13)	(-)	(-)	(1.76)	(2.74e)	(0.10e)	(2 557 454)	(..)	(..)	(2 917)	(3)
mines												
Thompson district												
Sherritt Gordon	2 700	1.42	1.73	-	-	7.57	0.28	733 844	36 991	25.12	9 509	7
Mines Limited,	(2 700)	(1.40)	(1.56)	(-)	(-)	(6.51)	(0.27)	(784 011)	(38 479)	(25.29)	(9 951)	(7)
Fox mine												
Lynn Lake area												
Ruttan mine	9 100	1.30	1.25	-	-	7.31	0.25	1 702 627	76 903	26.27	20 202	2,7
Leaf Rapids area	(9 100)	(1.36)	(1.02)	(-)	(-)	(6.51)	(0.27)	(2 311 444)	(105 384)	(27.05)	(28 840)	(2,7)
British Columbia												
Afton Operating	7 800	0.89	-	-	-	4.90	0.62	2 324 121	30 486	57.47	17 521	8
Corporation	(7 800)	(1.05)	(-)	(-)	(-)	(5.07)	(0.65)	(2 739 799)	(43 014)	(58.54)	(25 179)	(8,10)
Afton mine												
Kamloops												
Bethlehem Copper	18 000	0.39	-	-	-	2.40	0.03	8 708 160	60 129	34.60	20 800	..
Corporation,	(18 000)	(0.38)	(-)	(-)	(-)	(1.78)	(0.03)	(6 182 347)	(67 349)	(28.83)	(19 417)	(14)
Highland Valley												
Molybdenum grades of ore milled: 1981, 0.004% Mo; 1980, 0.005%												
Brenda Mines Ltd.,	27 900	0.137	-	-	-	1.20	0.02	10 199 300	38 160	29.95	11 429	10,11,14
Peachland	(27 200)	(0.13)	(-)	(-)	(-)	(1.10)	(0.02)	(9 126 857)	(32 390)	(29.03)	(9 403)	(11,12)
Molybdenum grades of ore milled: 1981, 0.033% Mo; 1980, 0.033% Mo.												
Canada Wide Mines	3 600	1.44	-	-	-	10.29	0.17	544 576	27 129	28.37	7 697	11
Ltd.	(3 600)	(1.28)	(-)	(-)	(-)	(..)	(..)	(72 586)	(3 464)	(27.64)	(869)	(..)
Granduc mine												
Stewart												
Craigmont Mines	5 300	0.70	-	-	-	-	-	1 263 590	32 500	27.84	9 048	11,13
Limited	(5 300)	(0.64)	(-)	(-)	(-)	(-)	(-)	(1 950 551)	(40 200)	(27.90)	(11 211)	(11,14)
Merritt												
DeKalb Mining	635	2.06	-	-	-	17.38	0.34	80 800	3 852	41.41	1 595	..
Corporation	(635)	(1.93)	(-)	(-)	(-)	(20.19)	(0.39)	(48 234)	(2 444)	(36.25)	(886)	(..)
Highland Valley												
Equity Silver Mines	4 550	0.39	-	-	-	102.9	0.96	1 910 000	35 200	16.19	5 700	11,14
Limited	(4 550)	(0.38)	(-)	(-)	(-)	(126.86)	(0.96)	(448 000)	(7 470)	(16.07)	(1 200)	(11)
Houston												
Falconbridge Nickel	7 300	0.32	-	-	-	3.09	0.08	1 008 695	13 607	20.69	2 815	11
Mines Limited	(7 300)	(0.27)	(-)	(-)	(-)	(3.12)	(0.07)	(996 432)	(10 885)	(21.13)	(2 259)	(11)
Tasu (Wesfrob) mine												
Tasu Harbour, Queen												
Charlotte Islands												
Iron grade of ore milled: 1981, 49.75% Fe; 1980, 47% Fe												

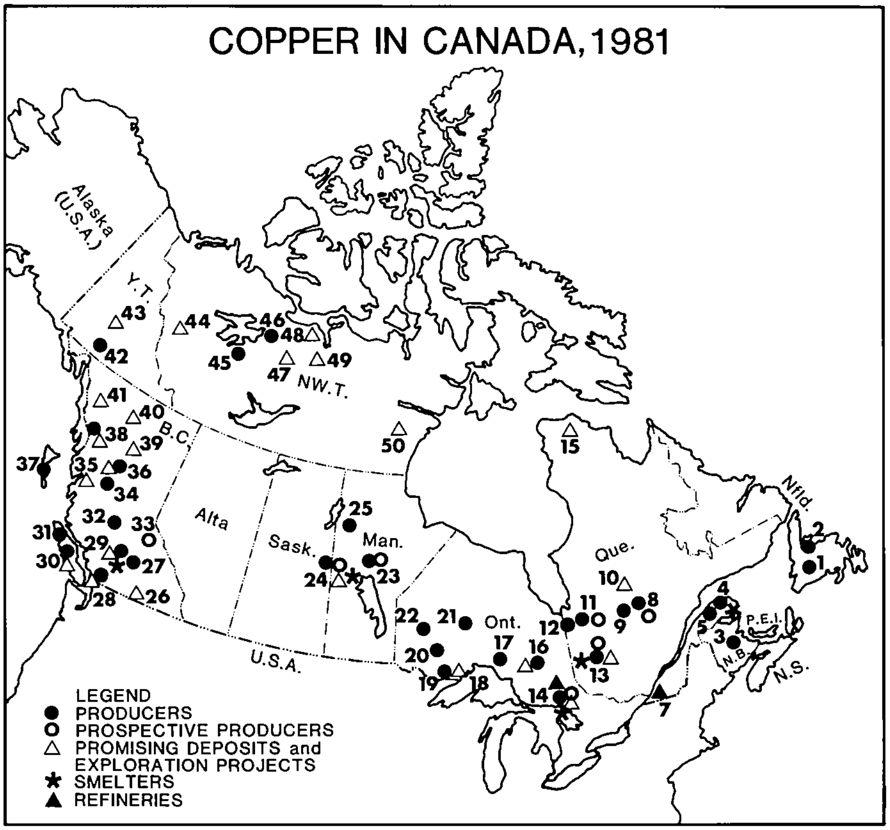
TABLE 3. (cont'd)

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. McLeese Lake, Caribou District	37 300 (37 300)	0.38 (0.38)	- (-)	- (-)	- (-)	0.69 (0.69)	- (-)	13 258 000 (12 643 870)	155 200 (135 199)	26.36 (27.43)	40 909 (37 085)	11,13,14 (7,11,14)
Molybdenum grade of ore milled: 1981, 0.0144% Mo; 1980, 0.0126% Mo												
Highmont Operating Corporation	22 700 (-)	0.15 (-)	- (-)	- (-)	- (-)	.. (-)	.. (-)	6 397 689 (-)	27 060 (-)	28.11 (-)	7 795 (-)	2 (-)
Molybdenum grade of ore milled: 1981, 0.032% Mo; 1980, (-)												
Lornex Mining Corporation Ltd. Lornex mine Highland Valley	72 600 (44 500)	0.415 (0.41)	- (-)	- (-)	- (-)	1.89 (2.06)	- (-)	20 737 213 (16 037 591)	248 998 (193 542)	31.69 (30.58)	78 907 (59 185)	11 (11)
Molybdenum grade of ore milled: 1981, 0.015% Mo; 1980, 0.017% Mo												
Newmont Mines Limited Similkameen Division Princeton	22 000 (22 000)	0.40 (0.46)	- (-)	- (-)	- (-)	1.37 (1.47)	0.34 (0.34)	6 863 214 (6 612 470)	80 673 (90 422)	28.91 (29.09)	23 323 (26 304)	11 (-)
Noranda Mines Limited (Babine Division) Bell Copper mine	16 400 (15 400)	0.48 (0.44)	- (-)	- (-)	- (-)	.. (..)	0.28 0.34	5 428 994 (5 012 196)	80 737 (62 909)	26.62 (26.53)	21 492 (16 690)	2 (2)
Granisle mine Babine Lake	12 700 (12 700)	0.37 (0.39)	- (-)	- (-)	- (-)	2.98 (2.06)	0.29 (0.21)	3 832 498 (3 936 725)	38 609 (40 062)	30.44 (33.10)	11 758 (13 261)	2,11,12,14 (2,11,12,14)
Northair Mines Ltd. Brandywine Mine	270 (270)	0.15 (0.50)	2.09 (2.15)	1.15 (1.38)	- (-)	28.63 (32.33)	7.92 (8.37)	62 548 (71 478)	- (-)	- (-)	67 (117)	- (-)
Utah Mines Ltd., Island Copper mine Coal Harbour Vancouver Island	37 200 (37 200)	0.43 (0.42)	- (-)	- (-)	- (-)	1.37 (1.82)	0.21 (0.27)	14 157 525 (13 757 175)	223 260 (213 773)	22.90 (22.94)	51 115 (49 068)	11,14 (11)
Molybdenum grade of ore milled: 1981, 0.17% Mo; 1980, 0.016% Mo												
Westmin Resources Limited Lynx and Myra mines, Buttle Lake	900 (900)	1.13 (1.22)	7.37 (7.58)	1.22 (1.23)	- (-)	127.2 (124.11)	2.67 (2.74)	246 150 (278 244)	7 977 (10 195)	27.25 (26.88)	2 580 (3 210)	11 (11)
Yukon Territory												
Hudson Bay Mining and Smelting Co., Limited Whitehorse Copper Division Little Chief Mine Whitehorse	2 300 (2 300)	1.42 (1.58)	- (-)	- (-)	- (-)	10.08 (10.29)	0.82 (0.96)	726 091 (775 013)	20 085 (23 718)	45.15 (45.23)	9 068 (10 728)	7 (7)

Northwest Territories

Echo Bay Mines Ltd.	130	0.91	-	-	-	923.1	-	38 338	2 861	10.7	317	10
Port Radium	(130)	(0.81)	(-)	(-)	(-)	(1167.09)	(0.11)	(36 076)	(..)	(..)	(261)	(..)
Great Bear Lake												
Terra Mining and	140	0.66	-	-	-	1159.0	0.34	1 565	181	5.8	10	10
Exploration Limited	(140)	(0.90)	(-)	(-)	(-)	(376.80)	(-)	(27 011)	(..)	(..)	(211)	(..)
Camsell River												
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 Nickel, Sudbury. (5) Falconbridge Nickel, 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.
8. Camchib Resources Inc. (Cedar Bay, Henderson and Merrill mines)
   Northgate Patino Mines Inc. (Copper Rand, Lemoine and Portage mines)
9. Corporation Falconbridge Copper, Opemiska Division (Perry, Springer and Cooke mines)
11. Noranda Mines Limited, Mattagami Division (Mattagami, Orchan, Norita mines)
12. Selco Inc. - Hudson's Bay Oil and Gas Company Limited (Selbaie mine)
13. Corporation Falconbridge Copper, Lake Dufault Division (Millenbach and Corbet Mines)
    Louvem Mining Company Inc.
14. Falconbridge Nickel Mines 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)

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

PROSPECTIVE PRODUCERS[1]

8. Camchib Resources Inc. (Grandroy and other mines)
11. Noranda Mines Limited (Phelps Dodge Corporation deposit)
13. Noranda Mines Limited (New Insco mine)
14. Falconbridge Nickel Mines Limited (Craig, Lindsley, North mines)
Inco Metals Company (Clarabelle, Copper Cliff North, Crean Hill, Fecunis, Levack East, Totten mines)
23. Inco Metals Company (Birchtree, Pipe No. 1, Soab North, Soab South mines)
24. Hudson Bay Mining and Smelting Co., Limited (Rod, Spruce Point, Trout Lake mines)
33. Noranda Mines Limited (Goldstream mine)

OTHER PROMISING DEPOSITS AND EXPLORATION PROJECTS[2]

10. Selco Inc. and Muscocho Explorations Limited (Lessard option deposit)
13. Noranda Mines Limited (Magusi River deposit)
14. Falconbridge Nickel Mines Limited (Onex mine)
Inco Metals Company (Cryderman, Whistle mines)
15. New Quebec Raglan Mines Limited
16. Teck Corporation - Metallgesellschaft Canada Limited - Domik Exploration Limited (Montcalm Twp.)
18. Great Lakes Nickel Limited
24. Hudson Bay Mining and Smelting Co., Limited (Wim mine)
26. Copper Giant Mining Corporation Limited (Poison Mountain deposit)
28. 20th Century Energy Corporation (Gambier Island deposit)
29. Bethlehem Copper Corporation (J.A. and Maggie deposits)
Valley Copper Mines Limited - Bethlehem Copper Corporation (Lake zone deposit)
30. Catface Copper Mines Limited (Falconbridge Nickel Mines Limited) (Catface deposit)
35. Placer Development Limited - Kennco Explorations, (Western) Limited (Berg Deposit)
36. Noranda Mines Limited (Morrison deposit)
39. Falconbridge Nickel Mines Limited (Sustut deposit)
Kennco Explorations, (Western) Limited (Huckleberry Mountain deposit)
40. Sumitomo Metal Mining Canada Ltd. - Esso Minerals Canada (Kutcho Creek deposit)

[1] Only mines with announced production plans and mines placed on standby.

[2] A more complete inventory 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.

41. Liard Copper Mines Ltd. (Schaft Creek deposit)
Stikine Copper Limited
Kidd Creek Mines Ltd. (Red Group)
43. Asarco Exploration Company of Canada, Limited, Silver Standard Mines Limited, Canadian Superior Exploration Limited, Falconbridge Nickel Mines Limited, and United Keno Hill Mines Limited (Minto Copper deposit)
44. Shell Canada Limited (Coates Lake, Jay deposits)
47. Kidd Creek Mines Ltd. (Izok Lake, Hood River deposits)
48. Kennarctic Explorations Limited (High Lake deposit)
49. Cominco Ltd. (Hackett River deposit)
50. Sulpetro Minerals Limited (Heninga Lake deposit)

SMELTERS

4. Canadian Copper Refiners Limited
Mines Gaspé Division
13. Noranda Mines Limited
14. Falconbridge Nickel Mines Limited
Inco Limited
24. Hudson Bay Mining and Smelting Co., Limited
29. Afton Mines Ltd.

REFINERIES

7. Canadian Copper Refiners Limited
14. Inco Limited

Craigmont Mines Limited is expected to cease mining of copper ore in January 1982, but the concentrator should continue operating until sometime later in the year, processing a one million t coarse iron tailings stockpile to recover a magnetite concentrate that can be used as a heavy medium in coal treatment plants.

Newmont Mines Limited completed mining at its Ingerbelle mine at Princeton, and began production from the nearby Copper Mountain orebody. Ore is now transported by conveyor, across the deep valley of the Similkameen River, to the concentrator. A portion of the Copper Mountain orebody was previously mined by The Granby Consolidated Mining, Smelting and Power Company, Limited. The Copper Mountain mine is presently expected to produce until the late 1990s.

Westmin Resources Limited continued to develop and explore its new Price and HW orebodies. The known size of the HW deposit has been increased by diamond drilling, with overall strike length of over 900 m and dip length of close to 500 m. The HW orebody is still open to the east and south.

The Afton mine of Teck Corporation and Metallgesellschaft Canada Limited was closed by a strike on November 20 and had not reopened by year-end.

SMELTING & REFINING

The Horne smelter of Noranda at Rouyn-Noranda was closed for several days by a strike which began on September 19. A new contract was soon negotiated with the union to replace the one that had expired on August 31.

Kidd Creek Mines Ltd. put its new Mitsubishi process copper smelter-refinery into operation during the year. The 59 000 tpy plant is expected to reach 80 per cent of capacity in 1982 and full capacity in 1983. The initial cathodes produced were reported to be of exceptionally high quality.

There is growing pressure from the public and from governments concerning SO_2 emissions from smelters, coal-fired generating stations, petroleum refineries and the like, which result in the formation of acid rain in the atmosphere. Of the six Canadian copper smelters, only Noranda's Horne and Hudson Bay Mining's Flin Flon smelters completely lack SO_2 containment. The equipment installed at Noranda's Gaspé smelter is not working to design, owing to malfunctioning of the acid plant and to faulty original design.

Inco's copper flash smelter uses oxygen, and the SO_2 produced is liquified and sold to industrial users. Falconbridge Nickel Mines Limited has recently completed a

TABLE 4. PROSPECTIVE COPPER PRODUCERS, 1981

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 option, La Gauchetière township	450 Cu 1.1% Zn 4.9%	..	Noranda	Development temporarily suspended.
Ontario				
Falconbridge Nickel Mines 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	1983	Flin Flon	Orebody leased from Falconbridge Nickel Mines 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.
Spruce Point mine, Reed Lake	653 Cu 2.7% Zn 4.3% Ag 32.6 g/t Au 1.7 g/t	1982	Flin Flon	Construction of this $16.1 million mine continued during the year.
Trout Lake mine, Flin Flon	1 630 Cu 2.6% Zn 4.3% Ag 9.8 g/t Au 1.5 g/t	1982-1983	Flin Flon	Mine to be developed for production by Hudson Bay at an initial rate of 815 tpd in 1982, rising to 1 630 tpd in 1983 at a cost of $25 million.

TABLE 4. (cont'd)

Company and Location	Mine or Mill Capacity tonnes/day and Ore Grade	Year Production Expected or Expansion Completed	Destination of Copper Concentrates	Remarks
British Columbia				
Noranda Mines Limited, Goldstream mine, 80 km north of Kamloops	.. Cu 3.6% Zn 2.6% Ag 20 g/t	1982	Noranda	Mine and concentrator to be developed at a cost of $62 million.
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. Mill rate to be increased to 2 720 tpd.

.. Not available.

smelter modernization program that meets environmental standards by production of sulphuric acid. SO_2 from the Afton Mines Ltd. smelter is captured and neutralized to form gypsum, which is disposed of in the tailings pond.

It seems increasingly likely that SO_2 emission controls, requiring at least partial SO_2 containment, will be imposed during the 1980s on Canadian base-metal smelters where containment is a practical alternative.

World Developments

In the United States, a number of companies have announced production cutbacks because of low copper prices. Duval Corporation closed its four copper mining operations for a three-month period beginning December 14, saying "it makes no sense for us to sell copper at prices substantially below production cost". In 1980, production from Duval's mines amounted to 125 000 t, some 11 per cent of total U.S. copper mine production. ASARCO closed its Silver Bell nine, which normally produces 19 000 tpy copper. The Anaconda Company abandoned development of its underground Kelly mine at Butte, Montana and has suspended production for one year at its Carr Fork mine at Toole, Utah, because of technical problems. Phelps Dodge Corporation reduced production at its Morenci, Arizona copper operations on March 15, 1981, reducing the company's overall mining rate by 8 per cent. Inspiration Consolidated Copper Company announced an indefinite closure of its Christmas mine in Arizona as of the end of 1981. Cyprus Pima Mining Company, Phelps Dodge Corporation and Magma Copper Company have all announced extended holiday shutdowns to cut production and Phelps Dodge has also announced layoffs and a shorter work week for its Arizona and New Mexico operations for the first quarter of 1982. With other U.S. companies producing copper at a loss, further cutbacks seem possible.

Standard Oil Company of Ohio (Sohio), a company controlled by The British Petroleum Company Limited, purchased Kennecott Corporation through an offer to shareholders, and Kennecott is now a division of a Sohio unit. In March,

TABLE 5. CANADIAN COPPER AND COPPER-NICKEL SMELTERS, 1981

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)	30 600	16 600	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 Nickel Mines Limited, Falconbridge, Ont.	Copper-nickel matte	570 000	..	27 000[e]	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 Metals Company (Inco Limited), Sudbury, Ontario	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.

TABLE 5. (cont'd)

Company and Location	Product	Rated Annual Capacity (tonnes of ores and concentrates)	Ore and Concentrates Treated (tonnes)	Blister or Anode Copper Produced (tonnes)	Remarks
Noranda Mines Limited, Horne smelter, Noranda, Que.	Copper anodes	900 000	791,000, of which 592 000 were custom concentrates	193 000	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 is under way to overhaul and modify the smelter, with electricity to become the plant's major energy source. A new 450 tpd oxygen plant will decrease unit fuel requirements and increase capacity of the continuous reactor, so another reverberatory furnace can be closed. Equipment expected to be operational first quarter 1983.
Noranda Mines Limited, Gaspé smelter, Murdochville, Que.	Copper anodes	325 000	272 000, of which 98 000 were custom concentrates	64 400	Equipped with one fluid bed roaster, one reverberatory furnace and two converters plus an acid plant. Fed with Gaspé and custom concentrates.
Hudson Bay Mining and Smelting Co., Limited, Flin Flon, Man.	Copper anodes	400 000		66 664, of which 37 755 were from custom concentrates or from Whitehorse Copper Division concentrates	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 and iron ore recovery plant feed. 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.
[e] Estimated; .. Not available.

TABLE 6. COPPER REFINERIES IN CANADA, 1981

Company and Location	Rated Annual Capacity	Output in 1981	Remarks
	(tonnes)		
Noranda Mines Limited, CCR Division, Montreal East, Quebec	435 000	396 000	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 Metals Company (Inco Limited), Copper Refining Division, Copper Cliff, Ont.	180 000	108 000	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.

Kennecott transferred a one-third interest in its Chino copper mining and processing facilities in New Mexico to Mitsubishi Corporation of Japan. Modernization of facilities at Chino will cost $350 million.

In Panama, Rio Tinto Zinc Corporation Limited and the Panamanian state mining company, Corporacion de Desarrollo Minero Cerro Colorado (Codemin), have announced a two-year trial project, as a preliminary to eventual mining of the huge Cerro Colorado copper deposit. The trial project, to cost $59 million, will include drilling, other work and a small test smelter. Rio Tinto has a 49 per cent interest in the project and Codemin 51 per cent. If completed, the Cerro Colorado project will cost nearly $US 2 billion and will produce more than 250 000 tpy of copper.

Sinking of a 500 m exploration shaft has begun at the huge Olympic Dam copper-uranium-gold deposit in South Australia. Although official tonnage and grades of the deposit have not been published, it is reported to contain 500 to 750 million t averaging between 1 per cent and 2 per cent copper and .05 per cent to .10 per cent U_3O_8. Drifts are to be driven from the shaft to obtain bulk samples for further testing. Twelve diamond drills are working to complete the delineation of the orebody.

Chile has announced that the six new copper mines expected to be developed in the country by 1990 will be operated by private firms, although this announcement does not indicate that the nationalized mines operated by Corporacion Nacional del Cobre de Chile (Codelco-Chile) will be returned to private hands. Because of falling ore grades, Codelco plans to spend $US 1.8 billion over the 1981-85 period at its operations to maintain productive capacity at present levels.

A production decision has been made for the Ok Tedi gold-copper orebody in Papua New Guinea. Production will begin in 1984 with the mining of the 34.3 million t gold ore cap, to be followed by mining of the underlying copper ore. Copper production will begin in 1986, with combined gold and copper ore production until the sixth year of mining at which time only

TABLE 7. WORLD MINE PRODUCTION OF COPPER, 1980 AND 1981

	1980	1981P
	(000 tonnes)	
United States	1 181.1	1 538.2
U.S.S.R.	1 130.0	1 140.0
Chile	1 067.7	1 080.8
Canada	716.4	718.1
Zambia	595.8	587.4
Zaire	459.7	504.8
Peru	366.8	327.6
Poland	343.0	308.0
Philippines	304.5	302.3
Mexico	175.4	230.2
Australia	243.5	225.9
Republic of South Africa	211.9	210.6
Papua New Guinea	146.8	165.4
Yugoslavia	116.8	111.0
Mongolia	44.0	71.8
Indonesia	59.0	62.6
Other communist countries	305.1	311.9
Other non-communist countries	396.5	429.4
Total	7 864.0	8 326.0

Sources: World Bureau of Metal Statistics, October 1982, and Energy, Mines and Resources Canada.
P Preliminary.

TABLE 8. WORLD PRODUCTION OF REFINED COPPER, 1980 AND 1981

	1980	1981P
	(000 tonnes)	
United States	1 686.0	1 984.1
U.S.S.R.	1 450.0	1 460.0
Japan	1 014.3	1 050.1
Chile	810.7	775.6
Zambia	607.1	564.0
Canada	505.2	476.7
Belgium	373.7	428.5
West Germany	373.8	387.3
Poland	357.3	327.1
Peru	230.6	209.1
Australia	181.4	192.1
Spain	153.7	152.1
Zaire	144.2	151.3
Republic of South Africa	147.9	144.8
United Kingdom	161.3	136.2
Yugoslavia	131.3	132.6
South Korea	79.0	113.0
Other communist countries	514.7	520.9
Other non-communist countries	441.4	449.0
Total	9 363.6	9 654.5

Sources: World Bureau of Metal Statistics, October 1982, and Energy, Mines and Resources Canada.
P Preliminary

copper ore will remain. The first stage of development will cost $Australian 730 million, the second stage an additional estimated $A 440 million and the third stage another $A 150 million.

In Peru, the Tintaya copper deposit is to be developed for production as an open-pit mine projected to have a life of 14 years. Canada's Export Development Corporation will lend $US 100 million, and a consortium of banks will provide $US 115 million, to Empresa Minera Especial Tintaya SA, a company owned by three state-owned Peruvian mining companies. Surveyer, Nenniger & Chênevert Inc. of The SNC Group in Montreal has the project management contract and will act as buyer for the $100 million of goods and services that will come from Canadian suppliers. Mine output will be some 48 000 tpy of copper in concentrates.

Smelting & Refining

Government-owned Oman Mining & Co. is to add a 20 000 tpy electrolytic copper refinery to its Sohar copper project in Oman, where first production is expected in 1982.

Copper Range Company is building a new $78 million electrolytic copper refinery at White Pine, Michigan to replace its present fire refinery. The company's fire-refined "Lake Copper" has had a limited market because of its high silver content.

In Brazil, the Caraiba copper smelter-refinery project of Caraiba Metais S.A. Industria e Comércio, near Salvador, is expected to come on-stream in two stages in March and September 1982, with full output to amount to 150 000 tpy of primary copper. Some 60 000 t of this copper will come from concentrates from the Caraiba mine at Jaguarari in northern Bahia state, 12 000 t from concentrates from Rio Grande do Sul state and the rest from imported concentrates. The government plans a second smelter-refinery, also with 150 000 tpy capacity, to be built either near Carajas, or by doubling the capacity of the Caraiba plant.

TABLE 9. WORLD CONSUMPTION OF REFINED COPPER, 1980 AND 1981

	1980	1981p
	(000 tonnes)	
United States	1 867.7	2 032.6
U.S.S.R.	1 300.0	1 320.0
Japan	1 158.3	1 254.1
West Germany	747.8	744.2
France	433.4	429.6
Italy	388.0	366.0
United Kingdom	409.2	333.1
Belgium	303.9	260.0
Canada	208.6	241.6
Poland	213.2	185.6
Brazil	246.0	177.9
Yugoslavia	122.6	150.4
Korea	84.0	144.0
Mexico	123.2	140.9
Australia	128.4	137.8
East Germany	120.0	122.0
Other communist countries	599.8	595.2
Other non-communist countries	896.9	845.0
Total	9 351.0	9 480.0

Source: World Bureau of Metal Statistics, October 1982.
p Preliminary.

Consumption

Non-communist world consumption of refined copper rose slightly from 7 079 000 t in 1980 to 7 085 800 t in 1981, compared to a decline of 6 per cent in 1980 relative to 1979.

STOCKS

Commercial Stocks

Total commercial stocks of refined copper held in the non-communist world, which were 1 036 600 t at the end of 1980, had risen by about 5 per cent to 1 086 900 t by the end of 1981, according to the World Bureau of Metal Statistics. London Metal Exchange stocks were 124 325 t at the end of 1981, compared with 122 600 t at the end of 1980. New York Commodity Exchange stocks were 169 570 t at the end of 1981, compared with 162 900 t at the end of 1980.

National Stockpiles

The United States strategic stockpile goal for copper was 907 184 t, with holdings at the end of 1981 of 20 200 t, no change from those at the end of 1980. Sales from the Japanese copper stockpile during 1981 resulted in a decline in holdings from 7 600 t at the end of 1980 to 4 800 t at the end of 1981.

PRICES

Copper prices dropped throughout 1981. The U.S. producer price for cathode, which was about 90 cents US/lb in early January, dropped to about 79 cents by year-end. The Canadian producer price was about $1.07 in January and only 94 cents by year-end. The premium for wirebar during the year was 1.25 cents/lb. The LME cathode price was about 90 cents US/lb in January and 75 cents in December.

The average Canadian producer price for full plate copper cathodes was $1.00 a pound with a premium of 1.25 cents/lb for wirebars. The average U.S. producer price for full plate cathodes was 84.21 cents US/lb. The average LME cash price for "copper-standard cathodes" was 78.98 cents US/lb and "copper-higher grade" 79.46 cents US/lb.

In constant dollar terms (i.e. after adjusting for inflation) copper prices near the end of 1981 were as low as, or lower than, any that have existed since the end of World War II.

At the beginning of September, the LME began trading a new copper contract to replace the former wirebar contract. The new contract for "copper-higher grade" allows delivery of all currently listed brands of wirebars as well as certain brands of higher quality cathodes on an equal price basis. It was felt that the new contract would provide an improved mechanism for hedging and pricing copper products. The decision followed a steady expansion of trading emphasis on high-quality cathodes, used extensively in the continuous casting of rod for wire drawing, while at the same time demand for wirebars has been steadily declining. Cash trading of the new contract began on December 1. The previous cathode contract has been renamed "copper-standard cathodes".

TABLE 10. WORLD COPPER PRODUCTION AND CONSUMPTION, 1981P

	Mine Production	Refined Production	Refined Consumption
		(000 tonnes)	
United States	1 538.2	1 984.1	2 032.6
U.S.S.R.	1 140.0	1 460.0	1 320.0
Japan	51.5	1 050.1	1 254.1
CIPEC[1]	3 065.5	2 024.7	349.8
Europe	183.6	1 340.0	2 521.7
Canada	718.1	476.7	241.6
Other communist countries	691.7	848.0	902.8
Other non-communist countries	937.4	470.9	857.4
Total	8 326.0	9 654.5	9 480.0

Sources: World Bureau of Metal Statistics, October 1982, 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

CHARACTERISTICS AND USES OF COPPER

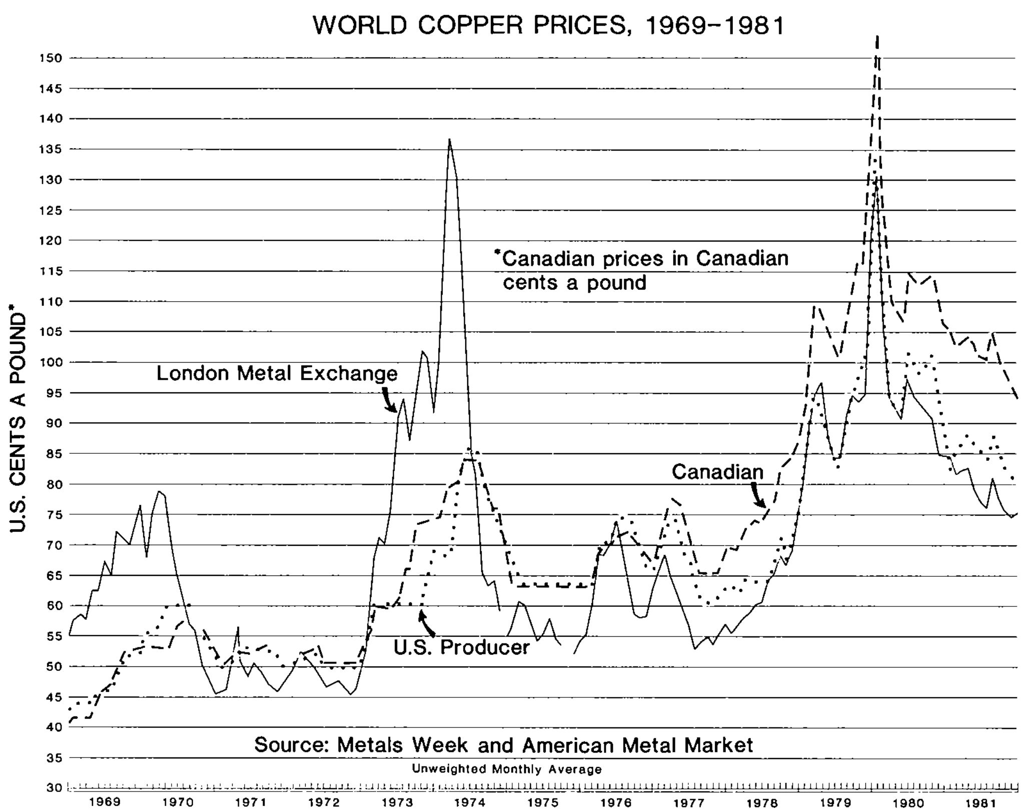
Most uses of copper are dependent on the metal's high electrical conductivity, durability and the high temperatures it can withstand. About half the copper consumed is for electrical uses, such as electrical and telecommunications wire and cable and electric motors. Other major uses are in industrial machinery, heat exchangers, turbines and locomotives. Copper is used in the motor vehicle industry. 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

Although in constant dollar terms copper prices are at near-to-record lows, copper stocks are only at normal levels. As a result, when the world economic situation eventually improves, copper seems likely to be in short supply and the price is likely to climb to much higher levels. In fact, if the economy should experience a strong recovery, copper prices could easily reach record levels, even after allowing for the effects of inflation.

It is uncertain when the world economy will recover. During the second half of 1980 and the first half of 1981 many economists were predicting an economic recovery to begin in the second half of 1981. At present the general opinion seems to be for improvement no earlier than the second half of 1982 and perhaps later than that. There is some possibility that current forecasts are excessively pessimistic, and that copper prices may recover more rapidly than many forecasters expect.

It is likely that world copper consumption will continue to grow in the short- to medium-term at about 3 per cent a year. New copper projects presently being developed or being considered for development, together with anticipated new copper discoveries, would appear to be capable of meeting world demand for copper at least into the first few years of the 1990s provided copper prices are adequate to bring on the needed new mines. However, as in the past, copper supplies are likely to be tight during periods of high demand.



WORLD COPPER PRICES, 1969-1981
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

TARIFFS

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	14.4	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, telephone wires, electric wires and cables	free	4.8	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 of year given)

Item No.		1981	1982	1983	1984	1985	1986	1987
					(%)			
33503-1		14.4	14.1	13.8	13.4	13.1	12.8	12.5
34820-1		4.8	4.6	4.5	4.4	4.3	4.1	4.0

UNITED STATES (MFN)

602.30	Copper, ores etc.			Remains free				
612.02	Unwrought copper etc.	1.7		- no change -				1.7
612.08	Copper waste and scrap	5.1	4.7	4.2	3.8	3.3	2.9	2.4

EUROPEAN ECONOMIC COMMUNITY (MFN)

Item No.		1981	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)

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.	8.2%	8.5%	7.3%

TARIFFS (cont'd)

Item No.	1981	Base Rate	Concession Rate
JAPAN (MFN) (cont'd)			
(b) Other			
(i) Containing by weight, not less than 25% of zinc and not less than 1% of lead.	21.75yen/kg	24yen/kg	15yen/kg
(ii) Containing more than 95% by weight of copper			
- blister copper in bar	8.2%	8.5%	7.3%
- other	23.25yen/kg	24yen/kg	21yen/kg
(iii) Containing not more than 95% by weight of copper	23.25yen/kg	24yen/kg	21yen/kg
(3) Waste and scrap			
(a) Unalloyed	1.9%	2.5%	free
(b) Other: containing more than 10% by weight of nickel	16.9%	22.5%	free
(c) Other	1.9%	2.5%	free

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; Official Journal of the European Communities, Vol. 23, No. L315, 1980; Customs Tariff Schedules of Japan, 1981; GATT Documents, 1979.

Crude Oil and Natural Gas

R.L. THOMAS

During 1980, the total number of wells drilled in Canada for oil and gas amounted to some 9,200 completions for an aggregate depth of more than 10.5 million m. Overall activity surpassed that of previous years. Expenditures on exploration and development increased substantially and revenues from the production of oil and gas also rose to a record level. During 1980, however, and especially after the announcement of the National Energy Program (NEP) and the federal budget on October 28, 1980, it became clear to analysts in industry and government that the year's level of activity would not be sustained in 1981. Natural gas was in over-supply relative to domestic and authorized export markets, industry had built up an excess capacity of equipment and services, and the price for crude was far below the international level. A climate of investment uncertainty existed following introduction of the NEP which was not dispelled until the energy agreements were signed between the federal and western provincial governments in the fall of 1981. The agreements provided a number of strong incentives, including a New Oil Reference Price for new and enhanced recovery oil in addition to the incentive under the NEP but also contained revenue raising fiscal measures.

Statistics compiled to date for 1981 indicate that relative to the exceptionally active year of 1980, drilling activity and metres drilled, will decline by 22 per cent to 7,200 well completions and an aggregate depth of 8.2 million m. Revenues from the sales of Crown lands will decrease by about 40 per cent, geophysical activity will be reduced by some 20 per cent, and rig activity will be down by almost 20 per cent.

Preliminary statistics indicate that for 1981, the production of crude oil and natural gas liquids in western Canada will decline by 7 per cent to 239 378 cubic m per day (m^3/d), or 19 388 m^3/d less than the average daily output in 1980 due to a combination of decline and shut-in production. The estimated daily production of synthetic crude oil will average 17 000 m^3/d or about 22 per cent less than in 1980. The total anticipated crude and liquids output for the year will average 256 378 m^3/d in 1981.

The sales of natural gas, both domestic and export, are expected to decline slightly by 5 million m^3/d to an average of 188 million m^3/d. Domestic consumption will decrease by 4 per cent to 139 million m^3/d and the volumes required for the export market will decrease by 4 per cent to 59 million m^3/d.

Revenue from the sale of crude oil, natural gas liquids and natural gas is expected to increase by almost \$1.0 billion to a new level of \$17.3 billion. Expenditures for exploration and development are anticipated to decline to \$13.8 billion, a decrease from 1980 of some \$1.0 billion.

Although refinery capacity remains unchanged at a level of 362 000 m^3/d, it is expected that approximately 284 000 m^3/d of crude oil will have been processed in 1981 compared to 301 000 m^3/d processed in 1980, for a reduction of 6 per cent while operating at 78 per cent capacity.

OUTLOOK

The record level of growth achieved by the Canadian oil and gas industry during 1980 has marked it as a peak year. This high level of activity carried on into the early part of 1981 when, at the commencement of the second quarter, it became obvious that a definite downturn was taking place.

Positive revisions to the National Energy Program and the petroleum pricing agreements reached between the federal and producing provinces' governments in the fall of 1981, are expected to take several months before creating an upswing in exploration and development activity. The high cost of borrowing has had a negative impact on the petroleum industry in an environment of declining corporate after-tax revenues.

Canada's conventional oil reserves in southern basins have been steadily declining for the past decade, but recent major oil discoveries in the frontier regions, off the east coast and in the Beaufort Sea are expected to offset the production decline when put on-stream. Also, improved oil recovery for pools in Alberta and Saskatchewan will contribute an additional 160 million m^3 of oil to established reserves within the next decade.

The supply of natural gas exceeds domestic requirements, and authorized exports are permitted to the extent of the deemed surplus. Major new gas reserves have been discovered in the Beaufort Sea, Arctic islands and off the east coast.

EXPLORATION

In the Mackenzie Delta-Beaufort Sea region of Canada's north, the active companies this year in offshore drilling are Dome Petroleum Limited, Gulf Canada Resources Inc. and Esso Resources Canada Limited. Wells are being drilled either from Dome-Canmar's four ice-reinforced drillships or from manmade islands. The use of drillships is restricted to the season when the water is ice-free, whereas drilling may be conducted year-round from manmade islands.

Dome **et al** Kopanoar 2I-44, delineation well, some 4 km west from Kopanoar M-13 oil and gas discovery, was completed and tested in 1981. Another of Dome's wells, Koakoak O-22, was re-entered and partially tested. The Kilannak A-77 well, which was suspended at mid-depth in 1980, was re-entered, drilled to total depth and abandoned. Dome also re-entered the Orvilruk O-03 and Kenalooak J-94 wells. Late in the year, Dome spudded the Irkaluk C-35 well and will drill and set shallow depth casing.

At mid-year, Gulf spudded the North Issungnak L-86 well located on a manmade island and is also dredging an island berm on which to place a caisson-type drilling pad at its Tarsiut A-25 location.

Esso **et al** Issungnak 20-61, a delineation well drilled from the artificial island platform of the Issungnak O-61 oil and gas discovery, tested 18 intervals of which 14 recovered oil and/or gas from six separate reservoir zones.

Three large marine dredges operated by Dome-Canmar and one by Esso are deployed in construction of artificial islands, sites for Dome **et al** Uniluk P-66, Esso W. Atkinson L-17 and Esso Itiyok M-17, which are to be drilled during 1982 and 1983.

In the Arctic islands, the Panarctic Oils Ltd. 1980-81 program consisted of three exploratory wells drilled from thickened sea-ice platforms located in water approximately 300 m deep. Both its Skate and Cisco wells were oil and gas discoveries. On land, the Bent Horn G-02 well was drilled and abandoned. Panarctic has spent some $60 million in the area but expects to suspend further operations in the delineation of the Bent Horn field. The company will airlift a new rig into the Arctic this winter, and plans with its four-rig system to drill five exploratory and delineation wells from ice-islands in the winter and spring of the 1981-82 season.

On the Labrador Shelf, Petro-Canada was operator for the Labrador Group which conducted an extensive drilling program during the summer months. The program included the drilling of two wildcat wells and the re-entering of two previously drilled wildcats. The North Leif I-05 well tested small quantities of waxy oil, the first such occurrence in what has been previously considered a gas-prone region.

In the Sable Island area of the Scotian Shelf, Mobil Oil Canada, Ltd. drilled a second delineation well on the Venture structure to a depth equivalent to the productive zones in the D-23 discovery well.

Offshore from Newfoundland, Mobil continued to delineate the Hibernia field. The fourth delineation well, near the P-15 discovery well, flowed good quality oil on five tests at rates up to 730 m^3/d from the Hibernia zone. In tests conducted above that zone, the Catalina zone, oil also flowed at rates up to 573 m^3/d. Some 30 km away from Hibernia, the Mobil **et al** Hebron I-13 wildcat well was tested with flow rates of up to 182 m^3/d of high density crude oil.

TABLE 1. CANADA, RESERVES OF LIQUID HYDROCARBONS AT END OF 1981

	Crude Oil	Pentanes Plus	Propane, Butane and Ethane	Total	Per cent of Total
			(000 cubic metres)		
Northern Canada	21 860	13 229	305	34 394	3.2
Alberta	718 848	74 078	98 989	891 915	82.4
Saskatchewan	117 045	273	922	118 240	10.9
British Columbia	25 904	2 961	3 036	31 901	2.9
Eastern Canada	5 918	0	0	5 918	0.6
Total	888 575	90 541	103 252	1 082 368	100.0

Source: Canadian Petroleum Association.

During 1981, there was successful exploration and development of oil and gas in western Canada but the current surplus of gas, and uncertainties in pricing and revenue sharing between the federal and provincial governments prior to agreements reached in the fall, resulted in an overall decrease of activity, particularly in gas development drilling.

One area affected by a decrease in development drilling was the Deep Basin of Alberta and British Columbia where Canadian Hunter Exploration Ltd. (CanHunter) started exploratory work in the Elmworth region in 1973 by studying the records of numerous abandoned wells. In 1976, the first significant discovery of gas was made and this was soon followed by 24 successful wells. The Elmworth field contains some 20 gas-producing zones of which five are in the Fahler interval. CanHunter estimates the overall region to contain 11 trillion m^3 of natural gas. The bulk of this potential estimate, largely of "tight gas", is not recognized by government regulatory agencies as being currently producible. Established reserves carried at present are in the range of 42-85 billion m^3. Current exploration in the Deep Basin is directed toward conventional reserves that can produce profitably at current gas prices. There are currently five gas plants in operation producing 11 million m^3 per day.

TABLE 2. CANADA, ESTIMATED YEAR-END MARKETABLE RESERVES OF NATURAL GAS, 1980 AND 1981

	1980	1981
	(million cubic metres)	
Alberta	1 661 442	1 723 130
British Columbia	208 694	222 280
Saskatchewan	33 651	32 557
Eastern Canada	8 301	8 751
Northern Canada	579 776	576 255
Total	2 491 864	2 562 973

Source: Canadian Petroleum Association.

In April of 1981, Sundance Oil Canada Ltd. announced the discovery of gas in the Hoadley field some 80 km south of Edmonton. The company estimates it will rank as the third-largest gas field in Canada, behind Elmworth and Milk River, with reserves of 170-200 billion m^3 of gas and almost 63 million barrels of natural gas liquids. Of the 44 wells drilled in the field, 37 were successful gas, 4 were oil, and 3 were dry, and abandoned.

Located northeast of the Peace River district in northern Alberta, Evi is situated between the established oil fields of Golden and Lubicon. Texas Pacific Oil Canada Ltd. announced in mid-year the discovery of oil in pinnacle reefs. Although very little information is available to date the Evi area may prove to be similar to the West Pembina play.

TABLE 3. PRODUCTION OF LIQUID HYDROCARBONS BY PROVINCE, 1980 AND 1981

	1980r		1981p	
	(000 m^3)	(m^3/day)	(000 m^3)	(m^3/day)
Alberta				
Crude	71 159[1]	194 424	64 205[2]	175 904
Condensate	114	312	102	280
Propane	5 281	14 429	5 177	14 184
Butane	3 258	8 902	3 134	8 586
Pentanes plus	5 897	16 112	5 652	15 485
Ethane	4 343	11 866	4 671	12 797
Total	90 052	246 045	82 941	227 236
Saskatchewan				
Crude	9 331	25 495	7 340	20 110
Condensate	17	46	17	47
Propane	80	219	80	219
Butane	37	101	37	101
Pentanes plus	25	68	25	69
Total	9 490	25 929	7 499	20 546
British Columbia				
Crude	2 002	5 470	2 031	5 564
Condensate	37	101	28	77
Propane	75	205	64	175
Butane	90	246	84	230
Pentanes plus	134	366	125	343
Total	2 338	6 388	2 332	6 389
Canada				
Crude	83 309[1]	227 620	74 382[2]	203 786
Condensate	168	459	146	400
Propane	5 436	14 853	5 322	14 581
Butane	3 385	9 249	3 255	8 918
Pentanes plus	6 055	16 544	5 802	15 896
Ethane	4 343	11 866	4 671	12 797
Total	102 696	280 591	93 578	256 378

Source: Statistics Canada.
[1] Synthetic equals 7 966. [2] Synthetic equals 6 205.
p Preliminary; r Revised.

In late-September, 1981, Joffre Resources Ltd. announced the discovery of two heavy oil pools in the Hayter area of eastern Alberta, south of Lloydminster. Nine wells were completed in the Dina zone with net pay ranging from 6 to 13 m, and two Sparky wells have been producing test rates of 8 m^3/d. Stepout wells have been producing as much as 97 m^3/d.

TRANSPORTATION

Interprovincial Pipe Line (NW) Ltd. was issued a Certificate of Public Convenience and Necessity by the National Energy Board in November, 1981 allowing construction to proceed on the proposed 866 km pipeline from Norman Wells, Northwest Territories to Zama in northern Alberta. The line was

TABLE 4. CANADA, LIQUIDS AND SULPHUR RECOVERED FROM NATURAL GAS, 1970-81

	Propane (cubic metres)	Butane (cubic metres)	Condensate Pentanes Plus (cubic metres)	Sulphur (tonnes)
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	3 582 000	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
1980r	5 402 400	3 365 900	6 212 800	6 182 500
1981P	5 321 600	3 255 300	5 947 700	5 613 761

Source: Statistics Canada.
r Revised; P Preliminary.

initially estimated to cost $360 million and is to carry 4.5 thousand m^3/d of crude oil and natural gas liquids from Esso Resources' project to expand production by waterflooding the Norman Wells field. Construction in the Northwest Territories is expected to commence in 1983 and the projected completion date for the line will be in mid-1985.

Two proposals were under consideration for the movement of Alaskan crude oil by tanker to a new oil port on Juan de Fuca Strait and then by pipeline to U.S. Northern Tier refiners. The proposal by the Northern Tier Pipeline Company involves construction of an all U.S. pipeline, while that of the Trans Mountain Pipe Line Company Ltd. would require building a parallel line to its current pipeline to Edmonton and using existing facilities to move the crude south to U.S. refiners. In July, 1981 Trans Mountain postponed indefinitely its proposal citing reduced U.S. oil demand, among other factors, as having a negative impact on the commercial viability of a new line. In October, 1981 the Washington State Energy Facility Site Evaluation Council (EFSEC) rejected Northern Tier's project on environmental and other grounds. However, Northern Tier is continuing to support its application and the EFSEC recommendation must be referred to the Governor of Washington for a final decision.

TABLE 5. OIL AND GAS WELLS IN WESTERN CANADA AT END OF 1981

	Wells Capable of Production		Wells Actually Producing	
	Oil	Gas	Oil	Gas
Alberta	20,072	22,611	14,243	18,797
Saskatchewan	10,684	868	7,890	756
Manitoba	853	-	748	-
British Columbia		1,665[1]	562	591
Northwest Territories and Arctic Islands	55	11	36	4
Total	31,664	25,155[1]	23,479	20,148

Sources: Provincial and federal government reports.
[1] British Columbia wells capable of production not broken down by oil and gas.
- Nil.

Alberta gas started flowing October 1, 1981 to the United States through the western leg of the Alaskan gas pipeline. Construction of the eastern leg is

TABLE 6. WELLS DRILLED BY PROVINCE, 1980 AND 1981

	Oil		Gas		Dry[1]		Total	
	1980	1981	1980	1981	1980	1981	1980	1981
Western Canada								
Alberta	1,639	1,483	3,968	3,085	1,388	1,264	6,995	5,832
Saskatchewan	1,099	512	49	25	295	251	1,443	788
British Columbia	31	27	219	95	134	87	384	209
Manitoba	18	47	0	0	9	15	27	67
Yukon, Northwest Territories and Arctic Islands	4	5	5	1	7	7	16	13
Westcoast offshore	0	0	0	0	0	0	0	0
Sub-total	2,791	2,074	4,241	3,206	1,833	1,624	8,865	6,909
Eastern Canada								
Ontario	12	6	91	76	122	95	225	178
Quebec	0	0	0	1	3	4	3	5
Atlantic provinces	0	0	0	0	0	1	0	1
Eastcoast offshore	2	4	1	2	6	3	9	9
Hudson Bay offshore	0	0	0	0	0	0	0	-
Sub-total	14	10	92	79	131	103	237	193
Total Canada	2,805	2,084	4,333	3,285	1,964	1,727	9,102	7,102

Source: Canadian Petroleum Association.
[1] Includes suspended and abandoned wells, but excludes miscellaneous and service wells.
- Nil.

progressing on schedule. By mid-October 430 km of 1 067 mm diameter of pipe had been welded in Saskatchewan and Alberta. The remaining 206 km will be constructed by the summer of 1982, and Alberta gas is scheduled to start flowing in September 1982.

The U.S. Congress has approved an important package of waivers to the President's 1977 decision on the Alaskan gas pipeline. These waivers will remove some of the major obstacles which are making private financing of this 7 700 km pipeline difficult. The present schedule is that 68 million m^3/d of Alaskan gas will begin to flow in 1986. The estimated cost of the pipeline and processing facilities is now $30 billion.

Upon completion of the Alaska Highway gas line, a pipeline from the Mackenzie Delta to Whitehorse has been proposed by Foothills Pipe Lines (Yukon) Ltd. to carry gas from the Delta and through the Alaska line to southern Canadian markets. This line, called the Dempster pipeline, is expected to carry up to 34 million m^3/d and cost of the proposed project is estimated to be $3.5 billion.

The Arctic Pilot Project (APP), a joint undertaking of Petro-Canada, Nova, an Alberta Corporation, Dome Petroleum and Melville Shipping Ltd., proposes to construct two ice breaking liquified natural gas (LNG) tankers to transport 7.3 million m^3/d of gas from Melville Island in the eastern Arctic islands to an LNG terminal in Quebec or the Maritimes. The earliest start-up date would be 1986 and estimated cost of the project is over $2 billion. The NEB has scheduled its hearing to begin February 2, 1982.

Polar Gas is proposing to construct a Y-line connecting both Arctic islands and Mackenzie Delta gas reserves for delivery to southern Canadian markets. Earliest start-up would be in 1990. This system would be over 5 000 km long and the throughput is estimated to be 61 million m^3/d.

After hearing a new application by Trans Quebec & Maritimes Pipeline Inc. (TQM) to build a gas pipeline from Quebec to the Maritimes, the National Energy Board has recommended that the gas pipeline be extended from Montreal to Cape Breton Island, Nova Scotia. The first 40 km of this

TABLE 7. CANADA, WELLS COMPLETED AND METRES DRILLED, 1980 AND 1981

	1980		1981	
	(No.)	(metres)	(No.)	(metres)
Western Canada				
British Columbia				
New field wildcats	75	164 559	36	103 259
Other exploratory	160	292 051	108	189 990
	235	456 610	144	293 249
Development	151	238 175	65	114 336
Total	386	694 785	209	407 585
Alberta				
New field wildcats	155	334 950	189	297 929
Other exploratory	2,444	3 649 302	2,163	3 145 228
	2,599	3 984 252	2,352	3 443 157
Development	4,445	4 413 681	3,534	3 422 798
Total	7,044	8 397 933	5,886	6 865 955
Saskatchewan				
New field wildcats	347	291 870	173	141 638
Other exploratory	541	466 042	361	314 541
	888	757 912	534	456 179
Development	570	461 480	267	238 660
Total	1,458	1 219 392	801	694 839
Manitoba				
New field wildcats	12	11 619	23	25 794
Other exploratory	0	0	10	8 958
	12	11 619	33	34 752
Development	15	11 890	34	31 294
Total	27	23 509	67	66 046
Yukon, Northwest Territories and Arctic Island				
New field wildcats	10	23 836	11	30 348
Other exploratory	0	0	0	0
	10	23 836	11	30 348
Development	7	13 274	2	8 470
Total	17	37 110	13	38 818
Total western Canada				
New field wildcats	599	826 834	432	598 968
Other exploratory	3,145	4 407 395	2,642	3 658 717
	3,744	5 234 229	3,074	4 257 685
Development	5,188	5 138 500	3,902	3 815 558
Total	8,932	10 372 729	6,976	8 073 243
Eastern Canada				
Eastcoast offshore				
New field wildcats	7	23 420	9	39 511
Other exploratory	0	0	0	0
	7	23 420	9	39 511
Development	2	9 224	0	0
Total	9	32 644	9	39 511
Ontario				
New field wildcats	19	11 474	31	19 266
Other exploratory	84	48 838	17	8 936
	103	60 312	48	28 202
Development	135	64 442	147	63 870
Total	238	124 754	195	92 072

TABLE 7 (Cont'd.)

	1980		1981	
	(No.)	(metres)	(No.)	(metres)
Quebec				
New field wildcats	3	8 253	4	6 879
Other exploratory	0	0	1	1 265
	3	8 253	5	8 144
Development	0	0	0	0
Total	3	8 253	5	8 144
Atlantic provinces				
New field wildcats	0	0	1	2 638
Other exploratory	0	0	0	0
	0	0	1	2 638
Development	0	0	0	0
Total	0	0	1	2 638
Total eastern Canada				
New field wildcats	29	43 147	45	68 294
Other exploratory	84	48 838	18	10 201
	113	91 985	63	78 495
Development	137	73 666	147	63 870
Total	250	165 651	210	142 365
Total Canada				
New field wildcats	628	869 981	477	667 262
Other exploratory	3,229	4 456 233	2,660	3 668 918
	3,857	5 326 214	3,137	4 336 180
Development	5,325	5 212 166	4,049	3 879 428
Total	9,182	10 538 380	7,186	8 215 608

Source: Canadian Petroleum Association.

line were completed in December 1981, and it is expected that the pipeline will reach Trois-Rivières by late-1982 and the Maritimes by 1985. This project is very important to Canada's off-oil objectives. The estimated costs of this 1 400 km pipeline are in excess of $1 billion.

MARKETS AND TRADE

Production of crude oil, natural gas liquids and synthetic crude oil averaged 256 378 m^3/d during 1981, an overall decrease of almost 9 per cent over 1980. Crude oil production averaged 187 190 m^3/d, natural gas liquids (including ethane) averaged 52 188 m^3/d and synthetic crude output averaged 17 000 m^3/d during 1981 whereas, during 1980 the figures were: 206 254 m^3/d, 52 512 m^3/d and 21 825 m^3/d, respectively. Canada's current refining capacity, which includes only the refineries in actual

TABLE 8. LENGTH OF PIPELINES IN CANADA FOR TRANSPORTING CRUDE OIL NATURAL GAS LIQUIDS AND PRODUCTS, 1964-81

Year-end	Kilometres[1]	Year-end	Kilometres[1]
1964	18 900	1973	30 146
1965	19 819	1974	31 262
1966	20 913	1975	31 831
1967	22 780	1976	32 863
1968	23 870	1977	33 463
1969	27 480	1978	34 421
1970	27 459	1979	34 868
1971	28 706	1980	35 663
1972	29 467	1981P	37 426

Source: Statistics Canada
[1] Includes producer gathering lines from 1969 to 1981.
P Preliminary.

TABLE 9. KILOMETRES OF EXISTING GAS PIPELINES IN CANADA, 1976-81

	1976	1977	1978	1979	1980	1981
Gathering						
New Brunswick	20.8	20.8	20.8	20.8	20.8	20.8
Quebec	2.1	0.0	0.0	0.0	0.0	0.0
Ontario	1 992.0	1 939.1	1 946.2	2 062.9	2 105.2	2 121.5
Saskatchewan	2 290.1	2 757.2	1 813.4	1 899.7	1 871.5	1 893.4
Alberta	12 848.4	13 822.3	13 816.2	14 355.0	16 077.8	17 619.8
British Columbia	2 069.8	2 120.3	2 590.6	2 708.3	3 084.3	3 079.0
Northwest Territories and Yukon	55.0	55.0	55.0	55.0	55.0	55.0
Total	19 278.2	20 715.2	20 242.2	21 101.7	23 214.6	24 789.5
Transmission						
New Brunswick	21.6	21.6	21.6	21.6	21.6	21.6
Quebec	237.7	265.0	256.4	256.3	256.4	276.0
Ontario	9 387.8	9 345.9	9 242.6	9 314.4	9 441.3	9 568.5
Manitoba	2 743.4	2 779.0	2 778.9	2 806.7	2 675.0	2 790.5
Saskatchewan	10 614.9	10 862.5	10 702.8	10 666.9	10 765.4	10 956.3
Alberta	15 596.0	17 075.4	17 739.5	18 000.0	18 120.6	19 063.4
British Columbia	5 087.5	5 177.1	5 249.3	5 230.6	5 283.3	5 327.1
Total	43 688.9	45 526.5	45 991.1	46 296.5	46 563.6	48 003.4
Distribution						
New Brunswick	146.1	146.1	146.1	146.1	146.1	146.1
Quebec	2 890.0	2 938.9	2 972.1	2 999.4	3 028.9	3 069.4
Ontario	28 715.7	29 378.8	29 444.1	30 478.4	31 836.9	32 942.9
Manitoba	2 738.8	2 815.1	2 876.1	2 976.7	3 049.4	3 068.3
Saskatchewan	4 966.3	5 078.8	5 287.8	5 421.2	5 592.1	5 785.2
Alberta	21 554.1	25 065.1	26 850.2	28 950.8	31 092.3	32 567.2
British Columbia	9 397.6	9 789.3	10 072.1	10 188.5	10 766.6	10 955.4
Total	70 409.5	75 212.1	77 648.5	81 161.1	85 512.3	88 534.5
Total Canada	133 376.7	141 453.8	143 881.8	148 559.3	155 290.5	161 327.4

Source: Statistics Canada.

operation, is approximately 362 000 m^3/d, of which some 284 000 m^3/d of crude is used for processing.

Exports of crude oil and products are expected to average some 69 479 m^3/d of which 31 per cent will have been crude, for a decrease in total exports of 8 653 m^3/d from 1980. Total imports were equal to 87 830 m^3/d, or 7 378 m^3/d less than the previous year.

Net withdrawals of natural gas during 1981 amounted to 67 848 million m^3, or 186 million m^3/d. This was a decrease of 3 per cent from 1980. Domestic sales accounted for 70 per cent with the remainder being required for export.

From January to September, the Toronto city gate price of natural gas was $2.60 per million British thermal units (Btu) excluding taxes. The export price of gas rose from $US 4.47 in March to $US 4.94 in April and remained constant through to September.

In January, the domestic price of Canadian crude at the wellhead was

TABLE 10. CONSUMPTION OF PETROLEUM PRODUCTS BY PROVINCE, 1981

	Motor Gasoline	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	3 091	253	1 442	1 983	3 503
Quebec	8 165	299	2 670	4 393	5 151
Ontario	12 875	207	3 381	3 911	2 568
Manitoba	1 543	95	766	121	121
Saskatchewan	2 000	120	1 050	164	16
Alberta	5 081	59	2 811	90	20
British Columbia	4 381	105	2 391	631	1 581
Northwest Territories and Yukon	95	81	229	121	20
Total	37 231	1 219	14 740	11 414	23 980

Source: Statistics Canada.

TABLE 11. CANADA, EXPORTS AND IMPORTS OF REFINED PETROLEUM PRODUCTS, 1980r AND 1981P

	Exports 1980	Exports 1981	Imports 1980	Imports 1981
	(000 cubic metres)			
Propane and butane	357	462	0	0
Aviation gasoline	0	0	0	0
Motor gasoline	672	702	176	119
Aviation turbo fuel (kero-type)	150	90	109	21
Kerosene, stove oil and tractor fuel	36	0	2	19
Diesel fuel oil	107	134	84	186
Light fuel oil No. 2 & No. 3	1 960	1 550	13	34
Heavy fuel oil No. 4, 5 & 6	2 699	2 405	1 111	1 198
Asphalt	77	163	19	21
Petroleum coke	0	0	757	780
Lubricating oils & greases	22	15	101	68
*Other products	1 283	1 552	149	66
Total, all products	7 363	7 073	2 521	2 512

Source: Statistics Canada.
r Revised; P Preliminary.
* Also includes Petro-chem feedstocks, Naphtha specialties, aviation turbo fuel (naphtha type) and still gas.

\$111.70/m^3 and this was increased to \$117.99/m^3 in July and again increased to \$133.73/m^3 in October. The export charges applied to crude oil decreased periodically, as the Canadian wellhead price increased, so that the total export price was the equivalent of the price paid for foreign crude in Montreal. An example of this charge for a Lloydminster-type crude leaving Canada for the United States was as follows: in January the charge payable was \$146.25/m^3 and decreasing, so that by October the charge was \$108.70/m^3.

There was considerable progress during 1981 in the legislation and implementation of the National Energy Program. In September, a pricing agreement was reached between Alberta government and the federal government providing for a price schedule for crude oil over the next five years. Shortly after, similar agreements were signed with the British Columbia and Saskatchewan governments.

TABLE 12. CANADA, CRUDE OIL PRODUCTION, TRADE AND REFINERY RECEIPTS, 1969-81

	Production	Imports	Exports	Refinery Receipts[1] Domestic	Refinery Receipts[1] Imports	Refinery Receipts[1] Total
	(000 cubic metres)					
1969	65 342	30 704	31 375	38 480	30 284	68 764
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

Source: Statistics Canada.
[1] Includes condensate and pentanes plus.

TABLE 13. CANADA, CRUDE OIL RECEIVED AT REFINERIES, 1980 AND 1981

Location of Refineries		Country of Origin: Canada	Middle East	Venezuela	Africa	Other	Total Received
		(000 cubic metres)					
Atlantic provinces	1980	61	11 182	4 053	152	700	16 148
	1981	0	6 941	3 109	281	1 587	11 918
Quebec	1980	16 561	3 896	5 578	321	3 010	29 366
	1981	12 274	3 398	4 883	1 500	5 397	27 452
Ontario	1980	31 212	0	0	0	3 273	34 485
	1981	29 762	0	0	84	2 367	32 213
Prairies	1980	20 030	0	0	0	66	20 096
	1981	19 354	0	0	0	0	19 354
British Columbia	1980	9 548	0	0	0	0	9 548
	1981	9 666	0	0	0	0	9 666
Northwest Territories and Yukon	1980	158	0	0	0	0	158
	1981	174	0	0	0	0	174
Total	1980	77 572	15 093	9 631	473	7 033	109 802
	1981	71 230	10 339	7 992	1 865	9 351	100 777

Source: Statistics Canada.

TABLE 14. CANADA, SUPPLY AND DEMAND OF OILS, 1980 AND 1981

	1980	1981
	(000 cubic metres)	
Supply		
Production		
Light-medium	64 123	57 269
Heavy	11 163	11 023
Synthetic	7 979	6 935
Pentanes plus	6 222	6 242
Natural gas liquids	13 176	13 213
Total production	102 663	94 682
Imports		
Crude oil	32 230	29 546
Products	2 521	2 512
Total imports	34 751	32 058
Total supply	137 414	126 740
Demand		
Domestic	106 992	99 918
Exports		
Light-medium	5 307	3 431
Heavy	6 039	5 475
Pentanes plus	622	438
Products	7 363	7 073
Natural gas liquids	9 187	8 943
Total exports	28 518	25 360
Stock changes	2 306	-1 132
Uses and losses	4 210	-330
Total demand	137 414	126 740

Source: Energy, Mines and Resources Canada.

TABLE 15. CANADA, SUPPLY AND DEMAND OF NATURAL GAS, 1980 AND 1981

	1980	1981
	(million cubic metres)	
Supply		
Gross new production	100 571	99 337
Field waste and flared	-1 664	-1 504
Reinjected	-11 798	-12 339
Net withdrawals	87 109	85 494
Processing shrinkage	12 155	11 721
Net new supply	69 826	67 848
Removed from storage	4 835	3 786
Placed in storage	4 441	4 319
Net storage	394	533
Total net domestic supply	70 533	68 475
Imports	3	3
Total supply	75 367	72 261
Demand		
Domestic sales		
Residential	9 616	9 795
Industrial	23 519	22 963
Commercial	10 120	10 128
Total	43 255	42 886
Field and pipeline use in production	6 390	5 939
Pipeline	2 042	2 139
Other	2 258	625
Adjustment metering differences	-1 271	110
Line pack changes	17	57
Total field and pipeline use	9 436	8 870
Gas unaccounted for	113	-1 079
Total domestic demand	52 804	50 677
Exports	22 563	21 584
Total demand	75 367	72 261

Source: Statistics Canada.

Gold

S. HAMILTON

SUMMARY

For gold, 1981 was a rather subdued year compared to the dramatic events of 1980. While world production remained virtually unchanged, the relative price weakness that became evident toward the end of 1980 persisted throughout 1981. This has been attributed in particular to the extraordinarily high interest rates that prevailed in the United States and in many other western countries during 1981. Other reasons included the positive attitude of the Republican administration in the United States toward business investment; the strength of the U.S. dollar which made gold more expensive in countries where the local currency weakened against the dollar; lower gold purchases in Middle Eastern countries; increased sales of gold by the U.S.S.R.; and the inability of the Republic of South Africa to adjust its sales to market conditions to the same extent as in 1980.

The price of gold is expected to remain subject to cyclical fluctuations, familiar to producers of other metals but until 1971 a phenomenon virtually unknown in the gold industry with its history of fixed prices. Gold producers are beginning to adjust by selling their output forward or hedging on the futures market.

CANADIAN SCENE

In Canada the intense level of exploration activity of 1980 was sustained throughout 1981. Claim staking continued in the historic gold mining camps, but areas in which new gold discoveries were reported, such as the Opapimiskan Lake area in Ontario, also saw substantial staking activity. Exploration of known properties continued with the dewatering of old shafts to permit underground exploration and re-evaluation of reserve statistics. Some operating mines re-evaluated their properties with an eye toward applying lower cost, bulk-mining methods to larger tonnage, lower grade reserves.

Volume of gold production in Canada in 1981 at 49 500 kg, was about 2 per cent below that in 1980 (which in turn was below that for 1979), as producers continued to mill lower-grade ore (Table 1). Unlike 1980, when value of production was up despite the lower output, value was down 24.39 per cent in 1981 due to the progressively weaker gold price. Canadian gold producers continued to benefit from a dollar that remained well below the value of its U.S. counterpart and, with a few exceptions, reported good earnings but well below those in 1980.

MINE DEVELOPMENTS

At the end of 1981 there were 36 lode gold mines in Canada operated by 28 companies. Four lode gold mines closed during the year. Les Mines Est-Malartic Ltée closed the Barnat mine which had been operated on a salvage basis since 1979. Darius Gold Mines Inc. gave up the attempt to redevelop the former O'Brien mine as a large tonnage, low-grade producer. Cusac Industries Ltd. did not resume its small scale, seasonal operation near Cassiar. Pamour Porcupine Mines, Limited suspended operations at the Camlaren property at Gordon Lake, Northwest Territories (leased from Discovery Mines Limited).

Ten mines opened during 1981, three in Quebec, five in British Columbia and one each in Ontario and the Northwest Territories. Other mines are completing development programs and will begin production in early-1982. Ontario remains the leading gold producer, followed by Quebec, British Columbia and the Northwest Territories.

Investment committed to development or expansion of gold mines from 1979 through 1981, exclusive of exploration expenditures, is conservatively estimated at $630 million. Approximately 2,500 jobs are being created in what had been a declining segment of the mining industry.

TABLE 1. CANADA, PRODUCTION OF GOLD 1980 AND 1981

	1980		1981P	
	kilograms	$000	kilograms	$000
Quebec	15 548	357,954	16 517	298,294
Ontario	18 384	423,243	16 518	292,638
British Columbia	7 477	172,151	7 689	136,223
Northwest Territories	4 209	96,920	3 663	64,894
Manitoba	1 591	36,626	1 248	22,114
Yukon	2 555	58,830	3 046	53,964
Saskatchewan	360	8,287	305	5,409
Newfoundland	234	5,381	241	4,263
Alberta	133	3,060	121	2,143
New Brunswick	129	2,965	152	1,174
Total	50 620	1,165,417	49 500	881,116

Source: Energy, Mines and Resource Canada.
P Preliminary.

Gold production in the Atlantic provinces continues to be a byproduct of base-metal mining. Examination of properties in the former gold producing area of central Nova Scotia has not yet shown results that would justify a production decision although there has been some test milling of bulk samples. In Quebec about 70 per cent of the gold output comes directly from lode gold mines, with about 30 per cent as a byproduct of base-metal mining and refining operations. Gold produced in Manitoba and Saskatchewan is byproduct from base-metal mines.

In Alberta a small amount of gold is obtained from placers in the North Saskatchewan River. In British Columbia gold is recovered from lode gold mines, base-metal production and placer mining. In the Yukon, output from the resurgent placer mining industry has surpassed byproduct gold output from copper mining. In the Northwest Territories gold production is from existing lode gold mines in the Great Slave Lake area and from a new producer in the District of Keewatin.

Quebec. The exploration and development activity reported in 1980 paid off with initial production from three new mines in 1981. Kiena Gold Mines Limited, near Noranda, has been shipping development ore to the Lamaque mill (division of Teck Corporation) at Val d'Or since mid-1981. Underground development increased the proven reserves and a new ore zone was discovered. Kiena plans to have its own mill in place when its three-year custom milling contract with Lamaque expires.

In March 1980, Bachelor Lake Gold Mines Inc. was incorporated as a Quebec-based company with Quebec Sturgeon River Mines Limited as the major shareholder. Bachelor Lake was brought into production at year-end at 455 tpd.

Belmoral Mines Ltd. completed reconstruction of the former Solbec mill to handle ore from the Ferderber and George Dumont (Bras d'Or) properties. The company has expansion plans for both properties and is involved with plans to reopen the Wood-Cadillac mine (in production from 1939 to 1949) sometime in 1983.

Muscocho Explorations Limited continued with development work on the Montauban property, although Société québécoise d'exploration minière (SOQUEM) withdrew from the joint venture. El Coco Explorations Ltd., part of the Belmoral group, shipped ore from an underground exploration and development program on the Gold Hawk property in Dasserat Township to Lamaque's mill and the Belmoral mill as capacity permitted. Exploration Aiguebelle Inc., in which SOQUEM holds an interest, has committed $8 million to bring its property in Destor Township into production by late 1982.

Long Lac Minerals Ltd., Thompson-Bousquet division, expanded capacity from 1 000 tpd to 1 450 tpd and the Silverstack Mines division, is proceeding with construction of a cyanide mill at the Doyon mine. Agnico-Eagle Mines Limited is continuing its expansion program to develop the adjacent, leased, Telbel property.

TABLE 2. CANADA, GOLD PRODUCTION BY SOURCE, 1970 AND 1975-81

	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	51 433 144	100.0
1976	38 333 013	72.8	517 375	1.0	13 770 722	26.2	52 621 110	100.0
1977	37 831 875	70.1	526 986	1.0	15 562 469	28.9	53 921 330	100.0
1978	36 339 934[r]	67.3	555 663[r]	1.0[r]	17 071 330[r]	31.7[r]	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[P]	31 150 000[e]	60.9	2 492 000[e]	4.9	17 500 000[e]	34.2	51 142 000	100.0
1981[e]	32 175 000[e]	65.0	2 970 000[e]	6.0	14 355 000[e]	29.0	49 500 000	100.0

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[P] Preliminary; [r] Revised; [e] Estimated.

TABLE 3. CANADA, GOLD PRODUCTION, AVERAGE VALUE PER GRAM AND RELATIONSHIP TO TOTAL VALUE OF ALL MINERAL PRODUCTION[1], 1970 AND 1975-81

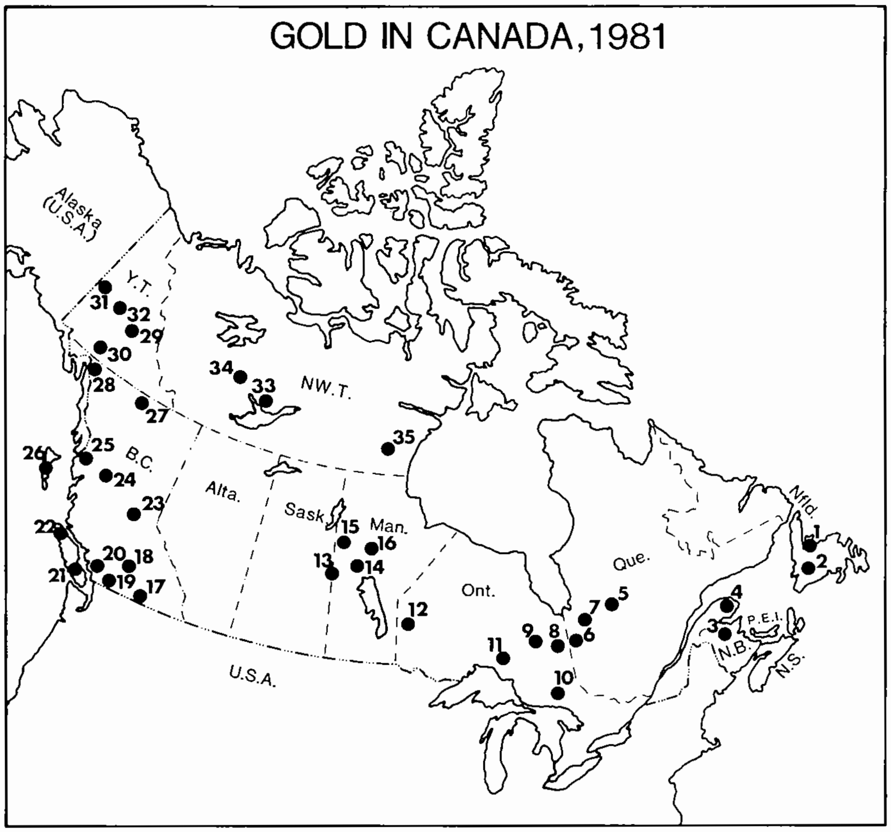
	Total Production	Total Value	Average Value per Gram[1]	Gold as per cent of Total Value of Mineral Production
	(grams)	($ Cdn)	($ Cdn)	(%)
1970	74 915 025	88,057,464	1.18	1.5
1975	51 433 114	270,830,389	5.27	2.0
1976	52 621 110	208,273,405	3.96	1.4
1977	53 921 330	272,331,217	5.05	1.5
1978	53 966 927	382,423,117	7.09	1.9
1979	51 142 359	590,766,328	11.55	2.3
1980	50 620 000	1,165,417,000	23.02	3.7
1981[P]	49 500 000	881,116,000	17.80	2.7

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Value not necessarily based on average annual gold price.
[P] Preliminary.

Ontario. During the summer Kidd Creek Mines Ltd. (formerly Texasgulf Canada Ltd.) began production from the open-pit section of the Owl Creek deposit.

The Detour Lake Joint Venture (Amoco Canada Petroleum Company Ltd., 50 per cent; Campbell Red Lake Mines Limited, 25 per cent; and Dome Mines, Limited, 25 per cent) began work on the first phase of the Detour Lake project in northern Ontario. Agreement was reached with the Ontario government on construction of a 150 km road linking the site with Highway 652, near Cochrane. Site preparation was begun in the spring, construction of buildings will begin in the spring of 1982, and production from the open pit at 2 000 tpd is scheduled for 1983. The second phase, including development of the underground mine which will bring capacity to 4 000 tpd and make it the largest gold mine in Canada, is scheduled for completion in 1987. Expansion of the Dome mine at Timmins from 2 000 tpd to 3 000 tpd is proceeding according to plan.

A number of smaller development projects are under way throughout the province. Hollinger Argus Limited did not exercise its option to develop the Goldlund property, so Goldlund Mines Limited is now endeavouring to bring the property into production itself at a rate of 180 tpd. Consolidated Louanna Gold Mines Limited announced that its O'Sullivan Lake property will produce at 125 tpd beginning in early-1982. Northgate



GOLD PRODUCERS 1981
(numbers refer to numbers on map)

Newfoundland

(1) Consolidated Rambler Mines Limited (a)
(2) ASARCO Incorporated (Buchans Unit) (a)

New Brunswick

(3) Heath Steele Mines Limited (a)

Quebec

(4) Gaspé Copper Mines, Limited (a)
(5) Chibougamau District
    Camchib Resources Inc. (a) (b)
    Corporation Falconbridge Copper (Opemiska Division) (a)
    Lemoine Mines Limited (a)
    Patino Mines (Quebec) Limited (Copper Rand Division) (a)
(6) Noranda Rouyn District
    Corporation Falconbridge Copper (Lake Dufault Division) (a)
    Noranda Mines Limited - Chadbourne mine (b)
    Les Mines Gallen Limitée (a)
(6) Malartic-Val d'Or District
    Camflo Mines Limited (b)
    Les Mines Est-Malartic Ltée (b)
    Kiena Gold Mines Limited (b)
    Lamaque Mining Company Limited (b)
    Sigma Mines (Quebec) Limited (b)
    Louvem Mining Company Inc.
    Darius Gold Mines Inc. (b)
    Long Lac Minerals Ltd. (b)
    Belmoral Mines Ltd. (b)
    Silverstack Mines Ltd. (b)
(7) Matagami District
    Agnico-Eagle Mines Limited (b)
    Mattagami Lake Mines Limited (a)

Ontario

(8) Larder Lake Mining Division
Kerr Addison Mines Limited (b)
Pamour Porcupine Mines, Limited (Ross Mine) (b)
Willroy Mines Limited (Macassa Division) (b)
(9) Porcupine Mining Division
Dome Mines, Limited (b)
Kidd Creek Mines Ltd. (Owl Creek Mine) (b)
Pamour Porcupine Mines, Limited (Nos. 1, 2 & 3 mines and Timmins property) (b)
Pamour Porcupine Mines, Limited (Schumacher Division) (a) (b)
(10) Sudbury Mining Division
Falconbridge Nickel Mines Limited (a)
Inco Limited (a)
Sungate Resources Ltd. (Renabie Mine) (b)
(11) Thunder Bay Mining Division
Noranda Mines Limited (Geco Mine)(a)
(12) Red Lake Mining Division
Campbell Red Lake Mines Limited (b)
Dickenson Mines Limited (b)

Manitoba

(13) Hudson Bay Mining and Smelting Co., Limited (Flin Flon) (a)
(14) Hudson Bay Mining and Smelting Co., Limited (Snow Lake) (a)
(15) Sherritt Gordon Mines Limited (Fox Lake and Ruttan mines) (a)
(16) Inco Limited (a)

British Columbia

(17) Cominco Ltd. (a)
(18) Teck Corporation (a)
Brenda Mines Ltd. (a)
Newmont Mines Limited (Similkameen Division) (a)
Bethlehem Copper Corporation (a)
(19) Carolin Mines Ltd. (b)
(20) Northair Mines Ltd. (a)
(21) Westmin Resources Limited (a)
(22) Utah Mines Ltd. (Island Copper Mine) (a)
(23) Mosquito Creek Gold Mining Company Limited, The (b)
(23) Small Placer Operations (c)
(24) Equity Silver Mines Limited (a)
(24) Noranda Mines Limited (Bell Copper Mine) (a)
(24) Noranda Mines Limited (Granisle Mine) (a)
(24) Du Pont Canada Inc. (Baker Mine) (b)
(25) Scottie Gold Mines Ltd. (b)
(26) Wesfrob Mines Limited (a)
(27) Erickson Gold Mining Corp. (b)
(27) United Hearne Resources Ltd. (b)
(28) Small Placer Operations (c)

Yukon Territory

(29) Cyprus Anvil Mining Corporation (a)
(30) Hudson Bay Mining and Smelting Co., Limited (Whitehorse Copper Division) (a)
(31) Small Placer Operations (Dawson City) (c)
(32) Small Placer Operations (Mayo) (c)
(30) Small Placer Operations (Kluane Lake) (c)

Northwest Territories

(33) Cominco Ltd. (Con and Rycon mines) (b)
(33) Giant Yellowknife Mines Limited (b)
(34) Camlaren Mines, Limited (Discovery property (b)
(35) Cullaton Lake Gold Mines Ltd. (b)

(a) base-metal, gold byproduct
(b) lode gold
(c) placer gold

Exploration Limited has continued exploration of the Orofino property and has substantially increased the tonnage of ore reserves while maintaining the grade. Pamour Porcupine Mines, Limited activated its No. 2 mine (the Hallnor) and continued rehabilitation work on the Hollinger. The Hollinger project in particular is essential to improve Pamour's ore grades.

A number of new discoveries were announced during the year. Dome Mines, Limited announced a "significant" discovery at Opapimiskan Lake, 130 km north of Pickle Lake. Preliminary drilling indicates 1 million t of ore grading 6.857 g Au/t. Corona Resources Ltd. has announced that Teck Corporation will do a feasibility study of the Corona property north of Hemlo in northwestern Ontario. More work will be required on both properties before it can be determined whether or not they should become new gold mines.

Manitoba. Brinco Limited in a joint venture with New Forty-Four Mines Limited is bringing the San Antonio property, in operation from 1932 to 1968, back into production at 350 tpd. Cost is $15 million for development and a new mill. Production commenced on

January 4, 1982. Hudson Bay Mining and Smelting Co., Limited is examining the Nor-Acme property near Snow Lake. Sherritt Gordon Mines Limited is studying the Agassiz deposit near Lynn Lake.

Saskatchewan. Work has been reported from properties in the Flin-Flon and La Ronge areas but nothing as yet suggests potential for significant mine development. It has been reported that the uranium deposits of the Athabasca Sandstone formation may contain sufficient gold to warrant byproduct recovery. This would be similar to conditions in South Africa where the gold mines have recovered uranium as a byproduct and where the uranium mines report gold values.

British Columbia. Carolin Mines Ltd., near Hope, British Columbia, brought the province's first major lode gold mine in recent years into production at 1 360 tpd at the end of 1981. Start-up was delayed by summer flooding on Ladner Creek. In central British Columbia, Du Pont Canada Inc. put its Baker mine near Chappell into operation in February and Scottie Gold Mines Ltd. began production from its Summit Lake property near Stewart in September. Both are small tonnage, high-grade operations in fairly remote areas. In the Cassiar area, United Hearne Resources Ltd. brought the Taurus property into production in September at 100 tpd.

Exploration continued to be very active, particularly in northern and central British Columbia. SEREM Ltd. has a drilling program on the Lawyers property near the DuPont mine. Near Stewart, the Silbak Premier and Big Missouri properties are possible candidates for reopening. E & B Explorations Ltd. is financing a re-examination of the Bralorne-Pioneer Mine. Blackdome Exploration Ltd. is looking at properties near Clinton, and the former mines of the Hedley camp, notably the Nickel Plate, are being re-examined. Development of any of these properties would require gold prices substantially above the current level.

In the Atlin-Cassiar region and the Cariboo, interest in placer mining has prompted a staking rush and most of the creeks are now solidly staked. Because some of the gold recovered is hoarded, it is quite difficult to estimate volume of production.

Yukon. In the Yukon, the principal development in gold mining has been the expansion of placer mining activity. All of the creeks in the Dawson City, Mayo and Kluane Lake areas with a history of gold production have been staked and are in production. Other areas are heavily staked but are not yet developed. About 70 per cent of placer output comes from the Dawson area with 15 per cent each from Mayo and Kluane Lake. In 1980, royalty was paid on over 73,000 oz of placer gold. Since not all gold recovered is sold and since no royalty is paid on nuggets used in local jewellery manufacture, total recovery was probably considerably higher, in the order of 100,000 oz. In 1981 royalty was paid on nearly 100,000 oz, indicating that output for the year was well over that figure. Most of the placer claims are being reworked for the third or fourth time and are only profitable if worked with large earth moving equipment. There is a tendency for family operations to sell out to better capitalized commercial concerns.

The Whitehorse copper mine of Hudson Bay Mining and Smelting continues to produce gold as a byproduct of its copper mining operation. United Keno Hill Mines Limited spent about $9 million to rehabilitate the Venus silver-gold property near Carcross but put the property on a care-and-maintenance basis near the end of the year rather than going into production, as weakness in both gold and silver prices made production uneconomic. Exploration is quite active but none of the known lode gold occurrences have potential for production at present.

Northwest Territories. Gold production in the Northwest Territories continued to come mainly from the Yellowknife area. Cominco Ltd. produced from the Con and Rycon properties and Giant Yellowknife Mines Limited produced from the Giant, Lolor and Supercrest properties. Giant is conducting an extensive exploration program on the Salmita property, 110 km northeast of Yellowknife and has optioned the mill and associated surface facilities at Tundra Gold Mines Limited's nearby Matthews Lake property in anticipation of a possible production decision in mid-1982. Pamour Porcupine Mines operated the Camlaren property of Discovery Mines but lost money during the first year of the joint venture and closed the operation permanently at the end of the 1981 season. Cullaton Lake Gold Mines Ltd. completed the surface facilities at its property north of Churchill and began producing at 330 tpd in November. Echo Bay Mines Ltd. reported that its development program for the Lupin property is on schedule. Production is

TABLE 4. PRINCIPAL GOLD (MINE) PRODUCERS IN CANADA

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
NEWFOUNDLAND								
ASARCO Incorporated, (Buchans Unit), Buchans	1 100 (1 100)	0.72 (0.82)	92.91 (102.51)	0.80 (0.85)	14.26 (14.8)	68 946 (75 296)	43.2 (49.4)	Property continues to operate on salvage basis.
Consolidated Rambler Mines Limited, Baie Verte	1 100 (1 100)	2.06 (2.09)	17.83 (18.55)	3.82 (3.51)	- (-)	143 244 (164 281)	207.3 (251.0)	Property operated on a month-to-month basis.
NEW BRUNSWICK								
Heath Steele Mines Limited, Newcastle	3 850 (3 650)	0.69 (1.03)	51.43 (55.20)	0.91 (0.84)	5.39 (5.79)	1 249 928 (1 252 406)	229.8 (417.5)	
QUEBEC								
Agnico-Eagle Mines Limited, Joutel	1 000 (1 000)	5.18 (5.76)	1.54 (1.23)	- (-)	- (-)	263 474 (324 241)	1 254.1 (1 716.3)	Effort concentrated on mine development and Telbel shaft project.
Bachelor Lake Gold Mines Inc. Desmaraisville	455	6.68	n.a.	-	-	n.a.	n.a.	Development work in 1981 Production officially began January 1982.
Belmoral Mines Ltd. Val d'Or	800 (660)	5.55 (5.48)	0.69e (1.03e)	- (-)	- (-)	91 574 (65 847)	406.0	Production from Ferderber and George Dumont mines.
Camflo Mines Limited, Malartic	1 150 (1 150)	4.03 (3.94)	0.15 (0.12)	- (-)	- (-)	420 027 (419 983)	1 591.4 (1 570.0)	Agreement with Malartic Hygrade Gold Mines Ltd. permits extension of workings into Malartic ground.
Campbell Resources Inc. Cedar Bay, Henderson and Merrill Pit copper, gold mines,	2 950 (2 950)	2.50 (2.78)	6.24 (6.86)	0.96 (0.99)	- (-)	330 791 (390 981)	705.6 (872.5)	Copper circuit.
Gwillim gold mine, Chibougamau	180	4.66	4.39	0.10	-	63 177	280.1	Cyanide circuit treats are from Gwillim mine.

TABLE 4. (cont'd.)

Company and Location	Combined 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.)								
Darius Gold Mines Inc. Val d'Or	225 (225)	4.35 (3.43)	0.93 (0.12)	- (-)	- (-)	47 818 (33 387)	158.7 (106.4)	Attempt to redevelop mine abandoned. Property sold to Sulpetro Minerals Limited.
Corporation Falconbridge Copper, Lake Dufault Division, Millenbach and Norbec mines, Rouyn-Noranda	1 450 (1 450)	0.69 (0.72)	19.51 (28.80)	2.79 (2.70)	1.19 (2.19)	452 953 (475 464)	250.2 (261.9)	
Corporation Falconbridge Copper, Opemiska Division Perry, Springer and Cooke mines, Chapais	2 600 (2 600)	1.06 (1.23)	10.29 (10.29)	1.61 (1.57)	- (-)	849 630 (964 052)	751.8 (1 004.1)	
Gaspé Copper Mines, Limited Copper Mt. Mill Murdochville	27 125 (27 125)	0.07 (0.055)	3.94 (2.89)	0.34 (0.45)	- (-)	8 996 001 (8 875 542)	88.4 (43.7)	
Gaspé Copper Mines, Limited Needle Mt. Mill Murdochville	3 720 (3 700)	0.07 (0.07)	5.90 (6.17)	1.26 (1.02)	- (-)	1 064 641 (1 350 780)	17.7 (22.3)	
Kiena Gold Mines Limited Lamaque Mining Company Limited	-	n.a	n.a	"	"	"	"	Development ore being shipped to Lamaque for custom milling.
Mine Ore	1 900 (1 900)	3.19 (3.20)	0.58 (0.48)	- (-)	- (-)	370 826 (399 260)	1 071.9 (1 008.4)	Mine has limited reserves.
Custom Ore Val d'Or	- (-)	4.46 (-)	0.69 (-)	- (-)	- (-)	152 173 (-)	613.9 (-)	Lamaque has a three-year contract to custom mill ore for Kiena Gold Mines Limited.
Long Lac Minerals Ltd. Malartic	- (-)	6.17 (-)	- (-)	- (-)	- (-)	383 608 (-)	2 393.2 (-)	Ore custom milled by Little Long Lac Minerals Group at Les Terrains Aurifères Malartic (Quebec) Limitée Mill.

Little Long Lac Minerals Group East Malartic Mill	1 000 (590)	n.a. (5.14)	n.a. (0.55)	- (-)	- (-)	352 224 (175 798)	2 095.6 (788.6)	Treats ore from La Mine Doyon Mill expanded to nominal capacity of 1 088 tpd.
Les Terrains Aurifères Malartic (Quebec) Limitée Mill Malartic	1 000 (1 000)	n.a. (6.48)	n.a. (0.67)	- (-)	- (-)	457 060 (296 695)	2 571.9 (1 916.2)	Treated ore from Barnat Shaft and from Thompson Bousquet division of Long Lac Minerals Ltd.
Louvem Mining Company Inc. Manitou Mill	900 (900)	2.28 (1.82)	11.26 (30.38)	0.13 (0.15)	4.22 (4.00)	96 182 (224 530)	183.3 (229.9)	
Mattagami Lake Mines Limited, Matagami	4 000 (4 000)	0.62 (0.51)	19.58 (21.39)	0.75 (0.77)	4.85 (4.81)	1 203 444 (1 328 360)	230.4 (305.9)	Merged into Noranda Mines Ltd. in fall 1979.
Noranda Mines Limited Horne Mill (Chadbourne Circuit) Noranda	3 450 (1 800)	3.15 (3.74)	3.33 (3.43)	- (-)	- (-)	217 604 (257 239)	600.1 (869.3)	Handles ore from the Chadbourne Mine and from La Mine Doyon.
Northgate Patino Mines Inc. Lemoine Mill, Chibougamau	300 (300)	4.08 (5.14)	69.60 (88.80)	3.70 (4.71)	8.47 (10.00)	85 002 (104 326)	303.6 (965.6)	
Northgate Patino Mines Inc. Patino Mill	3 100 (2 500)	2.54 (2.95)	9.12 (9.22)	1.64 (1.68)	- (-)	670 753 (615 035)	1 413.1 (1 519.5)	
Sigma Mines (Quebec) Limited, Val d'Or	1 270 (1 270)	4.05 (3.94)	0.77 (0.79)	- (-)	- (-)	441 j980 (438 942)	1 745.1 (1 669.0)	Active exploration program.
Long Lac Minerals Ltd. La Mine Doyon Val d'Or	" "	4.90 n.a.	n.a. n.a.	- -	- -	525 631 (344 485)	3 393.5 (2 181.0)	173,407.5 t ore shipped to Noranda as silicious smelter flux 352 223.6 t treated at Est-Malartic Mill. Construction of 900 tpd mill on site has begun.
ONTARIO								
Campbell Red Lake Mines Limited, Red Lake	1 000 (750)	20.23 (21.87)	2.06 (2.40)	- (-)	- (-)	335 223 (275 600)	6 236.4 (5 676.9)	Planned expansion completed.
Dickenson Mines Limited, Red Lake	635 (455)	5.44 (9.26)	1.68 (1.03)	- (-)	- (-)	171 906 (116 283)	776.4 (910.7)	Expansion program delayed by cash flow problems due to lower than anticipated gold prices.
Dome Mines, Limited, South Porcupine	1 800 (1 800)	4.66 (4.53)	0.75 (0.69)	- (-)	- (-)	505 483 (615 162)	2 274.2 (2 649.9)	Mine/mill capacity being increased from 1 185 to 2 720 tpd.

TABLE 4. (cont'd.)

Company and Location	Combined Mine Capacity	Gold	Silver	Copper	Combined Lead and Zinc	Ore Treated	Gold contained in Concentrate	Remarks
	Grade of Ore Treated							
	(tonnes of ore/day)	(grams/ tonne)	(grams/ tonne)	%	%	(tonnes)	(kilograms)	
ONTARIO (cont'd.)								
Falconbridge Nickel Mines Limited, Sudbury district	10 342 (7 620)	0.07 (0.07)	3.43 (3.43)	1.01 (0.94)	- (-)	2 754 690 (2 182 765)	93.0 (75.3)	Gold and silver grades are Mineral Policy Sector estimates.
Inco Limited, Sudbury and Shebandowan districts	49 450 (49 450)	0.17 (0.17)	4.46 (4.46)	1.28 (1.30)	- (-)	9 220 048 (10 608 845)	802.5 (1 109.4)	Gold and silver grades are Mineral Policy Sector estimates.
Kerr Addison Mines Limited, Virginiatown	1 225 (1 225)	6.75 (9.60)	0.34 (0.41)	- (-)	- (-)	246 451 (194 768)	1 602.2 (1 804.5)	Limited ore reserves. Current gold prices should allow continued production through 1984.
Noranda Mines Limited Geco Division Manitouwadge	4 080 (4 535)	0.10 (0.10)	46.63 (60.69)	1.83 (1.47)	3.26 (3.46)	1 329 489 (1 358 317)	99.1 (87.4)	
Pamour Porcupine Mines, Limited, Pamour Division Timmins	2 720 (2 720)	2.54 (2.85)	0.69 (0.69)	- (-)	- (-)	921 289 (931 956)	2 053.3 (2 396.2)	Re-evaluation of ore reserves in progress.
Pamour Porcupine Mines, Limited, Schumacher Division Schumacher	2 720 (2 720)	2.29 (2.19)	4.46 (2.85)	0.23 (0.25)	- (-)	808 923 (845 982)	1 529.9 (1 550.1)	
Willroy Mines Limited, Macassa Division, Kirkland Lake	295 (320)	18.07 (16.11)	2.13 (2.74)	- (-)	- (-)	104 472 (100 675)	1 592.0 (1 554.8)	Exploration program on adjacent claim blocks.
MANITOBA - SASKATCHEWAN								
Hudson Bay Mining and Smelting Co., Limited,								
Flin Flon Mill	7 050 (7 250)	1.30 (1.30)	19.95 (19.78)	1.58 (1.67)	2.24 (2.26)	983 990 (945 379)	678.0 (725.5)	
Snow Lake Mill	3 450 (3 450)	1.03 (1.10)	12.41 (16.66)	2.56 (2.65)	2.79 (3.46)	771 427 (756 283)	430.2 (462.1)	

Inco Limited Thompson	12 700 (12 700)	0.10 (0.10)	2.74 (2.74)	0.13 (0.13)	- (-)	1 801 391 (2 557 454)	117.2 (160.5)	Gold and silver grades are Mineral Policy Sector estimates.
Sherritt Gordon Mines Limited, Fox mine, Lynn Lake	2 700 (2 700)	0.28 (0.27)	7.57 (6.51)	1.42 (1.40)	1.73 (1.56)	733 538 (784 011)	182.6 (191.3)	
Sherritt Gordon Mines Limited, Ruttan Mine Leaf Rapids	6 800 (9 100)	0.25 (0.27)	7.31 (6.51)	1.30 (1.36)	1.25 (1.02)	1 702 809 (2 311 444)	379.4 (484.2)	
BRITISH COLUMBIA								
Afton Mines Ltd., Kamloops	7 700 (7 700)	0.62 (0.65)	4.90 (5.07)	0.89 (1.05)	- (-)	2 324 121 (2 739 799)	1 103.4 (1 315.5)	
Bethlehem Copper Corporation Highland Valley	17 690 (17 690)	0.03 (0.03)	2.40 (1.78)	0.39 (0.38)	- (-)	6 496 183 (6 281 347)	82.5 (92.8)	
Brenda Mines Ltd. Peachland	27 220 (27 220)	0.02 (0.02)	1.20 (1.10)	0.14 (0.13)	- (-)	10 119 317 (9 126 857)	112.0 (85.2)	
Carolin Mines Ltd. Ladner Creek Mine Hope	1 360	0.12	0.03	-	-	-	-	Began production late 1981.
Dankoe Mines Ltd. Keremeos	400 (400)	0.48 (0.39)	190.29 136.08)	- (-)	0.21 (0.27)	37 743 (30 028)	15.6 (9.4)	
DeKalb Mining Corporation Highland Valley	635 (635)	0.34 (0.39)	17.38 (20.19)	2.06 (1.93)	- (-)	80 800 (48 234)	21.0 (17.0)	
Du Pont Canada Inc. Baker Mine	90	19.20	381.26	-	-	16 726	278.3	
Erickson Gold Mining Corp., Cassiar	110 (95)	12.86 (19.99)	7.10 (21.87)	- (-)	- (-)	34 695 (29 201)	423.7 (560.2)	Mill expanded to 155 tpd.
Esso Minerals Canada, Granduc Operating Division, Stewart	3 625 (..)	0.17 (..)	10.29 (..)	1.44	- (-)	544 576 (..)	79.1 (..)	Closed June 30, 1978. Scheduled to be re-opened by Esso Minerals Canada in 1980.
The Mosquito Creek Gold Mining Company Limited	91 (64)	14.61 (16.15)	4.22 (4.29)	- (-)	- (-)	19 081 (11 419)	250.5 (136.8)	
Newmont Mines Limited, Similkameen Division, Princeton	20 000 (20 000)	0.34 (0.34)	1.37 (1.47)	0.40 (0.46)	- (-)	6 942 923 (6 612 470)	821.5 (1 168.8)	Developing Copper Mountain orebodies.

TABLE 4. (cont'd)

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
BRITISH COLUMBIA (cont'd)								
Noranda Mines Limited, Babine Division, Bell Copper Mine	15 875 (15 420)	0.28 (0.34)	- (-)	0.48 (0.41)	- (-)	5 429 531 (5 012 196)	968.6 (797.4)	Mill expansion to be completed by 1981.
Granisle Mine Babine Lake	11 975 (11 880)	0.29 (0.21)	2.98 (2.06)	0.37 (0.39)	- (-)	3 832 518 (3 936 725)	284.5 (387.1)	
Northair Mines Ltd., Brandywine Mine	270 (270)	7.92 (8.37)	28.63 (32.33)	0.15 (0.50)	3.24 (3.59)	62 548 (71 478)	474.6 (550.5)	Ore reserves limited.
Placer Development Limited Equity Silver	5 170 (4 540)	1.10 (0.96)	143.59 (126.86)	0.36 (0.38)	- (-)	1 909 905 (448 000)	641.9 (258.2)	
Utah Mines Ltd., Island Copper Mine, Coal Harbour, Vancouver Island	37 200 (37 200)	0.21 (0.27)	1.37 (1.82)	0.43 (0.42)	- (-)	14 157 525 (13 757 175)	1 622.8 (1 779.6)	
Wesfrob Mines Limited Tasu	5 440 (5 440)	0.08 (0.07)	3.09 (3.12)	0.32 (0.27)	- (-)	1 031 909 (996 432)	72.0 (55.7)	
Westmin Resources Limited Buttle Lake, Vancouver Island	900 (900)	2.67 (2.74)	124.11 (124.11)	1.13 (1.22)	8.59 (8.81)	246 150 (278 244)	580.1 (654.8)	
YUKON TERRITORY								
Cyprus Anvil Mining Corporation	9 300 (9 300)	0.15 (0.25)	42.00 (47.01)	- (-)	7.70 (7.80)	2 751 789 (2 825 150)	356.9 (371.7)	
Hudson Bay Mining and Smelting Co., Limited Whitehorse	2 350 (2 270)	0.82 (0.96)	10.08 (10.29)	1.42 (1.58)	- (-)	726 091 (775 013)	504.5 (674.1)	

NORTHWEST TERRITORIES

Cominco Ltd., Con and Rycon mines, Yellowknife	590 (590)	14.06 (16.46)	3.43 (4.29)	- (-)	- (-)	175 994 (192 303)	2 326.5 (3 013.3)	Mine shut down for eight weeks, six weeks of which were due to a strike.
Cullaton Lake Gold Mines Ltd.	270	10.97	0.34	-	-	8 666	10.8	Began production Nov. 1981.
Discovery Mines Limited Camlaren Mill	150 (136)	55.77 (16.18)	5.14 (4.80)	- (-)	- (-)	35 997 (11 142)	498.4 (147.3)	
Giant Yellowknife Mines Limited, Yellowknife	1 100 (1 100)	6.14 (6.72)	1.23 (1.37)	- (-)	- (-)	358 235 (206 149)	1 825.0 (1 190.7)	
Lolor Mines Limited, Yellowknife	..	..	..	-	-	Included with Giant		Ore treated at Giant mill.
Supercrest Mines Limited, Yellowknife	..	..	..	-	-	Included with Giant		Ore treated 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 was 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.

[1] Average daily tonnage milled.

- Nil; .. Not applicable; n.a. Not available.

expected at 1 000 tpd in mid-1982. The Lupin project will absorb employees from the Echo Bay silver operation which is being shut down.

Arsenic[1], an unwanted byproduct from gold ores in the Red Lake area and the Yellowknife area, has for many years presented mining companies with an expensive problem of ensuring safe storage of a toxic substance. Arsenic is now being used in certain industrial processes, demand for arsenic has increased and companies are able to earn some revenue while disposing of the accumulated material.

GOLD COINS

The Royal Canadian Mint received approval from Parliament to continue the Gold Maple Leaf bullion coin program beyond the initial three-year trial period. Since the total authorized annual minting of two million coins was not met in either 1980 or 1981, it was deemed sufficient to authorize a minting of one and a half million coins per year, which would just absorb Canada's annual gold output if no gold was diverted to other uses. In 1981 863,000 gold bullion coins were sold compared to 1.215 million in 1980 and 1 million in 1979. Sales during the first part of the year were limited by the high price, but as the price of gold fell, the sales picture improved.

In the numismatic field, the Mint produced a 22 karat gold proof coin commemorating the adoption of O Canada as the Canadian national anthem. The coin is 27 mm in diameter and weighs 16.956 g, 15.551 g of which are gold. The issue, with a face value of $100, is limited to 250,000 coins and the selling price was fixed at $C 295.

INTERNATIONAL DEVELOPMENTS

Mine development activity in Canada was paralleled in other parts of the world having known gold fields and an economic climate favourable to mining. A number of mine openings were reported from the western United States. Canadian mining companies are very active in U.S. gold mining. The major developed reported from South Africa was the merger of the East Driefontein Mine and West Driefontein Mine to make optimal use of the facilities at both properties and facilitate development of the adjacent North Driefontein property. The most dramatic increase in output has occurred in Brazil where thousands of individuals - garimpieros - work the placer deposits. The major placer development was the Serra Pelada, discovered in January 1980, which may already have produced 15 t of gold.

During the development of its El Indio gold-silver-copper mine in Chile, St. Joe Minerals Corporation encountered a high grade section reported at 47 491 t grading 357.68 g/t Au, 143.07 g/t Ag and 2.63 per cent Cu. The reserves of the main orebody are estimated at 3.1 million t containing 12.0 g Au, 143.07 g Ag and 3.5 per cent Cu per metric ton.

World gold production in 1981 was approximately the same as in 1980. Lower production in South Africa was offset by new production from countries in which gold mining was dormant until the price surge of 1979-80.

Republic of South Africa. South African gold production in 1981 was 657.6 t, down 2.6 per cent from 1980 (Table 5). The decline resulted from the reduction of the cut-off grade required by South African mining law in response to the higher prices that prevailed in 1980. Revisions of mining plans are time-consuming and the mines completed the changes and began mining to the new reserve limits in time to be caught by the fall that characterized gold prices during 1981. For the first half of 1981 the industry was sustained by a weakening of the rand against the U.S. dollar. However in the second half, a number of the companies posted losses and several applied for aid under the state mining assistance act. Mining plans are once again being revised and some difficulty is evident in financing the expansion and modernization projects under way at a number of the major producers. The expansion programs consist mainly of new shaft sinking to increase capacity and obtain access to new blocks of ore. Some existing shafts are being deepened.

Australia. Mine production of gold in 1981 is estimated at 16 230 kg, 5 per cent below that in 1980. Major producers recorded lower head grades although ore throughput remained of the same order. Despite falling prices, exploration, new development and re-development continued at a reasonable level with the major emphasis in Western Australia and Queensland. Minting of the Australian $200 gold coin continued during 1981 although no proof coins were issued.

[1] See arsenic review for details.

TABLE 5. GOLD MINE PRODUCTION IN THE NON-COMMUNIST WORLD

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
						(tonnes)					
South Africa	976.3	909.6	855.2	758.6	713.4	713.4	699.9	706.4	705.4	675.1	657.6
Canada	68.7	64.7	60.0	52.2	51.4	52.4	54.0	54.0	51.1	50.6	49.5
United States	46.4	45.1	36.2	35.1	32.4	32.2	32.0	30.2	30.2	27.6	40.6
Other Africa:											
Ghana	21.7	22.5	25.0	19.1	16.3	16.6	16.9	14.2	11.5	12.8	13.6
Zimbabwe	15.0	15.6	15.6	18.6	18.6	17.1	20.0	17.0	12.0	11.4	11.6
Other	2.5	1.7	1.7	1.5	1.5	1.5	1.5	2.0	2.5	8.0	12.0
Zaire	5.4	2.5	2.5	4.4	3.6	4.0	3.0	1.0	2.3	3.0	3.2
Total Other Africa	44.6	42.3	44.8	43.6	40.0	39.2	41.4	34.2	28.3	35.2	40.4
Latin America:											
Brazil	9.0	9.5	11.0	13.8	12.5	13.6	15.9	22.0	25.0	35.0	35.0
Colombia	5.9	6.3	6.7	8.2	10.8	10.3	9.2	9.0	10.0	17.0	17.7
Dominican Republic	-	-	-	-	3.0	12.7	10.7	10.8	11.0	11.5	12.8
Chile			3.2	3.7	4.1	3.0	3.0	3.3	4.3	6.5	11.4
Other	8.2	9.0	4.7	2.2	1.9	5.0	5.0	5.2	4.2	3.5	5.4
Peru	3.0	2.6	2.6	2.8	2.7	3.0	3.4	3.9	4.7	5.0	7.2
Mexico	4.7	4.6	4.2	3.9	4.7	5.4	6.7	6.2	5.5	5.9	5.0
Nicaragua	3.3	2.8	2.8	2.4	1.9	2.0	2.0	2.3	1.9	1.5	1.6
Total Latin America	34.1	34.8	35.2	36.9	41.8	55.0	55.9	62.7	66.6	85.9	96.1
Asia:											
Philippines	19.7	18.9	18.1	17.3	16.1	16.3	19.4	20.2	19.1	22.0	24.9
Japan	8.2	7.8	6.2	4.5	4.7	4.5	4.8	4.7	4.2	3.4	3.1
India	3.7	3.3	3.3	3.2	3.0	3.3	2.9	2.8	2.7	2.6	2.6
Other	2.1	2.7	2.7	2.7	2.7	3.0	3.0	3.0	3.0	3.0	3.8
Total Asia	33.7	32.7	30.3	27.7	26.5	27.1	30.1	30.7	29.0	31.0	34.5
Europe	7.6	13.2	14.3	11.6	11.0	11.4	13.2	12.5	10.0	8.6	8.5
Oceania:											
Papau/New Guinea	0.7	12.7	20.3	20.5	17.9	20.5	22.3	23.4	19.7	14.3	17.2
Australia	20.9	23.5	17.2	16.2	16.3	15.4	19.2	20.1	18.3	17.0	16.2
Other	2.8	3.2	2.8	2.2	2.2	2.3	1.8	1.1	1.0	1.0	1.1
Total Oceania	24.4	39.4	40.3	38.9	36.4	38.2	43.3	44.6	39.0	32.3	34.5
TOTAL	1 235.8	1 181.8	1 116.3	1 004.6	952.9	968.9	969.8	975.3	959.6	946.3	961.6

Source: Consolidated Gold Fields PLC, **Gold 1982,** p. 16.
- Nil.

United States. A sharp jump in mine production in the United States from 27.6 tin 1980 to 40.6 t in 1981 is attributed in part to the fact that in 1981 a number of small producers were found not to have reported production in previous years. Statistics for past years will likely have to be adjusted. As well, a number of new mines began producing and several recently opened projects attained rated capacity. Placer activity was strong, particularly in Alaska and California.

The Philippines. Gold output in the Philippines in 1981 was 25 t, of which 9 t was primary production, 15 t was byproduct or coproduct production from base-metal mines, and 1 t was from alluvial sources. The production costs of Philippine mines tend to be high due to low grades and the complexity of the ores.

Papua-New Guinea. Output of both gold and copper from the Bougainville Copper Limited mine increased in 1981 as a higher average grade was mined during the year. This will probably not continue in 1982. Construction of facilities for the Ok Tedi mine began in August 1981 with production scheduled for 1984. Until 1986 the mine will produce about 15 tpy of gold, declining thereafter as copper becomes the major product.

U.S.S.R. Gold production in the Soviet Union has been estimated by Consolidated Gold Fields Limited at between 280 and 350 t. In various articles from 1979 through 1981, Gold Fields has described some of the major producing facilities and areas and made an estimate (63 t) of the amount of gold recovered from base-metal operations. In 1980 Soviet gold sales were estimated at 80 t and it was assumed that the target for foreign exchange had been achieved by selling a relatively small amount of gold at the prevailing high price. The pattern held for the first half of 1981 with relatively modest sales that, if maintained, would have led to sales of about 90 t for the year. However, a poor grain harvest and the Polish crisis resulted in heavy sales into a weak market, thereby exerting downward pressure on the price. Total Soviet sales for 1981 are now estimated at 280 t.

GOLD SALES FROM OFFICIAL RESERVES

There were no sales from International Monetary Fund stocks during the year and there does not appear to be any interest on the part of members in establishing a new sales program. In June 1981 the United States government established a Gold Commission to "conduct a study to assess and make recommendations with regard to the policy of the U.S. government concerning the role of gold in domestic and international monetary systems". In its report, the Commission supported the sale of gold medallions by the Treasury and suggested the establishment of a bullion coin program. None of the members felt that U.S. gold stocks, which amount to 8 210 t, should be disposed of entirely but a minority felt that stocks should be maintained at this level with a view to possible reestablishment of gold in the monetary system. With respect to adoption of some form of gold standard, the Commission concluded that this would not be a fruitful method of dealing with inflation and that the technical difficulties of implementing some form of gold standard were insurmountable given the present state of world monetary disarray.

In contrast to other central banks, the Bank of Canada continued to dispose of gold from Canada's monetary reserves. Approximately 24 882 kg were sold in 1981, completing the sales program covering 62 206 kg begun in 1980.

ADDITIONS TO OFFICIAL RESERVES

Net additions to official reserves during 1981 are estimated at 136 853 kg, about half the level of official purchases during 1980. South Africa was unable to add to official reserves in 1981 due to its unfavourable balance of payments situation. Toward the end of the year, the Reserve Bank engaged in swaps whereby it sold gold to banking houses for cash while retaining the option of repurchasing it at a later date.

Eighty-five per cent of the official gold reserves are held by western industrialized countries and in such countries gold is a dominant component of central bank reserves, accounting for roughly 50 per cent of total reserves if assessed at market value in mid-1981. In addition to the western industrialized nations, the central banks of the oil exporting nations which, as a group have had current account surpluses since 1973, have added substantially to official reserves.

PRICES

The opening fixing of the London Gold Market on January 5, 1981 was $US 592, near the high for the year recorded the following day. By the end of January, the price had fallen to the $500 mark around which it moved in a \$480-\$520 range until June when the decline resumed. In July, the price fell below \$400 per ounce before recovering to the \$425 range. In September and October, the price held around the \$450 level but returned to the \$400 level in November and December. Compared to 1980, this was a dismal performance and was greeted with some pain in mining and marketing circles. The average price for 1981 was \$US 459.71 per ounce compared with an average of \$614.21 in 1980 and \$306.70 in 1979. The equivalent Canadian dollar gold price based on the average currency exchange differential was \$551.12per ounce compared with \$716.26 in 1980 and \$359.25 in 1979.

TABLE 6. AVERAGE ANNUAL PRICE OF GOLD, 1970 AND 1975-81

	London Gold Market[1]	
	\$US	equiv. \$Cdn
		(per troy ounce)
1970	35.97	37.55
1975	161.018	163.781
1976	124.836	123.107
1977	147.718	157.089
1978	193.228	220.407
1979	306.686	359.289
1980	612.562	716.087
1981P	459.715	551.178

[1] Annual average of London Gold Market afternoon fixing price, as reported by Sharpes Pixley Ltd.
P Preliminary.

USES AND CONSUMPTION[1]

The use of new gold for jewellery, coin and industrial purposes recovered from a total of 542 t in 1980 to 1 036 t in 1981. The net fabrication of new gold into carat jewellery increased by 400 per cent to 594 t in 1981. Jewellery sales remained disappointing for the first half of the year but as the price of gold stabilized around \$400 and the sale of old jewellery diminished, some rebuilding of stocks took place to meet anticipated Christmas demand. This demand was slow to develop in the industrialized countries but in the Middle and Far East buyers rushed to replace jewellery they had sold at peak prices in 1980. Some of the sales of small bars, coins and fake coins in the Middle East could be classified as hoarding because they are attached to bracelets or chains and worn as jewellery, so the two markets overlap. In Europe, the Italian jewellery manufacturing industry revived substantially but there was only a slight improvement in the United Kingdom, France and Switzerland, and none in West Germany or Spain. Demand from the Middle East and South America for Italian jewellery remains strong in 1982. In North America, demand for jewellery improved somewhat during the third quarter but tapered off again as the dimensions of the recession became apparent. Demand for class rings, which almost disappeared in 1980, revived slightly. More jewellery is being sold through high volume, low mark-up chain stores and catalogue showrooms and less emphasis is being placed on low volume, high mark-up shops.

In the Middle East, dishoarding of jewellery nearly ceased during 1981, the exceptions being Turkey and Iran where dishoarding was prompted by political events. Early 1981 was marked by trading of "old models" for new while, as the year progressed and prices fell, actual reinvestment in gold jewellery occurred. In the Far East, major demand developed in Hong Kong, Indonesia and Japan. In Japan, bullion imports increased from 32 t in 1980 to 167 t in 1981, of which 34 t were used in the fabrication of carat jewellery. The Japanese were also heavy purchasers of one-tenth and one-quarter ounce Krugerrands which were often set in frames to be worn as jewellery. The outlook for jewellery fabrication worldwide in 1982 is mixed. The lower gold price makes gold jewellery more affordable; however, the global recession is cutting into disposal incomes particularly the amount available for such non-essential purchases.

Electronics. During the price escalation of 1979 and 1980 most manufacturers of electronic components tried to reduce the amount of gold required by improving plating techniques, designing smaller components, substituting non-gold alloys and improving scrap recovery from obsolete equipment. The effects of this program remain in evidence despite the moderation in the gold price. In 1981, 85.2 t of gold were used in electronics compared to 85.5 t in 1980. Strong sales of electronic components offset the trend to lower gold use, a circumstance that may not persist in 1982 if economic conditions continue to deteriorate.

[1] Much of the information in this section was obtained from Consolidated Gold Fields PLC, **Gold 1982.** It does not include Comecon countries or The Peoples' Republic of China due to lack of data.

Dentistry. In most countries, demand for gold dental work continued to diminish in 1981. However, in Japan gold offtake for dental purposes increased from 5.9 t in 1980 to 10.2 t in 1981. Thus, the overall dental gold offtake fell only marginally, from 62.1 t in 1980 to 61.7 t in 1981. A trend to substitution of non-gold alloys and ceramics has slowed as concern has been expressed that some of the substitutes may pose a health hazard.

In 1981, a total of 66.1 t of gold were used in other industrial applications such as decorative platings and industrial and laboratory chemicals.

Fabrication of medals, medallions and fake coins declined from 36 t in 1980 to 28 t in 1981. In part, this reflects the failure of the United States American Arts Commemorative Series medallion program which suffered from an unwieldy marketing system. Fake coins are still popular in the Middle East, although they face competition from bullion coins and small gold bars.

Major producers of official coins were South Africa, Mexico, the United Kingdom, Canada and Taiwan. World production for 1981 was 226.7 t compared to 240.2 t in 1980. The Krugerrand accounted for nearly half of official coin production. In October, Mexico began minting a series of one ounce, half ounce and quarter ounce coins that will compete directly with the Krugerrand series. The United Kingdom minted 28 t of sovereigns. Taiwan issued a special gold coin to commemorate the seventieth anniversary of the founding of the Republic in one ounce, half ounce, and quarter ounce sizes. Sales of coins are reported as good, although there was substantial resale back into the market as the gold price fell.

INVESTMENT DEMAND

The practice of buying high carat jewellery as a form of investment, common in the Middle East, has already been discussed. Small bars have also been mentioned as they impinge on the jewellery market. Bar hoarding, in which the bars are not incorporated into jewellery items, is difficult to quantify but Consolidated Gold Fields estimates that at least 280 t were absorbed in small bar hoards in 1981. As the price of gold fell, the trade in small bars became quite brisk, particularly in areas of the world where there was an element of political uncertainty. However, small bar hoarders do not apparently have the power to influence the market and drive up prices comparable to that wielded by spectators acting in unison in response to perceived market signals.

Institutional and large scale investor demand was effectively negative during 1981; Consolidated Gold Fields estimates disinvestment at about 330 t. Aside from the negative factors, such as high interest rates, many investors had not recovered theirconfidence after buying near the peak price in 1980. As well, investment from the Middle East was limited by the attractive opportunities offered by the expanding economies in that area.

OUTLOOK

The 10 years since the formal monetary link to gold was abolished by the U.S. government have been sufficient to establish that the free market gold price is cyclical. However, the period of the cycle has not been established, nor has it become clear what the links are between the price of gold and various economic and political factors. The theory that the price of gold was tracking world oil prices, popular in 1979 and early 1980, has become less credible when the slump in gold prices far surpassed a decline in oil spot market prices. Also, the theory that poor economic conditions mean strong gold prices has not held up well in 1981. Some link probably exists between high interest rates and low gold prices as people prefer to receive interest payments rather than wait for a capital gain that might be a long time in coming. The "world anxiety coefficient" has been high throughout 1981, with acts of terrorism, local wars and an apparent arms race between the superpowers all being contributing factors; however, the impact on the price of gold, supposedly sensitive to such things, has been negligible. Nor has the price responded to diminished supplies as official sales ceased, dishoarding slowed and mine output fell as producers mined lower grade ore. There was one definite correlation; the price of gold fell as the U.S. dollar strengthened.

The price decline has not had a negative effect on major gold mine development programs. Most of these have sound financial backing, the developers recognize that the free market price of gold will fluctuate, and they anticipate being in production in time to catch the next upswing in the cycle. No one is willing to predict when the next upswing will come but the outlook for the price in the first half of 1982 suggests that it will remain in the range $US 350 to $US 450.

Gypsum and Anhydrite

D.H. STONEHOUSE

SUMMARY

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.

Production of gypsum has related closely to activity in the building construction sector where wallboard, the principal gypsum product, is used in both residential and nonresidential buildings. There has been a trend toward the use of relatively more gypsum wallboard in institutional and commercial buildings because of its fire retardant qualities. This, together with increasing amounts being used in retrofit applications, make it inaccurate to relate wallboard requirements directly to housing starts as was once possible.

Production and exports of gypsum from Canadian sources were high during the first three quarters of 1981 and the industry, up to that point, was hopeful of recovering from a rather disappointing 1980. However the demand from the U.S. building industry was suddenly reduced and total shipments for the year were not improved. In particular shipments were reduced from Ontario operations and from New Brunswick where Canadian Gypsum Company, Limited closed its quarry and wallboard plant late in 1980.

THE CANADIAN SCENE

Close to 70 per cent of the crude gypsum produced in Atlantic Canada, which is Canada's principal gypsum-producing region, is shipped to company wallboard plants in the eastern United States from Canadian subsidiary operations. The remainder is shipped up the St. Lawrence River to both wallboard and cement plants. New Brunswick production is used locally, 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 in British Columbia, supply the prairie and British Columbia markets. Imports from Mexico are used by both wallboard and cement producers in British Columbia.

Domtar Inc.'s new wallboard plant at Caledonia, Ontario began production during 1980. The new plant incorporates an energy- and labour-saving, one step, grinding and calcining technique to produce stucco. Domtar's long-term plans include development of a new underground mine at Caledonia.

Although there has not been the same tendency among Canadian companies in the gypsum industry as there has been in the cement industry to look to the United States for expansion opportunities, one company, Domtar Inc., acquired the gypsum wallboard assets of Kaiser Gypsum Co. in Long Beach and San Leandro, California in 1978. Subsequently, in 1981, its U.S. subsidiary purchased the gypsum deposits and wallboard plant of Grand Rapids Gypsum Co. for \$2.7 million, and also completed construction of a new wallboard plant at Tacoma, Washington.

TABLE 1. CANADA, GYPSUM PRODUCTION AND TRADE, 1980 AND 1981

	1980		1981P	
	(tonnes)	($)	(tonnes)	($)
Production (shipments)				
Crude gypsum				
Nova Scotia	4 988 000	22,457,000	5 559 000	28,990,000
British Columbia	784 000	5,822,000	700 000	5,880,000
Ontario	740 000	5,729,000	688 000	5,353,000
Newfoundland	635 000	4,312,000	669 000	4,683,000
Manitoba	144 000	1,009,000	166 000	1,417,000
New Brunswick	45 000	210,000	18 000	87,000
Total	7 336 000	39,539,000	7 800 000	46,410,000
Imports				
Crude gypsum				
Mexico	119 693	2,759,000	126 165	3,467,000
United States	35 024	795,000	17 197	393,000
Hong Kong	-	-	117	2,000
Total	154 717	3,554,000	143 479	3,862,000
Plaster of paris and wall plaster				
United States	18 790	2,906,000	18 593	3,295,000
France	33	6,000	126	36,000
United Kingdom	25	3,000	32	35,000
Italy	11	2,000	46	19,000
Other countries	43	8,000	54	12,000
Total	18 902	2,925,000	18 851	3,397,000
	(square metres)		(square metres)	
Gypsum lath, wallboard and basic products				
United States	446 856	956,000	470 141	806,000
West Germany	-	-	1 114	2,000
Total	446 856	956,000	471 255	808,000
Total imports gypsum and gypsum products		7,435,000		8,067,000
	(tonnes)		(tonnes)	
Exports				
Crude gypsum				
United States	4 960 240	25,671,000	5 080 608	27,551,000
Bahamas	-	-	14 238	107,000
Total	4 960 240	25,671,000	5 094 846	27,658,000
	(square metres)		(square metres)	
Gypsum lath, wallboard and basic products				
United States	13 995 823	11,322,000	10 630 271	8,287,000
Netherlands	572 457	555,000	331 421	358,000
Saudi Arabia	84 829	106,000	201 229	325,000
Other countries	117 898	145,000	281 055	312,000
Total	14 771 007	12,128,000	11 443 976	9,282,000
Total exports of gypsum and gypsum products		37,799,000		36,940,000

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

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 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, Loos, and Falkland in British Columbia; on the shores of Great

TABLE 2. CANADA, SUMMARY OF GYPSUM MINING OPERATIONS, 1981

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		
Canadian Gypsum Company, Limited	Hagersville	Underground mining of gypsum
Domtar Inc.	Caledonia	Underground mining of gypsum
Westroc Industries Ltd.	Drumbo	Underground mine development
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

Source: Energy, Mines and Resources Canada.

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.

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. In 1981 about 5 million square feet with a total value of less than $1 million was imported. Companies well situated for export trade are shipping some products offshore.

TABLE 3. CANADA, SUMMARY OF GYPSUM PRODUCTS OPERATIONS, 1981

Company	Location	Remarks
Newfoundland		
Atlantic Gypsum Limited	Corner Brook	Gypsum products manufacture
Nova Scotia		
Domtar Inc.	Windsor	Gypsum plaster manufacture
Quebec		
Canadian Gypsum Co., Ltd.	Montreal	Gypsum products manufacture
Canadian Gypsum Co., Ltd.	St.-Jerome	Gypsum products manufacture
Domtar Inc.	Montreal	Gypsum products manufacture
Westroc Industries Ltd.	Ste. Catherine d'Alexandrie	Gypsum products manufacture
Ontario		
Canadian Gypsum Co., Ltd.	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

Source: Energy, Mines and Resources Canada.

USES

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.

TABLE 4. WORLD PRODUCTION OF GYPSUM, 1980 AND 1981

	1980	1981[e]
	(000 tonnes)	
United States	11 227	10 900
Canada	7 336	7 800
France	5 987	6 200
U.S.S.R.	5 897	6 100
Spain	5 498	5 700
Iran	3 538	3 600
United Kingdom	3 266	3 400
West Germany	2 250	2 400
People's Republic of China	1 996	2 100
Mexico	1 709	1 700
Italy	1 642	1 700
Other market economy countries	17 938	18 800
Other central economy countries	2 866	3 000
World total	71 150	73 400

Sources: Energy, Mines and Resources Canada; United States Bureau of Mines Mineral Commodity Summaries, January 1982.
[e] Estimated.

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 5. CANADA, GYPSUM PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975-81

	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
1976	6 002 154	54 770	3 798 243	2 258 681
1977	7 233 931	24 042	4 994 323	2 263 650
1978	8 074 441	70 995	5 178 631	2 966 805
1979	8 098 166	152 953[r]	5 474 765	2 776 354[r]
1980	7 336 000	154 717	4 960 240	2 530 477
1981P	7 800 000	143 479	5 094 846	2 848 633

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; [r] Revised.

TABLE 6. CANADA, HOUSE CONSTRUCTION*, BY PROVINCE, 1980 AND 1981

	Starts			Completions			Under Construction		
	1980	1981	% Diff.	1980	1981	% Diff.	1980	1981	% Diff.
Newfoundland	1,775	1,504	-15.3	1,106	1,721	+55.6	1,548	1,316	-15.0
Prince Edward Island	96	19	-80.2	264	32	-87.9	16	3	-81.3
Nova Scotia	2,062	2,050	-0.6	2,821	2,237	-20.7	1,491	1,245	-16.5
New Brunswick	776	586	-24.5	952	787	-17.3	512	272	-46.9
Total (Atlantic Provinces)	4,709	4,159	-11.7	5,143	4,777	-7.1	3,567	2,836	-20.5
Quebec	23,064	23,121	+0.2	26,826	24,554	-8.5	11,476	10,290	-10.3
Ontario	35,432	45,399	+28.1	47,803	42,010	-12.1	28,544	31,304	+9.7
Manitoba	1,723	2,191	+27.2	3,697	3,477	-6.0	1,981	589	-70.3
Saskatchewan	4,018	4,407	+9.7	5,855	5,963	+1.8	3,839	2,237	-41.7
Alberta	25,730	33,172	+28.9	27,293	29,460	+7.9	17,676	20,547	+16.2
Total (Prairie Provinces)	31,471	39,770	+26.4	36,845	38,900	+5.6	23,496	23,373	-0.5
British Columbia	30,337	29,992	-1.1	24,379	27,714	+13.7	17,112	17,712	+3.5
Total Canada	125,013	142,441	+13.9	140,996	137,955	-2.2	84,195	85,515	+1.6

Source: Statistics Canada.

* For centres of 10,000 population and over.

TABLE 7. CANADA, VALUE OF CONSTRUCTION[1] BY TYPE, 1980-82

	1980	1981	1982
		($ millions)	
Building Construction			
Residential	13,872	16,360	16,397
Industrial	3,005	3,425	3,524
Commercial	5,912	7,163	7,945
Institutional	2,157	2,451	2,751
Other building	1,594	1,872	2,023
Total	26,540	31,271	32,640
Engineering Construction			
Marine	269	336	419
Highways, airport runways	3,731	4,313	4,429
Waterworks, sewage systems	1,997	2,127	2,396
Dams, irrigation	202	257	336
Electric power	4,297	4,981	5,900
Railway, telephones	1,851	2,165	2,612
Gas and oil facilities	6,709	7,718	9,675
Other engineering	2,731	3,789	5,151
Total	21,787	25,686	30,918
Total construction	48,327	56,957	63,558

Source: Statistics Canada.
[1] Actual expenditures 1980, preliminary actual 1981, intentions 1982.

OUTLOOK

Building construction expenditures were over $31 billion in 1981 and are expected to increase by about 5 per cent to more than $32.6 billion in 1982. Total construction will likely reach $63.5 billion in 1982 from just about $57 billion in 1981. 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.

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 1981**, production of anhydrite in that year was 174 287 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	5.5¢	12.5¢	free
29400-1	Gypsum, ground, not calcined	free	free	15%	free
28410-1	Gypsum tile	14.3%	13.6%	25%	9.0%

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

	1981	1982	1983	1984	1985	1986	1987
29300-1	5.5¢	5.3¢	5.0¢	4.8¢	4.5¢	4.3¢	4.0¢
28410-1	13.6%	12.8%	12.1%	11.4%	10.7%	9.9%	9.2%

UNITED STATES (MFN)

Item No.		
512.21	Gypsum crude	free

Item No.		1981	1982	1983	1984	1985	1986	1987
512.24	Gypsum, ground calcined, per ton	55¢	53¢	50¢	48¢	46¢	44¢	42¢
245.70	Gypsum or plastic building boards and lath, ad valorem	5.1%	4.7%	4.2%	3.8%	3.3%	2.9%	2.4%

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

TABLE 1. CANADA, IRON ORE PRODUCTION AND TRADE, 1980 AND 1981

	1980		1981P	
	(tonnes)[1]	($)	(tonnes)[1]	($)
Production (mine shipments)				
Newfoundland	24 620 000	895,558,000	26 008 000	1,058,275,000
Quebec	17 449 000	531,011,000	17 970 000	588,009,000
Ontario	6 345 000	260,676,000	5 267 000	247,213,000
British Columbia	654 000	13,670,000	599 000	24,117,000
Total[2]	49 068 000	1,700,915,000	49 844 000	1,917,614,000
Imports				
Iron ore				
United States	5 653 297	262,511,000	5 534 198	287,240,000
Brazil	221 995	7,417,000	257 877	7,675,000
Italy	-	-	73	6,000
Netherlands	-	-	5	5,000
Total	5 875 292	269,928,000	5 792 153	294,926,000
Exports				
Iron ore, direct shipping				
United States	2 792 834	51,253,000	2 269 602	44,429,000
Italy	445 237	8,362,000	501 050	9,399,000
Belgium and Luxembourg	133 956	2,478,000	114 551	2,202,000
Total	3 372 027	62,093,000	2 885 203	56,030,000
Iron ore, concentrates				
United States	3 712 646	107,438,000	3 760 615	125,438,000
Netherlands	5 205 255	109,509,000	4 356 760	95,981,000
Japan	3 806 857	73,677,000	4 105 213	82,235,000
United Kingdom	1 833 364	38,781,000	3 752 617	81,950,000
West Germany	1 226 886	26,423,000	1 498 716	33,106,000
Italy	1 296 792	26,816,000	1 165 567	26,230,000
France	1 653 086	35,146,000	974 365	23,097,000
Belgium and Luxembourg	328 266	7,366,000	732 814	19,514,000
Philippines	202 895	3,195,000	452 575	8,881,000
Yugoslavia	411 822	9,135,000	259 090	5,957,000
Austria	180 302	3,933,000	106 314	2,314,000
Portugal	97 263	3,116,000	49 858	1,241,000
Other countries	167 086	3,935,000	236 803	5,355,000
Total	20 122 520	448,470,000	21 451 307	511,299,000
Iron ore, agglomerated				
United States	10 750 661	508,302,000	13 198 629	695,065,000
United Kingdom	1 853 984	85,593,000	2 080 354	109,797,000
Netherlands	1 005 918	48,921,000	736 356	37,585,000
West Germany	1 031 582	49,477,000	478 024	25,724,000
Italy	311 212	13,064,000	403 321	18,460,000
Yugoslavia	100 007	4,529,000	130 019	6,715,000
Other countries	466 076	20,528,000	72 700	3,884,000
Total	15 519 440	730,414,000	17 099 403	897,230,000
Iron ore, nes				
United States	6 934	305,000	8 639	495,000
United Kingdom	-	-	7 277	284,000
Total	6 934	305,000	15 916	779,000

TABLE 1. (cont'd.)

	1980		1981P	
	(tonnes)[1]	($)	(tonnes)[1]	($)
Total exports, all classes				
United States	17 263 076	667,298,000	19 237 485	865,427,000
United Kingdom	3 687 348	124,374,000	5 947 522	193,949,000
Netherlands	6 211 173	158,430,000	5 093 116	133,566,000
Japan	3 988 366	81,154,000	4 105 213	82,235,000
West Germany	2 258 468	75,900,000	1 976 740	58,830,000
Italy	2 053 241	48,242,000	2 069 938	54,089,000
Belgium and Luxembourg	581 811	15,462,000	805 514	23,398,000
France	1 786 478	41,308,000	974 365	23,097,000
Yugoslavia	511 829	13,664,000	389 109	12,672,000
Other countries	679 132	15,450,000	852 827	18,075,000
Total	39 020 922	1,241,282,000	41 451 829	1,465,338,000
Consumption of iron ore at Canadian iron and steel plants	16 574 155	..	15 207 691	..

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.

ONTARIO: The Inco Limited pellet plant at Copper Cliff remained idle in 1981 and the company did not plan to reopen it in 1982.

The Griffith mine suspended all operations for three weeks beginning December 18, 1981 as a result of the strike at Stelco's steel plants.

The Algoma Ore division of The Algoma Steel Corporation, Limited, Adams and Sherman mines operated at close to capacity during the year.

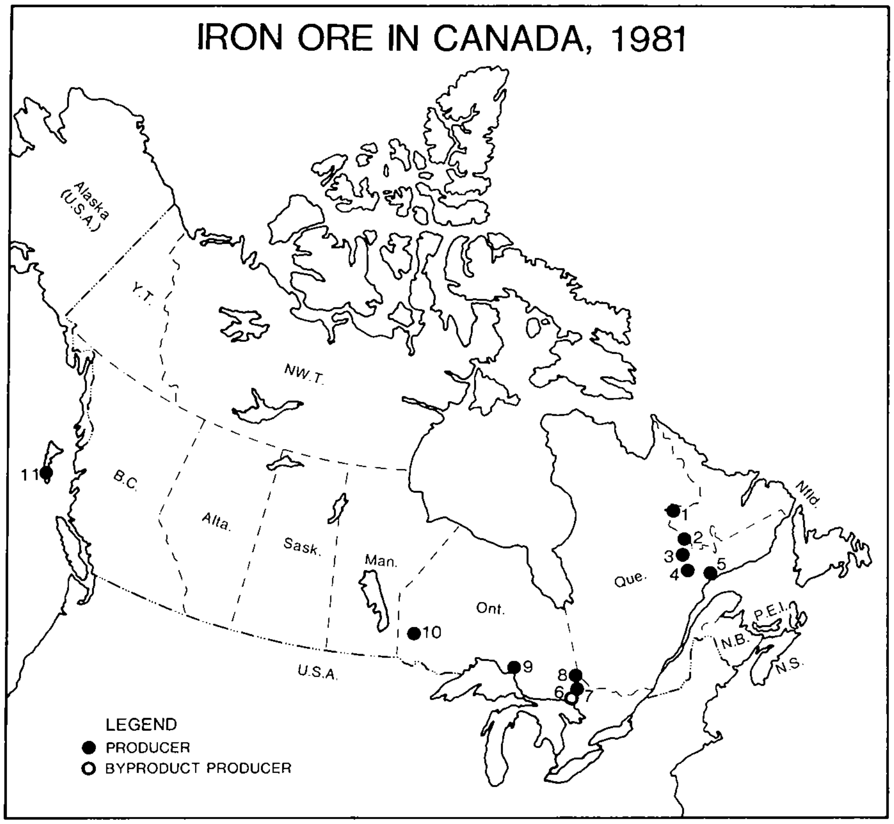
BRITISH COLUMBIA: Small tonnages of byproduct iron ore concentrates and byproduct concentrates continued to be produced respectively by Wesfrob Mines Limited, and Craigmont Mines Limited.

OTHER DEVELOPMENTS: Tolls on the Montreal-Lake Ontario section of the St. Lawrence Seaway are expected to be raised in 1982 and 1983. If the tolls are raised they will increase the cost of transporting iron ore on the Seaway from $1.09 a t in 1981, to $1.21 in 1982, and to $1.27 in 1983. It was reported that the increases were needed to offset deficits forecast for the 1981-83 period as a result of lower traffic and increased costs of operation.

A new oil and gas agreement was signed during the year between Ottawa and the Government of Alberta. Based upon price schedules for crude oil under the new agreement, the price of bunker "C" oil is forecast to increase from $153/m^3 in January 1981 to $390/m^3 on July 1, 1986. Assuming the production of one t of pellets from concentrates requires 0.85GJ, the cost of oil per t of pellets will increase from $3 in 1981 to $7.68 in 1986. This represents an annual compound increase of about 20 per cent.

In May 1981 the Transportation Fuel Cost Recovery Charge (TFCRC) was imposed by the federal government on marine and aviation transportation engaged in international transport. The charge, designed to recover the subsidized cost of fuel used by vessels and aircraft on routes to foreign destinations closed the gap between Canadian and world fuel costs in this application. In the past, these carriers took on fuel in Canada at prices subsidized by the federal government. The charge affects all iron ore shipped from Canada to U.S. Great Lakes ports*. However, due to

* All the ships transporting Quebec-Labrador ore to the U.S. Great Lakes ports are Canadian-owned.



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)
7. Sherman Mine of Dofasco Inc. (Temagami)
8. Adams Mine of Dofasco Inc. (Kirkland Lake)
9. Algoma Ore division of The Algoma Steel Corporation, Limited (Wawa)
10. The Griffith Mine (Bruce Lake)
11. Wesfrob Mines Limited (Moresby Is.)

Byproduct producers

6. Inco Limited (Copper Cliff)

TABLE 2. CANADA, IRON ORE PRODUCTION (SHIPMENTS), 1979-81

Company and Location	Ore Mined	Product Shipped	1979	1980	1981
			(000 tonnes, natural wt)		
Adams Mine, Kirkland Lake, Ont.	Magnetite	Pellets	1 242	1 213	1 231
Algoma Ore division of The Algoma Steel Corp. Ltd., Wawa, Ont.	Siderite	Sinter	1 711	1 500	1 485
Caland Ore Co. Ltd., Atikokan, Ont.	Hematite and goethite	Pellets	832	534	-
		Concentrate	303	639	-
Griffith Mine, Bruce Lake, Ont.	Magnetite	Pellets	1 530	1 520	1 537
Iron Ore Company of Canada, Schefferville, Que.	Hematite, goethite and limonite	Direct shipping	4 087	3 251	2 833
Carol Lake, Lab.	Specular hematite and magnetite	Concentrate	8 363	6 963	7 091
		Pellets	10 649	8 430	10 057
Sept Iles, Que.	Schefferville "treat ore"	Pellets	4 731	2 808	1 348
National Steel Corporation, Capreol, Ont.	Magnetite	Pellets	231	-	-
Quebec Cartier Mining Company, Mount Wright, Que.	Specular hematite	Concentrate	14 809	11 970	13 139
Sidbec-Normines Inc. Fire Lake and Lac Jeannine, and Port Cartier, Que.	Specular hematite	Concentrate	100	95	50
		Pellets (standard)	3 358	2 850	3 501
		Pellets (low silica)	731	1 354	1 343
Sherman Mine, Temagami, Ont.	Magnetite	Pellets	947	1 078	1 142
Steep Rock Iron Mines Ltd., Atikokan, Ont.	Hematite	Pellets	985	-	-
Wabush Mines, Wabush, Labrador and Pointe Noire, Que.	Specular hematite and magnetite	Pellets	5 539	4 855	4 791
Wesfrob Mines Limited, Queen Charlotte Islands, B.C.	Magnetite	Pellet feed	588	611	529
		Fine magnetite	-	24	38
Byproduct producer					
Inco Limited Sudbury, Ont.	Pyrrhotite	Pellets	135	66	180
Total			60 871	49 761	50 295

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

numerous complaints by Canadian shipowners and shippers, the charge was being reviewed by the government at the end of the year.

A feasibility study on shipping iron ore concentrates from Melville Peninsula in the Northwest Territories was completed during the year by Melville Shipping Ltd. of Montreal for Borealis Exploration Limited of Calgary. The study concluded that it is technically and logistically feasible to ship some 5 million tpy of iron ore during the 62 day navigation season of this region.

The steel mills in western Canada depend exclusively on scrap, a substantial portion of which (200 000 to 250 000 tpy) is imported from the United States. Also, steel consumption in the western provinces is growing rapidly. For these reasons Flin Flon Mines Ltd. is studying the possibility of mining iron ore deposits at Lake Nyberg, northern Saskatchewan and transporting the ore by pipeline to Anzac near Fort McMurray, Alberta. There the ore would be concentrated, pelletized and reduced to sponge iron, using natural gas from the Anzac gas field. The sponge iron would be delivered by the existing railway system to steel mills in western Canada.

INTERNATIONAL DEVELOPMENTS

As steel production continued to deteriorate in 1981 in the EEC countries and in Japan, steel mills substituted lower cost sinter for pellets as a furnace feed in order to keep production costs as low as possible. This created a surplus of pellets in the world, a deterioration of prices, and eventually the temporary closure of several pellet plants. Some of the plants that were closed include: IOC, Sidbec-Normines and Wabush Mines in Canada; Minntac, Minorca, National Steel Corporation, Tilden Mining Co., Empire Iron Mining Co. and Republic Steel Corp. in the U.S.; Hamersley Iron Pty Ltd. and Robe River Ltd. in Western Australia; Chowgule & Co. (Pvt.) Ltd. and Mandovi Pellets Ltd. in India; and Lamco J.V. Operating Co. in Liberia.

During the year the Brazilian state mining company, Companhia Vale do Rio Doce (CVRD) negotiated with steel producers in several countries of western Europe and Japan for the sale of iron ore to be produced at Carajas. Production at Carajas is expected to start in 1985 at an annual rate of 15 million tpy, rising to 35 million tpy by 1988. The Carajas project includes a

TABLE 3. PRODUCTION AND CAPACITY OF PIG IRON AND CRUDE STEEL AT CANADIAN IRON AND STEEL PLANTS, 1980 AND 1981

	1980	1981P
	(tonnes)	
Pig iron		
Production	10 892 628	9 743 499
Capacity at December 31[1]	11 797 000	12 216 000
Steel ingots and castings		
Production	15 901 243	14 811 223
Capacity at December 31	20 407 440	21 726 197

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, 1980 AND 1981

	1980	1981P
	(tonnes)	
Receipts imported	6 074 120[1]	5 961 357[2]
Receipts from domestic sources	11 429 416[3]	9 313 840[4]
Total receipts at iron and steel plants	17 503 536	15 275 197
Consumption of iron ore	16 574 155[5]	15 207 691[6]
Inventory at docks, plants, mines and furnace yards, December 31	14 535 031	17 266 747
Inventory change	..	2 731 716

Source: American Iron Ore Association.
[1] Compared with 5 875 292 t in Table 1. [2] Compared with 5 792 153 t in Table 1. [3] Compared with domestic shipments of 11 032 770 t compiled by Energy, Mines and Resources Canada. [4] Compared with 9 533 314 t compiled by Energy, Mines and Resources Canada. [5] Compared with 15 760 181 t compiled by Statistics Canada for blast furnace consumption. [6] Compared with 14 401 931 t compiled by Statistics Canada for blast furnace consumption.
P Preliminary; .. Not available.

TABLE 5. CANADIAN CONSUMPTION OF IRON-BEARING MATERIALS BY INTEGRATED[1] IRON AND STEEL PRODUCERS, 1981

Material Consumed	Consumed In				
	Sinter Plants at Steel Mill	Direct Reduction Plants	Iron and Steel Furnaces		
			Production of Pig Iron	Steel Furnaces	Total in Furnaces
	(tonnes)				
Iron ore					
Crude and concentrate	143 560	233 757	55 194	-	55 194
Pellets	44 865	1 194 489	11 931 648	136 567	12 068 215
Sinter	86 239	-	1 399 001	-	1 399 001
Sinter produced at steel plant	-	-	715 251	-	715 251
Direct-reduced iron	-	-	-	836 148	836 148
Other iron-bearing materials					
Flue dust	46 758	-	-	28 322	28 322
Mill scale, cinder, slag	321 046	-	444 502	18 052	462 554

Source: Company data.
[1] Dofasco Inc.; Sidbec-Dosco Incorporated; Sydney Steel Corporation; The Algoma Steel Corporation, Limited; Stelco Inc.
- Nil.

mine, town sites, port and railway and is estimated to cost $US 4.6 billion. It was reported that West Germany will take 5.98 million tpy of sinter feed, France 3.3 million tpy, Belgium-Luxembourg 2.0 million tpy, Italy 2.5 million tpy, South Korea 1.0 million tpy and Japan a hefty 10.0 million tpy. Several new mines including Capanema and Timpopeba were also being readied for production in the State of Minas Gerais, Brazil.

PRICES

In North America the Lake Erie base price for pellets was increased from 72.50 cents US per iron unit to 79.23 cents US, effective January, 1981. Mesabi non-Bessemer iron ore was increased from $US 28.05 per t to $US 32.01 effective July 1981. The price of Contrecoeur direct reduced iron ore pellets declined from $130 to $115 per t.

No. 1 heavy melting scrap increased to $US 107 a t in March, 1981 and then decreased gradually to a low of $US 76 at the end of the year. The decline reflected the sharp decrease in steel production in the United States that started early in the second half of the year.

In western Europe, the prices of iron ore fines and concentrates remained the same as at the end of 1980, while iron ore pellets

TABLE 6. WORLD IRON ORE PRODUCTION, 1979-81

	1979	1980	1981e
	(000 tonnes)		
U.S.S.R.	241 600	244 760	245 000
Brazil	95 460	97 240	100 000
Australia	91 690	95 530	91 000
People's Republic of China[e]	75 000	75 000	71 000
United States	87 090	70 730	75 000
Canada (mine shipments)	59 617	49 068	49 844
India	39 550	40 680	42 000
France	31 970	29 200	23 000
Sweden	26 620	27 170	25 000
Republic of South Africa	31 560	25 800	26 000
Liberia	18 350	18 250	17 000
Venezuela	14 180	15 420	14 000
Chile	8 290	9 310	..
Mauritania	8 910	8 940	..
Spain	8 830	8 800	..
North Korea	8 500	8 200	..
Mexico	6 440	6 520	..
Peru	5 440	5 700	..
Other countries	43 173	40 022	89 934
Total	902 270	876 340	868 778

Sources: APEF: Association of Iron Ore Exporting Countries; 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, 1979-81

		1979		1980		1981P	
		World	U.S.	World	U.S.	World	U.S.
Nova Scotia	tonnes	-	-	175	175	-	-
	$000	-	-	17	17	-	-
New Brunswick	tonnes	1 442	1 442	640	640	1 131	1 131
	$000	116	116	92	92	89	89
Quebec	tonnes	52 313	52 309	56 641	56 628	60 701	60 659
	$000	5,187	5,187	4,361	4,359	5,486	5,405
Ontario	tonnes	343 739	343 118	364 745	364 737	311 917	311 840
	$000	31,900	31,852	31,150	31,146	30,648	30,592
Manitoba	tonnes	90 222	90 222	56 385	56 385	55 781	55 781
	$000	8,271	8,271	3,823	3,823	4,390	4,390
Saskatchewan	tonnes	177 626	177 626	146 801	146 801	127 733	127 733
	$000	16,950	16,950	14,579	14,579	13,419	13,419
Alberta	tonnes	69 510	69 510	41 682	41 682	24 600	24 600
	$000	6,096	6,096	4,317	4,317	2,423	2,423
British Columbia	tonnes	2 677	1 908	2 999	2 669	2 005	1 956
	$000	256	204	300	276	270	265
Canada Total	tonnes	737 529	736 135	670 068	669 717	583 869	583 700
	$000	68,776	68,676	58,639	58,609	56,724	56,583

Source: Statistics Canada.
P Preliminary; - Nil.

decreased by 6.0 to 8.0 per cent. In Japan, 1981 iron ore prices for fines and pellets increased by 7.0 to 8.0 per cent relative to a year earlier.

OUTLOOK

The iron ore industry in Canada in 1982 is forecast to deteriorate as a result of the economic recession that is expected to continue for at least another year in the United States and western Europe. This problem will be compounded further by rapidly rising oil prices in Canada, a situation that will not affect major competitors such as Sweden and Brazil, who already pay the world price for oil. Pellet producers in Canada that export overseas will be affected the most.

Prices are expected to increase 10 to 15 per cent in 1982 in both western Europe and Japan in order to allow mine producers to improve earnings on their investment.

Iron ore originating in Quebec-Labrador and exported to steelmakers in the Great Lakes region of the United States will become progressively less attractive if the Transportation Fuel surcharge is retained and if the tolls on the St. Lawrence Seaway are increased as planned.

An oversupply of iron ore is forecast until about 1985 which means that prices will remain relatively depressed during that period.

Also, in view of rising energy prices, countries that import iron ore will tend to increase their supplies from sources as close as possible in order to minimize transportation costs; Canadian producers in this context could have difficulties maintaining their exports to eastern European and Asian countries.

TABLE 8. CANADA, EXPORTS OF STEEL SCRAP, BY PROVINCE OF LADING, 1979-81

		1979		1980		1981P	
		World	U.S.	World	U.S.	World	U.S.
Newfoundland	tonnes	-	-	-	-	-	-
	$000	-	-	-	-	-	-
Nova Scotia	tonnes	133	64	209	59	29	29
	$000	64	17	44	12	2	2
New Brunswick	tonnes	46	3	405	357	340	200
	$000	10	...	34	21	71	14
Quebec	tonnes	299 499 49	14 543	264 903	7 904	114 663	12 896
	$000	38,830	1,713	33,979	997	14,672	2,005
Ontario	tonnes	402 257	378 022	241 332	231 740	235 487	233 326
	$000	35,594	32,587	26,398	24,983	28,461	28,134
Manitoba	tonnes	9 940	9 866	6 924	6 887	1 472	1 472
	$000	1,412	1,399	1,243	1,237	281	281
Saskatchewan	tonnes	699	699	2 080	2 080	2 195	2 195
	$000	154	153	290	290	381	381
Alberta	tonnes	5 317	5 153	793	793	1 288	1 266
	$000	581	537	99	99	197	192
British Columbia	tonnes	139 354	134 532	116 583	110 443	90 769	87 068
	$000	12,210	11,570	13,936	12,951	9,889	9,272
Yukon	tonnes	-	-	-	-	72	72
	$000	-	-	-	-	4	4
Canada Total	tonnes	857 245	542 882	633 229	360 263	446 315	338 524
	$000	88,855	47,976	76,023	40,590	53,958	40,285

Source: Statistics Canada.
P Preliminary; - Nil; ... Less than five hundred dollars.

TABLE 9. LAKE ERIE BASE PRICE OF SELECTED ORES[1] AT YEAR-END, 1970 AND 1975-81

	1970	1975	1976	1977	1978	1979	1980	1981
	($US per tonne)							
Mesabi Non-Bessemer	10.63	18.21	19.94	20.84	21.95	24.21	28.05	32.02
Old Range Non-Bessemer	10.87	18.45	20.19	21.09	22.19	24.46	28.30	32.26
Pellets (per tonne natural iron unit)[2]	0.262	0.464	0.523	0.546	0.599	0.667	0.725	0.792

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 10. **SELECTED PRICES OF IRON ORE BOUND FOR JAPAN AND EUROPE 1976-81**
(US cents per Fe Unit DMT, FOB)

Ore	Market	Source	%Fe	1976	1977	1978	1979	1980	1981
Fines (including concentrate)	Europe	Rio Doce	(64)	22.7	23.0	21.5	23.5	28.1	28.1
		Iscor	(65)	23.0	22.3	20.6	22.4	26.9	26.9
		Kiruna	(66)	28.2	27.3	23.6	26.6	34.5	34.5
		Carol Lake		-	-	-	23.7	29.3	29.3
		Mt. Wright	(66)	-	25.0	22.5	24.0	29.75	29.75
	Japan	Rio Doce		17.4	19.8	19.7	21.6	25.4	27.3
		Iscor		17.9	17.9	18.5	21.6	25.0	26.9
		Hamersley		17.4	20.3	20.9	22.7	27.6	29.7
		Carol Lake	(65)	-	-	21.2	21.4	25.1	27.0
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
	Japan	Rio Doce		20.6	20.8	20.3	21.6	25.4	27.3
		Iscor	(65)	22.4	22.4	23.0	24.7	28.6	30.9
		Hamersley		21.5	25.6	24.3	25.7	31.2	34.2
Pellets	Europe	Rio Doce		43.8	42.8	36.4	40.2	47.1	43.1
		Kiruna		47.4	45.5	38.0	42.2	49.9	46.6
	Japan	Rio Doce (Nibrasco)		-	-	-	46.0	50.3	55.2
		Savage River		-	-	-	37.9	46.2	49.7

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

Domestic crude steel production in 1981 decreased by 6.9 per cent relative to the previous year to 14.8 million t.

Canadian demand for steel during the first half of 1981 was unusually buoyant and, as a result, all three major steel companies filled orders on an allocation basis. While a softening trend in consumption developed in the third quarter of the year and was clearly evident by December, domestic producers continued to have difficulty satisfying some orders because of a four-month strike that halted steel production in one-third of the industry. Soft markets, combined with the settlement of all strikes by early December, reversed the situation to over-supply at year-end.

The low value of the Canadian dollar in terms of United States and other currencies continued to stimulate exports of Canadian rolled steel products, particularly during the first half of 1981. Exports expressed in crude steel to all countries were 3.0 million t, a decline of 22 per cent relative to 1980 due to strong domestic demand and lower production. Imports increased significantly during the latter six months of the year because of the strengthening of the Canadian dollar, increasing competitiveness in the international steel industry, and a short-fall of some domestic products due to a strike at the largest steel producer. Accordingly, imports expressed in crude steel rose to 2.2 million t, an increase of 51 per cent from 1980.

World crude steel production decreased 1.4 per cent from 717.2 million t in 1980 to 707.3 million t in 1981. Eastern Europe, including the U.S.S.R., reported a decline of 1 per cent from 209.1 million t to 206.7 million t. The 10 European Community (EC) nations, with a reduction in production of 2.2 per cent from 128.9 million t to 126.0 million t, faired better than Japan. Japan's production in 1981 was a significant 8.7 per cent lower than a year earlier - 101.7 million t compared to 111.4 million t. United States production increased by 7 per cent to 108.8 million t from 101.7 million t. In addition to the United States, other increases in production occurred in most developing nations.

1981 saw the continuation of a "steel crisis" in Europe, with over-production and the threat of a suicidal price-cutting war. Import and delivery quotas on steel mill products, imposed by the EC Commission in 1980, continued through 1981 and were instrumental for support of Common Market price increases.

In the United States, imported steel increased 21.5 per cent to 18.1 million t, approximately 17.4 per cent of the domestic market. Imports were selling at prices considerably lower than domestic steel in spite of the existence of automatic anti-dumping legislation such as trigger price and surge mechanisms. U.S. steel producers became increasingly concerned with the level of imports and, by the end of the year, many countervail and anti-dumping petitions were filed with the U.S. Department of Commerce and the International Trade Commission under U.S. trade laws.

CANADIAN DEVELOPMENTS

Union contracts between the United Steelworkers of America and Stelco Inc. (Stelco) and The Algoma Steel Corporation, Limited (Algoma) expired on July 31, 1981 and both companies were struck on August 1. However, a new three-year agreement was negotiated and ratified at Algoma by August 3. Initially all of the Stelco plants were closed by the strike although several facilities, including Lake Erie Works at Nanticoke, Ontario were returned to production by the end of August. The strikes at Stelco's main works in Hamilton, mills in the Montreal area, and the Edmonton plant continued until early December.

TABLE 1. CANADA, GENERAL STATISTICS OF THE DOMESTIC PRIMARY IRON AND STEEL INDUSTRY, 1979-81

		1979	1980	1981P
Production				
Volume indexes				
Total industrial production	1971=100	136.6	133.9	135.3
Iron and steel mills[1]	1971=100	138.9r	140.8	136.1
		($ million)	($ million)	($ million)
Value of shipments, iron and steel mills[1]		5,858.4r	6,449.0	6,817.4
Value of unfilled orders, year-end, iron and steel mills		961.9r	935.7	789.4
Value of inventory owned, year-end, iron and steel mills		1,505.7r	1,551.8	1,929.5
		(number)	(number)	(number)
Employment, iron and steel mills[1]				
Administrative		11,775	12,542	13,733
Hourly rated		44,084	45,204	40,974
Total		55,859	57,746	54,707
Employment index, all employees	1961=100	161.9	166.5	158.0
Average hours per week, hourly rated		40.1	39.7	39.0
		($)	($)	($)
Average earnings per week, hourly rated		365.46	392.10	439.81
Average salaries and wages per week, all employees		383.71	413.37	469.06
		($ million)	($ million)	($ million)
Expenditures, iron and steel mills[1]				
Capital: on construction		60.1	85.6	101.8
on machinery		310.0	493.9	486.8
Total		370.1	579.5	588.6
Repair: on construction		47.3	42.1	47.1
on machinery		583.3	700.5	838.8
Total		630.6	742.6	885.9
Total capital and repair		1,000.7	1,322.1	1,474.5
		($ million)	($ million)	($ million)
Trade, primary iron and steel[2]				
Exports		1,444.1r	1,879.7	1,702.1
Imports		1,484.1r	1,243.0	1,401.2

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.

Both Dofasco Inc. and Algoma operated near capacity in 1981. Stelco customers were obliged to seek alternative sources of supply during the strike and, with no indication of an early settlement, placed orders with these alternative suppliers for future deliveries. Faced with somewhat eroded markets when the strike terminated, Stelco announced that production would resume at about 80 per cent of capacity. Employee recalls for part of the 12,300 workforce in Hamilton were delayed because of problems in restarting blast furnaces as well as the decision to reduce output for the remainder of the year.

Smaller Canadian steel producers, concerned with declining demand for their products in the second half of 1981, indicated that production curtailments and layoffs would have to be considered. Lake Ontario Steel Company Limited (Lasco) of Whitby, Ontario, where a $100 million expansion program to double steelmaking capacity to 907 000 tpy was completed in March, 1981, planned to reduce production by 30 per cent at the beginning of 1982.

Production at Stelco's Lake Erie Works (LEW) started in June 1980 and the first full year of operations, excluding the strike during August, was achieved in 1981. The facility produced 756 000 t of steel in 1981 compared to a rated annual capacity of 1.2 million t. Construction of the LEW coke oven battery was completed during 1981 and brought into production in November. Construction was also under way on a hot strip mill, which is expected to be completed in 1983. Expenditures for 1981 at LEW were $147.5 million. Total investments by Stelco in manufacturing and mining facilities were $212.3 million.

Algoma is currently undertaking a five-year expansion and renovation program that will require capital expenditures of approximately $250 million per year. One blast furnace was relined in 1981 and the company was proceeding with the construction of a $300 million seamless tube mill.

Dofasco made good progress on its expansion program during 1981. The No. 4 galvanizing line which will add 218 000 t of annual galvanizing capacity and expand existing capacity by 35 per cent, was brought into commercial production. Total coating capacity at the plant is projected to reach 770 000 tpy in the near future. Work is progressing on the No. 2 hot strip mill which is scheduled for completion in 1983. The new mill, with an initial capacity of just over 1 million tpy, will raise rolling capacity at the Dofasco Works to approximately 4 million t annually. In addition, Dofasco has decided to add a fourth continuous pickling line, estimated to cost $90 million. Construction on the latter project will begin in early 1982 and is scheduled for completion in 1984.

The three-year, $80 million expansion program at Interprovincial Steel and Pipe Corporation Ltd (IPSCO) was completed in 1981. The new installations have raised IPSCO's steelmaking capacity from 454 000 to 680 000 tpy, and large-diameter spiral pipe capacity by 50 per cent to 272 000 t annually. Also, the company is constructing a new casing and tube plant in Calgary, scheduled for completion in 1983 at a cost of $60 million.

In early 1981, Sydney Steel Corporation (Sysco), the federal government and the Province of Nova Scotia approved a renovation plan for the Sydney, Nova Scotia steel mill. The initial phase of the project, costing some $96.2 million, will consist of repairing and relining one blast furnace and making improvements to the open hearth furnaces and rolling mills. Sysco operated one blast furnace during 1981. However, a problem which developed in this furnace in December resulted in an interruption in pig iron production.

Nelson Steel Company Limited of Stoney Creek, Ontario began construction of a pickling plant at Nanticoke, Ontario. The plant will have a capability to process coils up to 35 t in weight and 190 cm in width. Scheduled to be in operation by mid-1982, the new facility will raise Nelson's annual pickling capacity, including two lines at Stoney Creek, to more than 725 000 tpy.

Enheat Inc. of Sackville, New Brunswick permanently closed its steel division in Amherst, Nova Scotia on November 30, 1981 because of weak demand for steel reinforcing bars. The steelmaking plant, which had employed about 120 workers at full production, had been idle since September, 1980.

INTERNATIONAL POLICY INITIATIVES

Europe: In October 1980, the European Community (EC) imposed production and delivery quotas for a variety of steel mill products in an effort to end savage price cutting that occurred as producers attempted

TABLE 2. CANADA, PIG IRON PRODUCTION, SHIPMENTS, TRADE AND CONSUMPTION, 1979-81

	1979	1980	1981P
		(tonnes)	
Furnace capacity January 1[1]			
Blast	11 240 019	11 272 000	11 626 000
Electric	566 990	525 000	590 000
Total	11 807 009	11 797 000	12 216 000
Production			
Basic iron	10 400 732	10 015 698	9 007 942
Foundry iron[2]	504 928	876 930	735 557
Total	10 905 660	10 892 628	9 743 499
Shipments	405 384	783 261	738 698
Imports			
Tonnes	9 913	2 076	3 711
Value ($000)	2 130	513	721
Exports			
Tonnes	255 524	562 351	321 012
Value ($000)	47 874	110 994	72 247
Consumption of pig iron			
Steel furnaces	10 275 058	9 966 585	9 589 451
Consumption of iron and steel scrap			
Steel furnaces	8 167 315	8 398 681	7 378 826

Sources: Statistics Canada: Primary Iron and Steel (monthly); Iron and Steel Mills (annual).
[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.

to maintain their share of a rapidly declining market. These controls were to end on June 30, 1981 but were continued throughout the year. Some 65 per cent of community production was affected. Mandatory production reductions of from 10 to 30 per cent were imposed on coils and strip, heavy sheet, heavy sections, light sections, reinforcing and merchant bar and wire rod.

The European Steel Manufacturers' Federation (EUROFER), whose members are the 15 main EC steel firms that together produce 80 per cent of community steel, had previously agreed to cut output and to increase prices. EUROFER could not reach an accord on the continuation of voluntary production cuts after June 1981.

West Germany singled out state aids of some $30 billion as the primary cause of the crisis in the industry. The West Germans threatened to impose border taxes on subsidized steel.

On June 25, the EC Commission Ministers announced an accord on phasing out state aids to the steel industry, with payments for redundant workers to be restricted to programs of early retirement, short time working and retraining. The accord also specified the conditions under which member countries could receive Community financial aid for restructing their steel industries. Submissions are to be received by September 30, 1982, approved by the Commission by July 1, 1983 and funds are to be dispersed no later than the end of 1985.

A further indication of the serious problems faced by the European community was the initiation of legal actions by the Commission. Fines were imposed on a West German company for exceeding quotas under the mandatory quota system and legal proceedings were initiated against countries which did not adequately notify the Commission concerning aids.

TABLE 3. CANADA, CRUDE STEEL PRODUCTION, SHIPMENTS, TRADE AND CONSUMPTION, 1979-81

	1979	1980	1981P
		(tonnes)	
Furnace capacity, January 1[1]			
Steel ingot			
Basic open-hearth	3 742 137	3 742 250	3 742 250
Basic oxygen converter	10 185 870	10 329 900	11 746 200
Electric	4 228 388	4 449 500	4 526 000
Total	18 156 395	18 521 650	20 014 450
Steel castings	451 234	425 390	392 990
Total furnace capacity	18 607 629	18 947 040	20 407 440
Production			
Steel ingot			
Basic open-hearth	3 295 093	3 250 833	1 999 248
Basic oxygen	9 115 530	8 771 284	8 679 354
Electric	3 444 065	3 661 860	3 958 669
Total	15 854 688	15 683 977	14 637 271
Continuously cast, included in total above	3 192 286	4 072 921	4 770 276
Steel castings[2]	223 353	217 266	173 952
Total steel production	16 078 041	15 901 243	14 811 223
Alloy steel in total	2 184 057	1 974 564	1 659 287
Shipments from plants			
Steel castings	199 746	198 095	159 691
Rolled steel products	12 229 716	12 294 817	11 999 291
Total	12 429 462	12 492 912	12 158 982
Steel ingots included with rolled steel products above	500 176	938 229	583 705
		(000 tonnes)	
Exports, equivalent steel ingots	2 767.1	3 838.3	2 985.2
Imports, equivalent steel ingots	2 314.2r	1 434.9	2 170.2
Indicated consumption, equivalent steel ingots	15 625.1r	13 497.8	13 996.2

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.

The Commission extended its influence to external measures designed to help resolve the "steel crisis". These measures included the monitoring and licencing of imports, the publication of basic prices to protect against dumped or subsidized imports, the negotiation of quota import agreements with 14 countries and the monitoring of imports from 21 countries.

United States: A variety of instruments were used in an attempt to control steel imports into the United States. The steel Trigger Price Mechanism (TPM), whereby the U.S. Commerce Department would start an investigation for dumping if imported steel was sold below specific prices based on Japanese production costs, was introduced in 1978, suspended in 1979, revised and reinstated in 1980 and continued in force during 1981.

By the second quarter of 1981, the TPM had caused the price of foreign steel to increase by about $40 per short ton over the price of domestic steel. Prices under the TPM were increased to an average of $US 405.18 per short ton during the first quarter and to $US 422.95 during the second quarter. The last half of the year saw no further increases in the base price.

Another instrument employed by the United States to control imports of steel was the Surge Mechanism, which was a system of automatic monitoring that could result in antidumping or countervail investigations. When import trends in specialty and carbon steel products approached levels that had been determined to be injurious by the International Trade Commission of the United States Department of Commerce, a surge was deemed to exist and investigations were initiated. Specifically, a surge was deemed to exist when imports, as a percentage of domestic consumption, rose above the average level of the previous 10 years. For carbon steel, structural plate, cold finished bars and sheet piling, the prescribed limits were 15.2 per cent of apparent consumption while capacity utilization in the U.S. steel industry was less than 87 per cent.

A third mechanism that acted to restrict trade was the proliferation of U.S. laws which limited foreign steel used in public funded projects.

By the end of 1981, a large number of U.S. steel producers, unhappy with increasing imports of steel and dissatisfied with the effectiveness of the Trigger Price Mechanism, had prepared antidumping and countervail cases against many foreign steel suppliers, aimed predominately at European steel producers.

The President of the United States approved the steel industry pollution bill as part of the program to revitalize the U.S. steel industry. This bill extended the deadline for steel companies to comply with clean air legislation from December 31, 1982 to December 31, 1985.

Canada: Canadian steel producers were expressing concern with the surge of low cost imports that occurred by the end of 1981. The Department of National Revenue continued to monitor imports although no suits for dumping were reported.

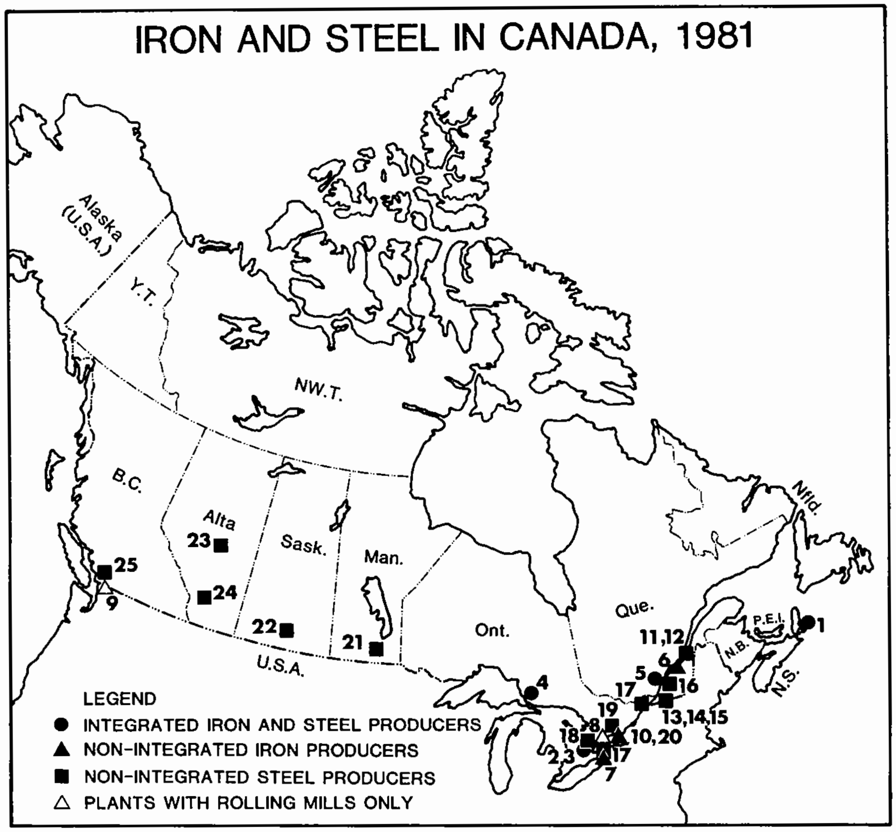
PRICES

During 1981, the Lake Erie base price of iron ore pellets increased from 72.50 cents US a natural iron unit to 79.23 cents US.

TABLE 4. PRODUCER SHIPMENTS[1] OF ROLLED STEEL[2], 1980 AND 1981

	1980	1981	Growth
	(000 tonnes)		(per cent)
Ingots and semis	813.8	996.8	+ 22.5
Rails	782.6	839.7	+ 7.3
Wire rods	1 236.8	987.2	- 20.2
Structural shapes	577.4	520.7	- 9.8
Concrete reinforcing bar	765.0	681.0	- 11.0
Other hot-rolled bars	1 002.7	1 022.1	+ 1.9
Track material	79.2	68.0	- 14.1
Plate	1 773.3	1 802.8	+ 1.7
Hot-rolled sheet and strip	2 319.8	2 274.3	- 2.0
Cold finished bars	98.2	95.0	- 3.3
Cold reduced sheet, strip other and coated	1 848.8	1 761.0	- 4.8
Galvanized sheet	997.2	950.7	- 4.7
Total	12 294.8	11 999.3	- 2.4
Alloy steel in total shipments	926.4	947.0	+ 2.2

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.



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 Precision, 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 6. CANADA, TRADE IN STEEL BY PRODUCT[1], 1979-81

	Imports			Exports		
	1979r	1980r	1981P	1979r	1980r	1981P
	(000 tonnes)					
1. Steel castings (including grinding balls)	15.9	16.3	13.9	34.7	14.2	11.9
2. Ingots	69.5	94.8	69.8	20.0	65.3	185.5
3. Semi-finished steel blooms, billets, slabs	108.0	9.9	22.9	100.8	261.3	540.9
4. Total (1+2+3)	193.4	121.0	106.6	155.5	340.8	738.3
5. Finished steel						
A) Hot-rolled						
Rails	15.9	23.8	18.2	221.5	240.3	134.2
Wire rods	166.3	106.5	134.4	360.7	541.8	279.0
Structurals	273.1	209.8	244.4	334.0	299.4	214.9
Bars	113.4	67.3	53.0	154.8	290.5	247.2
Track material	4.7	5.9	4.6	11.6	13.4	16.3
Plate	439.3	247.7	437.2	303.5	340.0	234.7
Sheet and strip	283.2	170.9	425.9	218.9	417.1	218.1
Total hot-rolled	1 295.9	831.9	1 317.7	1 605.0	2 142.5	1 344.4
B) Cold-rolled						
Bars	20.5	16.2	12.2	11.4	15.3	14.1
Sheet and strip	76.1	29.1	72.8	57.4	135.9	83.3
Galvanized	89.2	31.2	76.6	148.7	166.0	132.1
Other[1]	151.3	103.3	109.7	188.4	233.4	156.2
Total cold-rolled	337.1	179.8	271.3	405.9	550.6	385.7
6. Total finished steel (A+B)	1 633.0	1 011.7	1 589.0	2 010.9	2 693.1	1 730.1
7. Total rolled steel (2+3+6)	1 810.5	1 116.4	1 681.7	2 131.7	3 019.7	2 456.5
8. Total steel (4+6)	1 826.4	1 132.7	1 695.6	2 166.4	3 033.9	2 468.4
9. Total steel (raw steel equivalent)[2]	2 314.2	1 434.9	2 170.2	2 767.1	3 838.3	2 985.2
10. Fabricated steel products						
Steel forgings	9.5	9.2	4.0	45.4	40.6	32.8
Pipe	285.1	322.1	280.8	415.5	388.8	389.9
Wire	82.2	52.6	43.8	84.1	94.9	83.6
11. Total fabricated	376.8	383.9	328.6	545.0	524.3	506.3
12. Total castings, rolled steel and fabricated (8+11)	2 203.2	1 516.6	2 024.2	2 711.4	3 558.2	2 974.7

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.

recession deepened and high interest rates depressed the U.S. economy, thereby reducing the demand for steel. Canadian exports to the United States for the full year totalled 2 368 000 t in 1981 compared to 2 248 000 t in 1980. The volume of steel exported to countries other than the United States was 607 000 t down from the previous year's total 1 329 000 t.

OUTLOOK

The weakness in western world markets that developed in 1980 continued throughout 1981 and is expected to persist well into 1983. Capital investment and consumption will continue to be held in check by high interest rates and widespread unemployment.

The world steel industry has entered a major restructuring and consolidation phase which is not expected to result in a significant capacity expansion throughout the 1980s. Steel intensity is expected to continue to decline in the next few years.

Economic recovery is predicted to begin in early 1983 and should peak in the middle of the decade. . The annual growth rate in world steel consumption, using 1981 as the

TABLE 7. CANADA, VALUE[1] OF TRADE IN STEEL CASTINGS, INGOTS, ROLLED AND FABRICATED PRODUCTS, 1979-81

	Imports			Exports		
	1979r	1980r	1981p	1979r	1980r	1981p
	($000)					
Steel castings	33,628	41,301	27,592	32,685	16,148	13,125
Steel forgings	32,928	48,004	18,992	74,446	69,775	61,628
Steel ingots	19,200	24,560	22,797	4,562	14,627	44,634
Rolled products						
Semis	39,562	9,671	10,648	26,145	71,628	167,253
Other	963,299	697,831	914,134	904,062	1,209,612	878,221
Fabricated						
Pipe and tube	310,707	358,039	353,606	283,780	302,625	389,096
Wire	82,638	63,084	52,724	70,584	84,340	75,896
Total steel	1,481,962	1,242,490	1,400,493	1,396,264	1,768,755	1,629,853

Source: Statistics Canada.
[1] The values in this table correspond with the tonnages shown in Table 6.
p Preliminary; r Revised.

TABLE 8. CANADA, TRADE IN STEEL[1] BY COUNTRY, 1979-81

	Imports			Exports		
	1979r	1980	1981p	1979r	1980	1981p
	(000 tonnes)					
United States	910.2	622.8	708.8	2 247.9	2 229.0	2 367.7
ECSC[2] countries	621.4	275.4	683.4	143.0	226.2	86.8
Japan	365.8	373.2	323.7	6.1	49.0	0.9
Other	305.8	245.2	308.3	314.4	1 054.0	519.3
Total	2 203.2	1 516.6	2 024.2	2 711.4	3 558.2	2 974.7

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.

base year, is forecast at approximately 1-3 per cent to the end of 1985. An interval of slackening demand could produce low or negative growth from 1986 to 1987.

Canada: The Canadian economy is facing many problems similar to those plaguing the rest of the western world including poor demand for steel, with little, if any, improvement expected in 1982. The automotive, agricultural equipment, construction and appliance sectors continue to be depressed, and short-term activity in the oil and gas energy sector may be considerably lower than previously expected due to weakening demand and falling prices for oil.

However, in spite of a decline, the energy sector is quite active and represents a considerable long-term potential demand for steel. The sector should rebound strongly when the economy improves and energy prices begin to increase.

The potential for future exports, primarily to the United States, is good, particularly in light of the predicted upswing in the North American economy. Canadian suppliers are in a favourable position due to the established pattern of trade in steel between Canada and the United States, the high level of efficiency of the Canadian steel industry and the relatively low value of the

TABLE 9. WORLD RAW STEEL PRODUCTION, 1980 AND 1981

	1980	1981P
	(million tonnes)	
U.S.S.R.	147.9	149.0
United States	101.7	108.8
Japan	111.4	101.7
West Germany	43.8	41.6
People's Rep. of China	37.1	35.6
Italy	26.5	24.6
France	23.2	21.2
Poland	19.5	15.6
United Kingdom	11.3	15.6
Czechoslovakia	14.9	15.2
Canada	15.9	14.8
Romania	13.2	13.5
Brazil	15.3	13.2
Spain	12.7	12.9
Belgium	12.3	12.3
South Korea	8.6	10.8
India	9.5	10.7
South Africa	9.1	8.9
Australia	7.6	7.6
Mexico	7.1	7.6
East Germany	7.3	7.5
North Korea	5.8	5.5
Netherlands	5.3	5.5
Austria	4.6	4.7
Yugoslavia	3.6	4.0
Luxembourg	4.6	3.8
Sweden	4.2	3.8
Hungary	3.8	3.6
Taiwan	4.2	3.1
Bulgaria	2.6	2.6
Argentina	2.7	2.5
Finland	2.5	2.4
Turkey	2.5	2.4
Others	14.9	14.7
Total	717.2	707.3

Source: International Iron and Steel Institute.
P Preliminary.

Canadian vis-à-vis the U.S. dollar. A low-valued Canadian dollar is expected to persist in the medium-term.

Canadian steel production is expected to show little, if any, growth in 1982 but a significant growth of some 15-20 per cent is forecast to occur by the end of 1984. The second half of the decade should see average growth rates of between 1 and 2 per cent per year with total annual production close to 21 million t in 1990.

United States: The steel market in the United States is expected to continue to deteriorate in 1982, with annual shipments forecast at less than 80 million t. High interest rates which are not expected to decline until the last half of 1982, will significantly depress demand.

There has been a significant drop in steel intensity in the United States since 1975, mainly due to the impact of rising oil prices on the automobile industry and a decline in public construction projects such as highways and bridges. This decline in steel intensity is expected to level out in the near future.

U.S. steel production is forecast to begin a slight increase by the end of 1982, averaging 2 to 4 per cent growth per year to 1985, possibly declining to negative growth rates for the following two or three years, and resuming growth by the end of the decade.

Japan: Forecasts for 1982 predict a slight decrease in Japanese steel production, a growth in domestic consumption and a decline in exports. This trend to increased domestic consumption relative to exports will likely continue in the short-term. Forecasts to 1985 show Japan's steel industry increasing shipments to about 105 million t, a small rise relative to 1981. Capacity utilization is predicted to exceed 90 per cent by the end of the decade.

Western Europe: 1982 is expected to be another year of low production. The outlook beyond 1983 is somewhat better because the benefits of planned industrial rationalization should be evident at that time. With the closing of obsolete plants, an increase in productivity will occur. The forecast increase in demand should result in capacity utilization increasing to the 90 per cent range by 1990, with quantities of steel produced increasing an average of about 1 per cent per year from 126 million t in 1981 to almost 138 million t by 1990.

TABLE 10. CANADIAN CRUDE STEEL SUPPLY AND DEMAND, 1970 AND 1975-81

	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
1976	13 290	1 374	1 825	1 865	2 401[r]	12 799	12 714[r]
1977	13 631	1 520	2 032	2 232	2 767	12 919	12 896
1978	14 898	1 632	2 278	2 884	3 581	13 646	13 595
1979	16 078	2 314[r]	2 956[r]	2 767	3 553	15 625	15 481[r]
1980	15 901	1 435	2 067	3 838	4 594	13 498	13 374
1981P	14 811	2 170	2 714	2 985	3 676	13 996	13 849

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 6). [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; r Revised.

TABLE 11. CANADA, EXPORTS OF STEEL SCRAP, BY PROVINCE OF LADING, 1979-81

		1979		1980		1981P	
		World	U.S.	World	U.S.	World	U.S.
Newfoundland	tonnes	-	-	-	-	-	-
	$000	-	-	-	-	-	-
Nova Scotia	tonnes	133	64	209	59	29	29
	$000	64	17	44	12	2	2
New Brunswick	tonnes	46	3	405	357	340	200
	$000	10	...	34	21	71	14
Quebec	tonnes	299 499 49	14 543	264 903	7 904	114 663	12 896
	$000	38,830	1,713	33,979	997	14,672	2,005
Ontario	tonnes	402 257	378 022	241 332	231 740	235 487	233 326
	$000	35,594	32,587	26,398	24,983	28,461	28,134
Manitoba	tonnes	9 940	9 866	6 924	6 887	1 472	1 472
	$000	1,412	1,399	1,243	1,237	281	281
Saskatchewan	tonnes	699	699	2 080	2 080	2 195	2 195
	$000	154	153	290	290	381	381
Alberta	tonnes	5 317	5 153	793	793	1 288	1 266
	$000	581	537	99	99	197	192
British Columbia	tonnes	139 354	134 532	116 583	110 443	90 769	87 068
	$000	12,210	11,570	13,936	12,951	9,889	9,272
Yukon	tonnes	-	-	-	-	72	72
	$000	-	-	-	-	4	4
Canada Total	tonnes	857 245	542 882	633 229	360 263	446 315	338 524
	$000	88,855	47,976	76,023	40,590	53,958	40,285

Source: Statistics Canada.
P Preliminary; - Nil; ... Less than five hundred dollars.

TABLE 12. CANADA, IMPORTS OF STEEL SCRAP, BY PROVINCE OF ENTRY, 1979-81

		1979		1980		1981P	
		World	U.S.	World	U.S.	World	U.S.
Nova Scotia	tonnes	-	-	175	175	-	-
	$000	-	-	17	17	-	-
New Brunswick	tonnes	1 442	1 442	640	640	1 131	1 131
	$000	116	116	92	92	89	89
Quebec	tonnes	52 313	52 309	56 641	56 628	60 701	60 659
	$000	5,187	5,187	4,361	4,359	5,486	5,405
Ontario	tonnes	343 739	343 118	364 745	364 737	311 917	311 840
	$000	31,900	31,852	31,150	31,146	30,648	30,592
Manitoba	tonnes	90 222	90 222	56 385	56 385	55 781	55 781
	$000	8,271	8,271	3,823	3,823	4,390	4,390
Saskatchewan	tonnes	177 626	177 626	146 801	146 801	127 733	127 733
	$000	16,950	16,950	14,579	14,579	13,419	13,419
Alberta	tonnes	69 510	69 510	41 682	41 682	24 600	24 600
	$000	6,096	6,096	4,317	4,317	2,423	2,423
British Columbia	tonnes	2 677	1 908	2 999	2 669	2 005	1 956
	$000	256	204	300	276	270	265
Canada Total	tonnes	737 529	736 135	670 068	669 717	583 869	583 700
	$000	68,776	68,676	58,639	58,609	56,724	56,583

Source: Statistics Canada.
P Preliminary; - Nil.

TABLE 13. CANADA, EXPORTS OF STAINLESS STEEL SCRAP, BY PROVINCE OF LADING, 1979-81

		1979		1980		1981P	
		World	U.S.	World	U.S.	World	U.S.
Newfoundland	tonnes	-	-	-	-	14	14
	$000	-	-	-	-	3	3
Nova Scotia	tonnes	243	14	157	52	140	122
	$000	178	10	155	41	116	102
New Brunswick	tonnes	618	-	154	-	350	281
	$000	260	-	120	-	263	221
Quebec	tonnes	6 693	3 211	4 638	1 518	2 136	1 519
	$000	5,400	2,296	3,319	1,350	1,942	1,398
Ontario	tonnes	15 539	10 264	11 781	7 348	12 011	11 377
	$000	7,638	4,946	9,900	5,835	6,953	6,277
Manitoba	tonnes	30	30	154	154	163	163
	$000	23	23	71	71	75	75
Saskatchewan	tonnes	-	-	69	69	-	-
	$000	-	-	10	10	-	-
Alberta	tonnes	215	215	70	70	39	39
	$000	145	145	60	60	26	26
British Columbia	tonnes	4 082	3 601	1 603	627	1 589	868
	$000	1,332	998	1,082	341	1,031	522
Canada Total	tonnes	27 420	17 335	18 626	9 838	16 442	14 383
	$000	14,976	8,418	14,717	7,708	10,409	8,624

Source: Statistics Canada.
P Preliminary; - Nil.

TABLE 14. CANADA, ROLLED STEEL SUPPLY AND DEMAND, 1977-81

	Producer or Mill Shipments[1]	Exports[2]	Imports[3]	Apparent Rolled Steel Consumption[4]	Raw Steel Production[5]
			(000 tonnes)		
1977	10 327	1 761	1 168	9 734	13 631
1978	11 693	2 267	1 257	10 683	14 898
1979	12 230	2 132	1 811r	11 909r	16 078
1980	12 097	3 020	1 116	10 193	15 901
1981P	11 999	2 456	1 682	11 225	14 811
% Change 1981/1980	-0.8	-18.7	+50.7	+10.1	-6.8

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 134 000 t in 1977, 157 000 t in 1978, 200 000 t in 1979, 198 000 t in 1980 and 160 000 t in 1981. [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 149 099 t in 1977, 170 493 t in 1978, 223 353 t in 1979, 217 266 t in 1980, and 173 952 t in 1981.
P Preliminary; r Revised.

TABLE 15. PRICES FOR RAW MATERIALS AND SELECTED STEEL PRODUCTS, 1980 AND 1981[1]

	Currency	1980	1981
Raw Materials			
Iron Ore Pellets, Lake Erie Base Price, per metric iron unit[2]	$US	0.725	0.7923
Coal, imported premium medium-volatile bituminous, long term contract, cif Ontario steel mills, per tonne	$Cdn	84.00-89.00	92.00-99.00
Scrap, Number 1 heavy melting, per tonne	$US	100.00	78.90
Direct Reduced Iron, per tonne	$US	130.00	115.00
Basic Pig Iron, per tonne	$Cdn	240.00	268.00
Steel		($Cdn per tonne)	
Hot Rolled Sheet		391.00	461.00
Cold Rolled Sheet		464.00	556.00
Galvanized Sheet		521.00	643.00
Tin Plate		700.00	811.00
Plate		442.00	522.00
Large Structurals		436.00	524.00

Sources: 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.

Lead

J. BIGAUSKAS

SUMMARY

Refined lead consumption in 1981 in the western world continued on a down trend that began in 1979. Metal stocks held by producers declined gradually until August and then rose quickly until the end of the year. Consumer stocks were steady throughout the year. Lead prices - buoyed by output restrictions due to strike disruptions, closures for environmental reasons and declining metal stocks - strengthened during the first eight months. Later, prices declined steadily as overproduction, spurred by the earlier prices, led to a growing oversupply.

CANADIAN DEVELOPMENTS

Canadian lead mine production recovered from the low production levels of 1980 and attained approximately the 1979 level of production (Table 1). Production of lead in 1980 had been lower because of strikes and production problems at some of the major producers. Lead mine production increased substantially from the 296 641 t produced in 1980 to 332 000 t in 1981.

Canadian exports of both refined lead and lead contained in concentrates remained virtually unchanged in 1981 despite shifts in export destinations. Large declines in shipments of concentrates to Japan and West Germany were balanced by increased sales to Belgium and the United States. Refined lead exports to the United States rose from 33 000 t to 58 000 t, offsetting a broad decline to most other markets.

The Buchans mine in Newfoundland, operated by ASARCO Incorporated, continued with exploration and development of new ore zones below and at the extremity of existing mine workings. With gradually diminishing reserves in the older, developed areas of the mine, new ore reserves will soon be required to ensure continued operation.

The two new producers in Nova Scotia, the Gays River mine of Esso Resources Canada Limited and the Cape Breton mine of Yava Mines Limited, encountered major production problems. The Gays River property experienced substantial operating losses because of ore irregularities and heavy inflows of water. Production ceased in August and the plant has been mothballed for a year while attempts are made to develop better-grade ore and prevent underground flooding. The Yava operation also suffered continued cash losses and exploration results failed to confirm the tonnage needed to justify moving the mill to the mine site to reduce operating costs. The company has not been able to repay outstanding loans and has been placed in receivership. Production is not expected to resume in the foreseeable future.

In New Brunswick, Brunswick Mining and Smelting Corporation Limited completed the expansion of its No. 12 mine near Bathurst early in the year and mine production, starting in April, increased to 10 000 t of ore a day from 9 070 t. The new production level increases annual capacity by 10 000 t of lead and 30 000 t of zinc in concentrates. Zinc and lead output in 1981 was close to double that in 1980, when production was interrupted by a four-month strike. Brunswick Mining ranks as one of the world's largest producers of zinc and lead concentrates. Anaconda Canada Exploration Ltd. has been doing metallurgical test work and studying the feasibility of reopening its Caribou zinc-lead-copper mine near Bathurst.

In Quebec, the Louvicourt mine of Louvem Mining Company Inc. ceased production because of depletion of ore reserves. At Noranda Mines Limited's Geco Division, mill modifications have increased recoveries of lead as well as zinc and copper. A small exploration program north of the mine failed to detect any significant mineralization at depth. Noranda's "F" zone mine in the

TABLE 1. CANADA, LEAD PRODUCTION, TRADE AND CONSUMPTION, 1980 AND 1981

	1980		1981P	
	(tonnes)	($000)	(tonnes)	($000)
Production				
All forms[1]				
British Columbia	76 710	83,459	79 414	77,961
Northwest Territories	51 337	55,853	65 076	63,885
New Brunswick	42 551	46,295	64 920	63,732
Yukon	65 771	71,558	51 651	50,706
Nova Scotia	2 567	2,793	6 054	5,943
Newfoundland	4 347	4,729	3 178	3,120
Ontario	7 680	8,356	2 264	2,222
Manitoba	576	627	367	360
Quebec	88	96	4	8
Total	251 627	273,766	272 928	267,937
Mine output[2]	296 641	..	332 045	..
Refined production[3]	162 463	..	168 450	..
Exports				
Lead contained in ores and concentrates				
Japan	89 631	68,054	51 716	25,006
United States	13 381	8,124	41 944	21,609
Belgium-Luxembourg	9 592	5,740	18 832	11,488
West Germany	18 281	12,392	13 622	6,767
U.S.S.R.	8 662	7,173	9 566	5,285
Other countries	7 461	4,821	10 414	5,577
Total	147 008	106,304	146 094	75,732
Lead pigs, blocks and shot				
United States	32 972	31,555	57 810	53,496
United Kingdom	36 121	36,922	32 534	25,917
Italy	8 348	8,948	6 560	6,026
West Germany	15 394	14,496	5 952	5,248
Belgium and Luxembourg	502	607	6 003	4,965
Netherlands	4 886	12,248	3 218	2,698
Other countries	28 316	28,060	7 739	6,345
Total	126 539	132,836	119 816	104,695
Lead and alloy scrap (gross weight)				
Brazil	1 575	368	1 783	3,473
United States	2 662	1,961	2 967	1,941
Sweden	1 536	1,161	2 269	1,326
Taiwan	1 191	530	1 328	552
Denmark	574	381	445	211
Other countries	13 566	7,491	992	358
Total	21 104	11,892	9 784	7,861
Lead fabricated materials not elsewhere specified				
United States	3 780	4,055	3 325	3,180
U.S.S.R.	-	-	2 699	2,380
Denmark	214	224	273	320
South Korea	-	-	346	254
Other countries	683	710	176	202
Total	4 677	4,989	6 819	6,336

TABLE 1. (cont'd)

	1980 (tonnes)	1980 ($000)	1981P (tonnes)	1981P ($000)
Imports				
Lead pigs, blocks and shot	2 602	3,051	9 220	8,720
Lead oxide, dioxide and tetroxide	926	1,264	1 363	1,687
Lead fabricated materials not elsewhere specified	1 165	1,465	2 786	3,772
Lead concentrates	34 280	25,925	48 945	36,737
Lead in crude ores	136	82	2 347	761
Lead in dross, skimmings and sludge	7 717	4,052	57	27
Lead and lead alloy scrap	50 970	19,354	40 796	12,585

	1979 Primary	1979 Secondary[5]	1979 Total	1980P Primary	1980P Secondary[5]	1980P Total
			(tonnes)			
Consumption [4]						
Lead used for, or in the production of:						
Antimonial lead	1 209	x	x	1 300	x	x
Battery and battery oxides	44 509	4 729	49 238	49 600	8 172	57 772
Cable covering	x	x	x	x	x	x
Chemical uses; white lead, red lead, litharge, tetraethyl lead, etc.	14 612	6 556	21 168	14 054	7 490	21 544
Copper alloys; brass, bronze, etc.	302	70	372	163	71	234
Lead alloys:						
solders	1 765	5 780	7 545	1 684	4 956	6 640
others (including babbitt, type metals, etc.)	306	2 548	2 854	136	238	374
Semi-finished products: pipe, sheet, traps, bends, blocks for caulking, ammunition etc.	2 172	x	x	3 290	x	x
Other lead products	3 696	9 764	16 841	4 379	11 303	20 272
Total, all categories	68 571	29 447	98 018	74 606	32 230	106 836

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 anitimonial lead.
P Preliminary; - Nil; .. Not available; x Confidential, but included in "other".

TABLE 2. CANADA, LEAD PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975-81

	Production		Exports				
	All forms[1]	Refined[2]	In ores and concentrates	Refined	Total	Imports 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
1976	256 324	175 720	140 933	114 421	255 354	1 941	107 654
1977	280 955	187 457	137 820	130 819	268 639	821	106 962
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
1981P	272 928	168 450	146 094	119 816	265 910	9 220	..

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.

Sturgeon Lake area of Ontario started production in 1981 with an annual capacity of 1 000 t of lead and 12 000 t of zinc in concentrates. The ore is treated at Mattabi Mines Limited's concentrator.

With exhaustion of their open-pit, Mattabi Mines began sinking a shaft to the lower ore zone in the fall reaching a depth of 90 m at the end of 1981. Ore production is scheduled for 900 tpd until the shaft is completed. Until then a decline ramp will service the mine. Texasgulf Canada Ltd. changed its name to Kidd Creek Mines Ltd. near the end of 1981. Although primarily a zinc-copper-silver producer, Kidd Creek ships lead concentrates without further processing.

Underground exploration is under way on the Tom claims of the Hudson Bay Mining and Smelting Co., Limited. Additional underground data is being sought for a feasibility study at this Yukon Territory prospect.

Cyprus Anvil Mining Corporation and Hudson's Bay Oil and Gas Company Limited (HBOG) are conducting a major exploration program on the Cirque deposit in the Akie River District north of Williston Lake in north-central British Columbia. During 1981, a diamond drilling program was completed, as was construction on an 80 km access road to the property. Work to date indicates a lead-zinc-silver district of potentially major proportions. During the year, Hudson's Bay Oil and Gas acquired from Standard Oil Company (Indiana) its 63 per cent interest in Cyprus Anvil and subsequently offered to purchase the remaining outstanding common shares. Cyprus Anvil is continuing its Vangorda Plateau development program in the Yukon. Modifications to its Anvil concentrator, started in 1980, have been completed at a cost of some $71 million. The modifications were necessary to handle the ores from the Vangorda and Grum deposits. The company has started a $240 million long-term development program to bring these properties into production in 1985 and 1988 respectively. The new ore will be blended with ore from the existing Faro deposit and will see the life of the Faro camp possibly extended into the next century.

Cominco Ltd. completed construction and development work at its Polaris mine on Little Cornwallis Island in the arctic. Cominco has been a pioneer in northern mine development, first with the Con mine at Yellowknife in the Northwest Territories, then the Black Angel mine in Greenland, and now the Polaris. The Polaris will be the world's most northerly mine, located only 45 km southeast of the magnetic north pole. Start-up of the mine was scheduled for the beginning of 1982, and at full design capacity, the Polaris mill will produce 130 000 tpy of zinc in concentrates and 30 000 tpy of lead in concentrates. This will make Cominco, which celebrated its 75th anniversary in 1981, the world's largest producer of lead and zinc. A barge measuring 122 m by 30.5 m constructed by Davie Shipbuilding Limited at Lauzon, Quebec, was outfitted at Trois-Rivieres by a joint venture of Comstock Quebec Ltée and Dominion Bridge-Sulzer Inc. It contained the concentrator, powerhouse, warehouses, laboratories, changehouse, repair shops and offices. Work on the barge was completed in early July and it was towed the 4 800 km to the mine by the middle of August. The barge was permanently berthed on a prepared area of the shoreline. The only other buildings exposed to the elements in this area, where the temperature is usually well below 0°C with prolonged periods of 100 km/hr winds, is the concentrate storage shed and an accommodation complex. The waters around the island are navigable for only a short period starting in August, when the mine's production must be shipped out and all major supplies brought in. In 1982, the first shipments of about half of an average year's production will be shipped out. Ore reserves at Polaris are estimated at 23 million t averaging 14.1 per cent zinc and 4.3 per cent lead.

Another northern project is rapidly reaching the production stage. Cadillac Explorations Limited of Calgary has received the financing necessary to complete the development of its mining leases on Prairie Creek in the Nahanni mining district of the Northwest Territories. A 900 tpd mill built on the property is expected to be completed in 1982 and production at the rate of 25 000 tpy of lead and 25 000 tpy of zinc in concentrates is planned. Proven ore reserves in one of 12 known mineralized zones is reported as 1.4 million t averaging 11.2 per cent lead, 12.2 per cent zinc, 0.4 per cent copper and 6.0 oz/t silver.

Other lead and zinc projects in Canada under serious consideration include:

. The Howard's Pass zinc-lead deposit in the Yukon Territory, held by Placer Development Limited and United States Steel Corporation, with potential annual output of 200 000 t of zinc and 100 000 t of lead in the late-1980s.

. The Great Slave Reef zinc-lead deposit near Pine Point in the Northwest Territories, held by Westmin Resources Limited, Philipp Brothers (Canada) Ltd. and Du Pont Canada Inc., with potential output of 45 000 tpy of zinc and 22 000 tpy of lead in the late-1980s.

. The Tom zinc-lead deposit in the Yukon Territory held by Hudson Bay Mining and Smelting Co., Limited, with potential output of 90 000 t of zinc and 90 000 t of lead in the late-1980s.

. The Cirque deposit in the Akie River District of British Columbia held by Cyprus Anvil and Hudson's Bay Oil and Gas with potential output of 30 000 t of lead and 140 000 t of zinc in the late-1980s.

Canada's primary lead output in 1981 was 168 450 t, up from the 162 463 t produced in 1980. Cominco, as part of its current rehabilitation and expansion program, is adding 35 000 t to its existing 145 000 tpy capacity for producing electrolytic lead. The new capacity is expected to come onstream in 1985.

Sintering and acid plant bottlenecks and low lead, high sulphur content in concentrates were cited by the other Canadian producer, Brunswick Mining and Smelting Corporation Limited, as reasons for falling short of their production expectations in 1981.

Refined lead production was maintained at the 1980 level by Cominco Ltd. Investigation of the Russian (Kivcet) flash smelting/electric furnace was undertaken by this firm in order to assess its potential for modernizing the Trail, British Columbia facility. Brunswick Mining and Smelting Corporation Limited also demonstrated an improved process for recovering lead and silver in pilot tests at the Belledune, New Brunswick smelter. In addition, a campaign by management and workers to reduce costs was continued by this company in 1981.

Canadian secondary lead production in 1981 is estimated at 70 000 t, slightly lower than the 72 117 t produced in 1980. The Canadian secondary lead industry, in common with the secondary industry in other industrialized countries, is experiencing a scarcity of scrap supplies at prevailing lead prices, which may account for the low operating rate of the secondary industry.

CONSUMPTION

Consumption of refined lead in Canada (refined pig lead, including the lead content of antimonial lead regardless of source) continued the cyclical pattern of recent years (see Tables 1 and 2). An increase in producer shipments in 1981 indicates that consumption in Canada may have increased over 1980 levels.

TABLE 3. UNITED STATES CONSUMPTION OF LEAD BY END-USE, 1980 AND 1981

	1980	1981P
	(tonnes)	
Storage batteries	645 357	599 717
Gasoline antiknock additives	127 903	111 366
Solder, type metal, terne metal and bearing metals	61 032	40 755
Pigments	78 430	65 653
Ammunition - shot and bullets	48 662	50 441
Sheet and pipe	28 393	12 038
Cable covering	13 408	11 759
Caulking	5 684	2 088
Other uses	61 434	37 045
Total reported[1]	1 070 303	930 862
Estimated undistributed consumption	-	194 400
Grand Total	1 070 303	1 125 300

Source: United States Bureau of Mines, **Mineral Industry Surveys,** Lead Industry in December 1981.
[1]Includes lead content of scrap used directly in fabricated products.
P Preliminary; - Nil.

TABLE 4. NON-COMMUNIST WORLD MINE PRODUCTION[1] OF LEAD, 1980 AND 1981

	1980	1981P
	(000 tonnes)	
United States	562	452
Australia	382	363
Canada	297	332
Peru	189	187
Mexico	146	149
Republic of South Africa	132	147
Morocco	116	128
Yugoslavia	122	119
Sweden	70	85
Spain	87	84
Japan	45	47
Argentina	33	34
Ireland	58	29
West Germany	31	29
Denmark	30	27
Brazil	25	24
Italy	24	21
Other countries	189	198
Total	2 538	2 455

Source: International Lead and Zinc Study Group, Monthly Bulletin, April 1982.
P Preliminary.

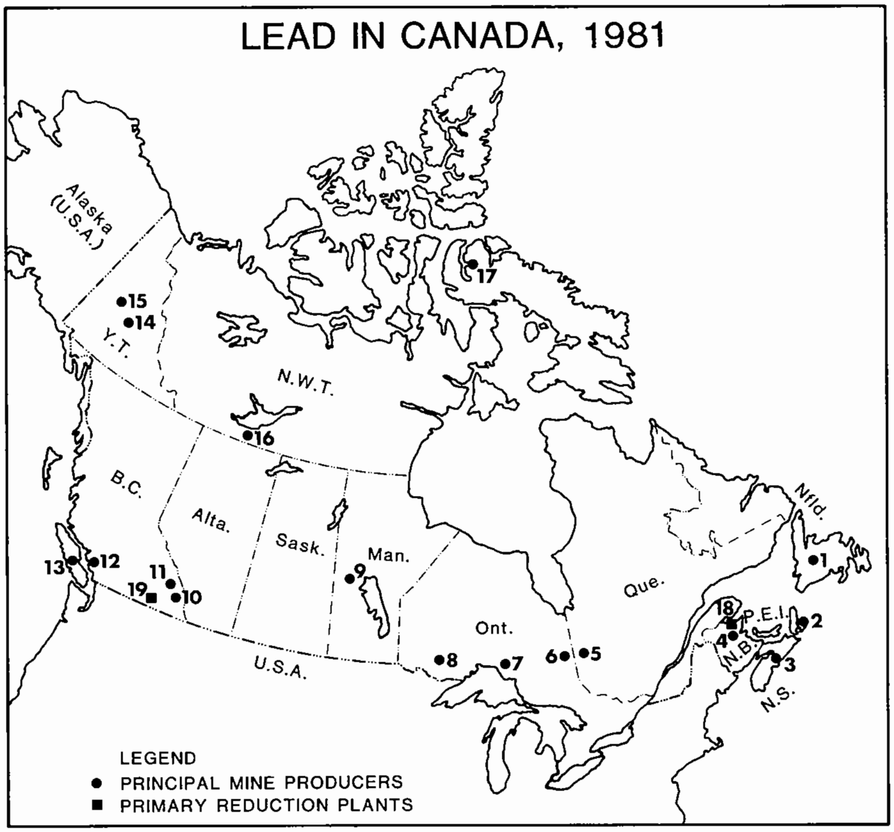
WORLD DEVELOPMENTS

Non-communist world lead mine production in 1981, at an estimated 2.4 million t, was 43 000 t, or 1.7 per cent below that in 1980 (see Table 4). Increased production in South Africa and Canada was more than offset by decreases because of strikes in the United States and Ireland. Refined metal production was down 192 000 t from 1980 (see Table 6).

Production of lead concentrates in South Africa continued to increase as a major new lead mine reached its capacity. The Broken Hill mine of Black Mountain Mineral Development Company Limited at Aggeneys, Cape Province came into production in 1980 and has the capacity to produce 90 000 tpy of lead and 18 000 tpy of zinc in concentrates.

The Que River project of Aberfoyle Limited, 47 per cent owned by Cominco Ltd., started production in 1981 and is expected to produce at an annual rate of 12 000 t of lead and 20 000 t of zinc in concentrates. The ore is treated at the nearby concentrator of Electrolytic Zinc Company of Australasia Ltd. which increased its capacity to accommodate the Que River ore. During 1982 and 1983, total lead capacity in Australia resulting from new mines coming on-stream is expected to increase by some 70 000 tpy. In Australia, strike difficulties in early 1981 at the North Broken Hill Holdings Ltd.'s lead-zinc-silver mines led to cutbacks in production at the Port Pirie lead smelter, operated by The Broken Hill Associated Smelters Pty. Ltd. (BHAS), to 70 per cent of capacity.

The Missouri lead belt in the United States was hit by a series of strikes which forced St. Joe Minerals Corporation to close its mines for three months and its Herculaneum, Missouri lead smelter for two months. Subsequently, a strike closed AMAX Inc.'s Missouri lead mining and smelting facilities for 2½ months.



Principal mine producers
(numbers refer to locations on map above)

1. ASARCO Incorporated (Buchans Unit)
2. Barymin Explorations Limited (Yava Unit)
3. Esso Minerals Canada (Gays River)
4. Brunswick Mining and Smelting Corporation Limited (Nos. 12 and 6 mines)
   Heath Steele Mines Limited
5. Louvem Mining Company Inc. (Louvem Unit)
6. Kidd Creek Mines Ltd.
7. Noranda Mines Limited (Geco Division)
8. Mattabi Mines Limited
   Noranda Mines (Lyon Lake)
9. Hudson Bay Mining and Smelting Co., Limited
10. Cominco Ltd. (Sullivan mine)
11. Dickenson Mines Limited (Silmonac mine)
12. Northair Mines Ltd.
13. Westmin Resources Limited
14. Cyprus Anvil Mining Corporation
15. United Keno Hill Mines Limited
16. Pine Point Mines Limited
17. Nanisivik Mines Ltd.

Primary Reduction Plants

18. Brunswick Mining and Smelting Corporation Limited, Smelting Division
19. Cominco Ltd., Trail

TABLE 5. PRINCIPAL LEAD MINES IN CANADA, 1981 (1980)

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
Newfoundland												
ASARCO Incorporated, Buchans Unit, Buchans	1 100 (1 100)	0.80 (0.85)	5.31 (5.42)	8.95 (9.38)	92.9 (102.5)	0.72 (0.82)	68 946 (75 297)	5 395 (6 319)	54.73 (52.60)	2 953 (3 324)	3 403 (3 822)	3 (1,3)
Nova Scotia												
Barymin Explorations Limited, Yava Unit	550 (550)	.. (-)	.. (4.56)	.. (-)	.. (5.11)	.. (-)	.. (172 815)	.. (10 181)	.. (68.24)	.. (6 948)	.. (6 948)	.. (5)
Esso Resources Canada Limited, Gays River	1 500 (1 500)	.. (-)	.. (1.43)	.. (2.04)	.. (-)	.. (-)	.. (261 942)	.. (4 802)	.. (75.10)	.. (3 606)	.. (3 635)	.. (5)
New Brunswick												
Brunswick Mining and Smelting Corporation Limited, Bathurst	10 000 (9 050)	0.35 (0.31)	3.50 (3.56)	8.74 (8.80)	97.9 (97.4)	- (-)	3 422 690 (1 848 036)	290 781 (169 292)	27.43 (26.81)	79 775 (45 395)	89 864 (50 716)	1,5,6,8 (1,2,5,8)
Heath Steele Mines Limited, Newcastle	3 600 (3 600)	0.91 (0.84)	1.45 (1.45)	3.94 (4.34)	51.4 (55.2)	0.69 (1.03)	1 249 928 (1 252 406)	31 187 (39 761)	24.61 (20.10)	7 675 (7 992)	11 090 (11 351)	3,5,6,7,8 (1,3,5,7,8)
Quebec												
Louvem Mining Company Inc. (SOQUEM), Val d'Or	900 (900)	0.19 (0.15)	0.19 (0.11)	4.03 (3.89)	29.5 (30.4)	0.96 (1.82)	32 276 (224 530)	- (-)	- (-)	- (-)	3 (181)	8 (-)
Ontario												
Corporation Falconbridge Copper, Sturgeon Lake Joint Venture, Sturgeon Lake	Ceased October 1980 (1 100)	(1.46)	(1.05)	(5.89)	(131.7)	(0.48)	(371 623)	(6 826)	(29.53)	(2 016)	(2 745)	(2)

Kidd Creek Mines Ltd.,	12 250	..	..	..	..	..	..	..	..	..	..	..
Kidd Creek Mine,	(12 250)	(1.83)	(0.18)	(5.78)	(86.4)	(-)	(3 899 575)	(27 785)	(11.53)	(3 204)	(5 293)	(3)
Timmins												
Mattabi Mines Limited,	2 700	..	..	..	..	..	..	..	..	..	..	..
Sturgeon Lake	(2 700)	(0.44)	(0.87)	(7.24)	(106.6)	(-)	(846 940)	(20 398)	(21.64)	(4 414)	(5 618)	(1,2,3)
Noranda Mines Limited,	4 550	..	..	..	..	..	..	..	..	..	..	..
Geco Division,	(4 550)	(1.47)	(0.14)	(3.32)	(60.7)	(0.10)	(1 358 317)	(1 536)	(46.13)	(708)	(1 659)	(1,2)
Manitouwadge												
Manitoba-Saskatchewan												
Hudson Bay Mining and	7 250	1.58	0.14	2.10	20.0	1.30	983 990	-	-	-	559	..
Smelting Co.,	(7 250)	(1.67)	(0.15)	(2.11)	(19.8)	(1.30)	(945 379)	(-)	(-)	(-))	(521)	(-)
Limited,												
Flin Flon concen-												
trator												
Snow Lake concen-	3 450	2.56	0.14	2.65	12.4	1.03	771 427	736	61.78	455	694	2
trator	(3 450)	(2.65)	(0.23)	(3.23)	(16.7)	(1.10)	(756 283)	(953)	(60.43)	(576)	(1 127)	(2)
British Columbia												
Cominco Ltd.,	9 050	-	4.43	3.23	62.1	-	2 209 669	134 281	62.66	84 140	88 986	..
Sullivan mine,	(9 050)	(-)	(3.85)	(2.73)	(44.6)	(-)	(2 132 416)	(109 917)	(62.21)	(68 380)	(72 675)	(2)
Kimberley												
Dickenson Mines Limited,	(100)	-	4.18	3.49	430.3	-	26 764	1 940	55.4	1 075	1 093	2
Silmonac mine,	(100)	(-)	(3.21)	(3.03)	(295.9)	(-)	(28 223)	(1 420)	(58.50)	(831)	(845)	(2)
Sandon												
Northair Mines Ltd.,	250	0.15	1.15	2.09	28.6	7.92	62 548	1 271	48.82	620	675	2
Brandywine area	(250)	(0.50)	(1.38)	(2.15)	(32.3)	(8.37)	(71 478)	(1 879)	(46.55)	(874)	(936)	(2)
Teck Corporation,	100	-	0.35	0.82	353.1	-	35 774	395	20.48	81	110	2
Beaverdell	(100)	(-)	(0.23)	(0.56)	(290.7)	(-)	(38 550)	(283)	(20.95)	(59)	(80)	(2)
Westmin Resources												
Limited	900	1.13	1.22	7.37	124.1	2.67	246 150	5 358	42.73	2 289	2 809	2
Lynx and Myra Falls	(900)	(1.22)	(1.23)	(7.58)	(124.1)	(2.74)	(278 244)	(6 592)	(42.00)	(2 768)	(3 275)	(2)
mines,												
Buttle Lake												

TABLE 5. (cont'd.)

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/	(%)	(%)	(%)	(grams/	(grams/	(tonnes)	(tonnes)	(%)	(tonnes)	(tonnes)	
Yukon Territory												
Cyprus Anvil Mining Corporation, Faro	9 050 (9 050)	- (-)	2.90 (3.12)	4.80 (4.68)	42.0 (47.0)	0.15 (0.25)	2 751 789 (2 825 150)	111 628 (130 038)	55.10 (52.48)	61 507 (68 248)	65 934 (73 711)	4,8 (4,5,8)
United Keno Hill Mines Limited, Elsa	450 (450)	- (-)	3.59 (3.39)	0.64 (0.79)	750.2 (787.2)	- (-)	60 712 (79 636)	3 531 (4 705)	29.11 (34.00)	1 028 (1 600)	1 028 (1 603)	3 (3)
Northwest Territories												
Nanisivik Mines Ltd., Baffin Island	2 200 (2 200)	- (-)	.. (2.37)	.. (14.28)	.. (66.2)	.. (-)	.. (435 147)	.. (13 375)	.. (70.60)	.. (9 442)	.. (9 967)	6,8 (6)
Pine Point Mines Limited, Pine Point	10 000 (10 000)	- (-)	2.02 (1.96)	4.78 (5.49)	- (-)	- (-)	3 298 655 (3 289 329)	78 429 (74 170	77.16 (76.04)	60 516 (56 399)	64 723 (61 421)	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; .. Not available.

TABLE 6. NON-COMMUNIST WORLD PRODUCTION[1] OF REFINED LEAD, 1980 AND 1981

	1980	1981P
	(000 tonnes)	
United States	1 150	1 002
West Germany	350	349
United Kingdom	325	333
Japan	305	317
Australia	232	240
Canada	235	238
France	219	228
Mexico	185	166
Italy	134	133
Spain	124	119
Belgium	106	102
Yugoslavia	102	86
Peru	87	84
Republic of South Africa	78	67
Brazil	85	66
Other countries	387	382
Total	4 104	3 912

Source: International Lead and Zinc Study Group, Monthly Bulletin, April 1982.
[1] Total production by smelters or refineries, or refined pig lead, plus the lead content of antimonial lead - including production on toll in the reporting country - regardless of the type of source material; i.e., whether ores, concentrates, lead bullion, lead alloys, mattes, residues, slag or scrap. Remelted pig lead and remelted antimonial lead are excluded.
P Preliminary.

The Bunker Hill Co. announced the closure of its Kellogg, Idaho lead-zinc-silver smelting complex for economic reasons. The plant was outmoded and could not meet environmental standards. The shutdown of the 99 000 tpy zinc and 115 000 tpy lead facility started in the middle of November.

Employees of the Tara Mines Ltd. mine at Navan, Ireland went on strike early in July and were still on strike at the end of the year. The Tara mine is a major producer of concentrates for the European smelting industry, having a capacity to produce about 220 000 tpy of zinc and 40 000 tpy of lead in concentrates. Equipment breakdown at the lead-zinc smelter of Australian Mining & Smelting Limited located at Avonmouth, England stopped production for a month and forced the company to declare **force majeure** on its lead bullion shipments.

The Italian lead producer, SAMIN S.p.A. closed its San Gavino smelter in Sardinia for environmental reasons. Annual capacity of this plant was rated at 50 000 t of refined lead. A furnace breakdown from August until December forced Boliden Metall AB to halt shipments from its Swedish smelter.

Future primary smelting capacity under construction in 1981 amounted to 159 000 tpy. These projects are located in Italy, Bolivia, Peru, India and Canada. Known feasibility studies are under way for a further capacity increase of 200 000 tpy worldwide.

New secondary smelter plants under construction or known to be under consideration will add 53 000 tpy of future capacity by the middle of the decade, if realized. Hollandse Metallurgische Industrie Billiton BV, is currently replacing an old secondary refinery with a new one. Additional production capability is expected to be 20 000 t for 1982.

CONSUMPTION AND STOCKS

Non-socialist world consumption of refined lead continues the downward fall begun in 1979. A total of 3 756 000 t was used during the year reflecting declines in every continent but Asia (see Table 7). Notable increases in demand came from Korea, Thailand, Iran and other Asian countries.

Refined metal stocks held by producers increased slightly over 1980 levels in Canada. The increase was proportionally less than in Japan or the United States. Elsewhere, stock levels held steady. London Metal Exchange stocks were more volatile, dropping from 73 000 t to 49 000 t (at the end of 1980 and 1981, respectively) as a result of consumer purchases. Worldwide surplus production narrowed in 1981 compared with 1980, with a more rapid decline in metal production than that of consumption.

PRICES

The U.S. producer price for lead was 39 cents a pound at the end of 1980 and in Canada the producer price was 45.5 cents. During 1981 the price fluctuated with changes in supply and anticipated demand, the main factor in the United States being lengthy strikes in the Missouri lead belt which ended in August. Declines in January and early February brought the producer

TABLE 7. NON-COMMUNIST WORLD CONSUMPTION[1] OF REFINED LEAD, 1980 AND 1981

	1980	1981P
	(000 tonnes)	
United States	1 094	1 051
Japan	392	382
West Germany	333	332
United Kingdom	296	266
Italy	275	256
France	212	211
Canada	110	115
Spain	114	102
Mexico	96	95
Yugoslavia	105	85
Australia	71	71
Brazil	83	70
Other countries	751	720
Total	3 932	3 756

Source: International Lead and Zinc Study Group, Monthly Bulletin, April 1982.
[1] Consumption of those types of metal as reported under "production" in Table 6.
P Preliminary.

TABLE 8. LEAD METAL PRICES, 1981

Month	London Metal Exchange Spot	U.S. Domestic Delivered Price	Canada Delivered Carlots
	£ per tonne	¢ per pound	$ per pound
January	293.5	33.8	42.63
February	300.5	30.4	37.13
March	326.9	35.0	42.60
April	348.8	37.5	44.50
May	333.7	36.4	45.00
June	361.1	38.0	45.80
July	418.6	41.0	49.63
August	452.6	43.9	53.30
September	420.8	40.3	50.50
October	389.3	37.0	44.88
November	350.0	33.9	40.90
December	354.3	31.1	37.38
1981 Average	362.5	36.5	44.52
1980 Average	391.3	42.5	49.35

Source: International Lead and Zinc Study Group, Monthly Bulletin, April 1982; **Northern Miner** quotes as compiled by Energy, Mines and Resources Canada.

price down to 30 cents in the United States and to 36 cents in Canada. The price then increased gradually until early August when it was 46 cents in the United States and 56 cents in Canada. Then, with ample supplies, it declined and at year-end was 34 cents in the United States and 40 cents in Canada. Table 8 shows monthly averages as compiled by Energy, Mines and Resources Canada.

The monthly average settlement price for lead on the LME fell from £317 a t in December 1980 to £294 in January. It increased to £453 in August, reaching a peak of £509 on August 12. It then fell to below £400 at the beginning of October and continued to the £363 level by the end of December.

TRADE

Imports of lead in ores and concentrates by Japan decreased slightly in 1981, however a notable shift toward diversification of sources was evident. Decreased imports from Australia, Canada and the Philippines were replaced by increased purchases from Peru and other countries. West Germany's increased demands were met largely by Sweden during 1981. Although purchases of concentrates remained steady for France, increased reliance on diverse sources, largely as a result of declines in shipments from Ireland, was notable. U.S. imports of concentrates grew in 1981 with Canada and Honduras supplying increased needs there. Brazil's imports of lead in ores and concentrates dropped substantially from 21 000 t in 1980 to 9 000 t in 1981. Imports of lead bullion by West Germany, France and Belgium also saw relatively large drops during the year.

Imports of refined lead metal declined significantly during 1981 for West Germany, Italy, the Netherlands and Switzerland. Demand from the United States increased however. At the same time, export sales of lead metal from France and Morocco continued to grow. For countries such as the Netherlands, Yugoslavia and Mexico however, refined metal sales abroad followed a falling trend.

GOVERNMENT INITIATIVES

On December 8, 1980 the U.S. Supreme Court ruled against petitions filed by the Lead Industries Association and a number of concerned companies and maintained the standard of 1.5 micrograms of lead per cubic metre of ambient air as promulgated by the Environmental Protection Agency (EPA). A standard, promulgated by the Occupational Safety and Health Administration (OSHA) for workplace exposure, was partly stayed by the U.S. Supreme Court pending decision on a comprehensive appeal filed by the lead industry. In June 1981, the Court upheld provisions of the OSHA lead standard, which had become effective on May 15, 1981, including provisions related to lead levels in blood. The standard has reduced the trigger levels for all lead-intensive occupations, with the exception of those at primary and secondary lead smelters, from 70 to 60 micrograms of lead per 100 g of blood. The EPA standard for lead in gasoline of 0.5 g of lead per gallon of gasoline went into effect in October 1980. The standard is the limit on the quarterly average of all gasoline produced. However the U.S. Administration is studying the possibility of raising the limit for small refiners to ease the economic burden on them. It is also considering relaxing or rescinding the entire lead phase-down rule.

In Britain, the government announced plans to reduce the lead content of gasoline no later than the end of 1985 from 0.4 to 0.15 g per litre. The new limit is the lowest provided for under European Community rules and is matched at present only by West Germany.

USES

Canadian producers of refined lead continue to adapt to the changing requirements of the most significant lead product, the lead-acid battery. Cominco Ltd. began commercial production of its wrought lead strip manufacturing equipment. This development promises to improve upon previous methods of battery grid manufacture.

Technological improvements in the design of lead-acid batteries continue to reduce weight and improve performance in the starting, lighting, and ignition (SLI) market. A decline in the amount of lead needed per battery is predicted as a result. The potential for lead consumption in this market is bolstered, however, by the growth of diesel engine populations. Cranking power requirements are much higher than those for gasoline types. Replacement battery sales are expected to increase as a result of shortened battery life.

In addition, requirements are growing in the sheet-lead and stand-by battery markets, partially offsetting declines in other uses worldwide. While the electric vehicle battery outlook continues to be uncertain, large-scale utility load levelling applications show promise for the near future. Work on the world's largest commercial battery (1 540 t of lead) continues in the U.S.

OUTLOOK

In the long term, only lead-acid batteries appear to show promise as a growing end-use for lead. Gasoline additives such as the alkyl lead compounds, TEL and TML, are predicted to decline especially in the industrialized world because of environmental legislation. Demand growth may occur for these octance boosters but only in developing nations. Non-socialist world lead consumption is expected to grow by 2 per cent per year until 1990 with batteries contributing the strongest stimulus. However, further technological improvements in battery life, reductions in the amount of lead used per battery and decreasing engine sizes may dampen prospects even in the market.

With increasing emphasis on batteries as an end-use for lead, significant restructuring of the supply market may present problems for primary producers. Increased competition from the scrap recycling industry worldwide can be expected with improved prices, more efficient secondary smelting technology, innovative scrap collection systems or further rationalization of the secondary sector. Further market competition will result from primary capacity expansions in excess of demand.

Given that, lead - because of its characteristic co-production with zinc and other metals from naturally occurring ores - will continue to be supplied as long as markets for these other commodities are favourable, any declines in lead usage or accelerated additions to capacity will continue the patterns of oversupply, price instability and increasing market competition for the future. Growth in lead consumption will mean growth for cost-competitive and innovative producers of lead, one of the earliest metals known and used by man.

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	4.9%	4.8%	25%	3%
33900-1	Manufacturers of lead not otherwise provided for	16.6%	15.7%	30%	10%

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

Item No.	1981	1982	1983	1984	1985	1986	1987
			(%)				
33800-1	4.8	4.6	4.5	4.4	4.3	4.1	4.0
33900-1	15.7	14.8	13.9	12.9	12.0	11.1	10.2

UNITED STATES (MFN)

Item No.		
602.10	Lead bearing ores per lb. on lead content	0.75¢
624.02	Lead bullion	3.5%
624.03	Other	3.5%

		1981	1982	1983	1984	1985	1986	1987
				(%)				
624.04	Lead waste etc.	3.4	3.2	3.0	2.8	2.7	2.5	2.3

EUROPEAN ECONOMIC COMMUNITY: (MFN)

Item No.		1981	Base Rate	Concession Rate
			(%)	
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)

Item No.			(%)	
26.01	Lead ores & concentrates	free	free	free
78.01	Lead unwrought			
	Unalloyed	7.1	7.5	6.0
	Alloyed	8.8	12.0	6.5
	Other	5.4	7.0	4.7
	Lead waste & scrap	3.8	5.0	3.2

Sources: The Customs Tariff and Commodities Index, January 1981, Revenue, Canada; Tariff Schedules of the United States Annotated (1981), USITC Publication 1111; U.S. Federal Register Vol. 44, No. 241; Official Journal of the European Communities, L315, Vol. 23; Customs Tariff Schedules of Japan, 1981.

Lime

D.H. STONEHOUSE

SUMMARY

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. 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 Canada's total lime output in 1981, 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. With the addition of some new and larger capacity in recent years the industry can not produce between 10 000 and 12 000 tpd or about 3.5 million tpy.

Canadian production of lime in 1981 approached that of the previous year despite the fact that utilization of lime by the steel industry and by the mining industry was reduced, reflecting a downturn in

TABLE 1. CANADA, LIME PRODUCTION AND TRADE, 1980 AND 1981

	1980		1981P	
	(tonnes)	($000)	(tonnes)	($000)
Production[1]				
By type				
Quicklime	2 364 000	118,200	2 269 000	..
Hydrated Lime	190 000	11,032	194 000	..
Total	2 554 000	129,232	2 463 000	148,473
By province				
Ontario	1 759 000	87,950	1 711 000	103,500
Quebec	366 000	19,859	348 000	20,589
Alberta	184 000	8,800	170 000	9,838
British Columbia	116 000	5,780	112 000	6,753
Manitoba	..	3,500	..	4,296
New Brunswick	..	3,343	..	3,497
Total	2 554 000	129,232	2 463 000	148,473
Imports				
Quick and hydrated				
United States	39 005	3,085	23 046	1,905
France	18	28	43	51
West Germany	1 000	192	-	-
United Kingdom	878	129	-	-
Total	40 901	3,434	23 089	1,956
Exports				
Quick and hydrated				
United States	399 272	21,009	429 116	25,496
Honduras	1 153	109	1 244	218
Barbados	1 596	258	415	35
Other countries	1 145	154	227	25
Total	403 166	21,530	431 002	25,774

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, 1975-81

	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
1976	1 703 374	227 019	1 930 393	36 882	309 355	1 657 920
1977	1 767 406	232 638	2 000 044	24 480	359 540	1 664 984
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 480r	490 863	1 409 942
1980	2 364 000	190 000	2 554 000	40 901	403 166	2 191 735
1981P	2 269 000	194 000	2 463 000	23 046	431 002	2 055 044

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Producers' shipments and quantities used by producers. [2] Production, plus imports, less exports.
P Preliminary; r Revised.

TABLE 3. CANADIAN LIME INDUSTRY, 1981

Company	Plant Location	Type of Quicklime
New Brunswick		
Havelock Processing Ltd.	Havelock	High-calcium
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]
	Hespeler	Dolomitic[2]
Reiss Lime Company of Canada, Limited	Spragge	High-calcium
Stelco Inc.	Ingersoll	High-calcium[2]
Steetley Industries Limited	Dundas	Dolomitic
Manitoba		
The Manitoba Sugar Company, Limited[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
Summit Lime Works Limited	Hazell	High-calcium and dolomitic
British Columbia		
Steel Brothers Canada Ltd.	Kamloops	High-calcium
Texada Lime Ltd.	Fort Langley	High-calcium

Source: Energy, Mines and Resources Canada.
[1] Production for captive use. [2] Hydrated lime produced also.

Note: Domtar Inc., Steetley Industries Limited, and Steel Brothers Canada Ltd. operate lime divisions in the United States.

each of these major market areas. Environmental control in such areas as water and sewage treatment, and removal of SO_2 from smelter stack gases and thermal power plant emissions, will undoubtedly require large amounts of lime in the future. These markets have not yet shown significant gain in Canada.

Developments within the industry in Canada in 1981 included the completion and start-up of a second kiln at the Pavilion Lake, British Columbia plant of Steel Brothers Canada Ltd., adding 350 tpd to the plant's capacity.

Exports of lime were up slightly from 1980. Canadian companies operating lime plants in the United States include Steel Brothers Canada Ltd. with a new plant at Delta, Utah; Steetley Industries Limited with a plant at Gibsonburg, Ohio and the Lime Division of Domtar Inc. operating a plant at Bellafonte, Pennsylvania. Domtar Inc. sold

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	1 208 530[2]	72,851
Pulp and paper mills	303 484	15,356	271 945	16,393
Water and sewage treatment	113 219	5,729	22 760[3]	1,372
Nonferrous smelters	113 818[2]	5,759	111 388[2]	6,715
Cyanide and flotation mills	68 805[2]	3,481	(4)	(4)
Sugar refineries	19 006	962	25 841	1,558
Other industrial[1]	643 531	32,563	633 273	38,174
Agricultural	17 084[3]	864	17 370	1,048
Road stabilization	8 716[3]	441	9 338[3]	563
Other uses	97 056	4,911	162 555	9,799
Total	2 554 000	129,232	2 463 000	148,473

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.

its Tacoma, Washington plant to Continental Lime Inc. of Utah to permit Domtar to concentrate its production and marketing efforts in the northeastern United States and in Canada. Continental will continue to operate the Tacoma plant with limestone supplied from Domtar's Texada Island quarry in British Columbia.

USES

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 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.

TABLE 5. WORLD PRODUCTION OF QUICKLIME AND HYDRATED LIME INCLUDING DEAD-BURNED DOLOMITE SOLD AND USED, 1980 AND 1981

	1980P	1981e
	(000 tonnes)	
U.S.S.R.	24 500	25 300
United States	17 270	17 520
Japan	9 700	10 000
West Germany	9 000	9 300
Poland	7 500	7 700
France	4 800	5 000
Brazil	4 500	4 600
Mexico	4 400	..
Romania	3 900	..
East Germany	3 500	..
Czechoslovakia	3 000	..
United Kingdom	2 980	..
Belgium	2 800	2 900
Canada	2 554	2 463
Italy	2 400	2 400
Yugoslavia	2 400	..
Other countries	14 693	35 946
Total	119 897	123 129

Sources: Energy, Mines and Resources Canada; Statistics Canada; U.S. Bureau of Mines Minerals Yearbook Preprint 1980; U.S. Bureau of Mines, Mineral Commodity Summaries, 1982.
P Preliminary; e Estimated; .. Included in other countries.

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.

PRICES

Canada lime prices quoted in Corpus Chemical Prices

	December 1981
Lime carloads and truckload lots fob plant	
High calcium quicklime - bulk	$56.22 per tonne
High calcium hydrated - bulk	$59.14 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)

Item No.		
512.11	Lime hydrated	free
512.14	Lime other	free

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

Magnesium

A. JOHNSTON

For the first time in six years, world primary magnesium production declined in 1981, yet production still continued to outpace demand and the year ended with a large inventory accumulation. As metal markets weakened following the downturn of the economy, producers responded with production cuts, especially in the United States and Japan. Capacity utilization in the western world at year-end was 79 per cent. With magnesium consumption expected to increase by an average of 3.6 per cent annually over the next few years, existing western world capacity should be adequate until 1986.

Growth in demand for primary magnesium will be adversely affected by increased recovery of secondary magnesium from aluminum beverage can scrap, which contains some magnesium, and by the large price spread between magnesium and aluminum, exacerbated by world economic problems. However, to ensure growth of the industry, major producers continue to improve production and processing technology, reduce energy costs, and develop new products and alloys.

Because magnesium production is comparatively energy-intensive, new plants will be attracted to countries with abundant energy resources, such as Brazil, where a new plant started producing in October, and Canada, where the development of new production facilities is under study by Canadian and Japanese interests in British Columbia.

CANADA

Chromasco Limited is the only Canadian producer of primary magnesium. The company, located at Haley, Ontario, has produced magnesium since 1942, by reducing a local dolomite with ferrosilicon using external heat sources (Pidgeon process). Capacity of the plant is equivalent to about 4 per cent of annual world output. Other products of the plant include calcium and strontium metal using essentially the same equipment. The purity of the magnesium produced by Chromasco can be as high as 99.95 per cent, and finds application in the chemical industry.

Although production of magnesium in Canada has remained relatively steady over the past few years, it fell by 5.4 per cent in 1981 (Table 2). A significant proportion of output is exported. Consumption in 1981, at 5 942 t, was up 10 per cent from the previous year (Table 1).

Asbestos Corporation Limited, controlled by Société nationale de l'amiante (SNA), is constructing a processing plant at Thetford Mines to extract magnesium oxide from asbestos residues for use in fireproof materials. Start-up is scheduled for the spring of 1983. Another current SNA project using asbestos tailings involves a pilot plant for the production of magnesium metal.

Discussions between Cominco Ltd. and Mitsui & Co., Ltd. have led to a joint study into the feasibility of building a 15 000 - 20 000 tpy magnesium plant and a 30 000 tpy ferrosilicon facility at Kimberley, British Columbia. Cominco has excess hydroelectric capacity available to supply power to the proposed plants. Magnesium, plus the ferrosilicon not used in the magnesium reduction process, would be exported to Japan.

WORLD

Magnesium demand continued to weaken as the world recession intensified in mid-1981. Because production outpaced demand, the year ended with a large inventory accumulation. World primary production fell by 7 per

TABLE 1. CANADA, CONSUMPTION OF MAGNESIUM, 1976-1981

	1976	1977	1978	1979	1980	1981P
	(tonnes)					
Castings and wrought products[1]	1 087	879	952	1 447	1 412	644
Aluminum alloys and other uses[2]	3 143	5 343	3 001	3 003	4 000	5 298
Total	4 230	6 222	3 953	4 450	5 412	5 942

Source: Energy, Mines and Resources Canada.
[1] Die, permanent mould and sand castings, structural shapes, tubing, forgings, sheet and plate. [2] Cathodic protection, reducing agents, deoxidizers and other alloys.
P Preliminary.

cent (Table 2), the first decline in annual output since 1975, while capacity utilization in the western world declined to 80 per cent. In response to weakening markets, especially in housing and transportation, and high inventories, output of primary magnesium in the United States and Japan fell 16 and 39 per cent, respectively, in 1981. Of the ten countries producing primary magnesium metal during the year, the United States accounted for about 44 per cent of total world production, followed by the U.S.S.R. with 26 per cent, and Norway with 16 per cent.

Total world consumption of primary magnesium was down 7 per cent in 1981 compared to the year before (Table 3). Consuming countries include the United States with 31 per cent of the world total, the U.S.S.R. with 23 per cent, West Germany with 10 per cent, Japan with 8 per cent, China with 4 per cent, and a number of other countries with lesser amounts, including Canada.

Recycling is of moderate importance in magnesium, and data on amounts recovered are poor in most countries. Reported recoveries in 1981 in the United States were up 14 per cent to 42 000 t (in all forms), equal to one third of primary U.S. production; in Japan output was 28 400 t, up 32 per cent; in EEC countries it remained steady at 3 300 t; and India reported a small amount of secondary production.

The United States entered 1981 with one less magnesium producer because the American Magnesium Company suspended indefinitely its 9 000 tpy operation in December 1980. The remaining three producers have a capacity of 161 000 tpy, The Dow Chemical Company dominating with 70 per cent of current U.S. capacity. Dow, which uses an electrolytic process to extract magnesium from seawater, closed 25 per cent of its 114 000 tpy plant at Freeport, Texas, in October, for a period of six months to a year. The company also has delayed plans to increase capacity by 10 000 tpy, but expects to continue its 2 500 tpy low-energy pilot plant operation.

AMAX Specialty Metals Corporation, which extracts magnesium from natural brines, maintained production levels at its 25 000 tpy plant at Great Salt Lake, Utah. However, expansion proposals to almost double capacity have been delayed until demand improves.

Northwest Alloys, Inc., an Aluminum Company of America (Alcoa) subsidiary, reduced production by 50 per cent between June and September at its 22 000 tpy plant at Addy, Washington. Magnesium metal is produced by reducing dolomite with ferrosilicon using the Magnetherm process, developed in France by Société Française d'Electrometallurgie (SOFREM), whereby heat for the reactive process is generated by electrical resistance in the slag.

In response to weakening demand, U.S. production of primary magnesium, at 129 600 t, fell to 77 per cent of rated capacity. Of the 42 000 t of secondary production, approximately 18 000 t was from old scrap.

Norsk Hydro A/S, the world's second largest magnesium producer, announced a modernization program that could increase magnesium capacity by 20 per cent at its 50 000 tpy plant at Porsgrunn in southern Norway. Replacement of the Norsk electrolysis cell line with new, larger cells will result in lower energy consumption and a 30 to 40 per cent reduction of the workforce.

TABLE 2. WORLD PRIMARY MAGNESIUM PRODUCTION, 1979, 1980 and 1981

	1979	1980	1981
	(000 tonnes)		
United States	147.4	154.1	129.6
U.S.S.R.[e]	75.0	75.0	76.0
Norway	44.2	44.4	47.6
Canada	9.0	9.3	8.8
France	9.0	9.3	7.3
China, P.R.[e]	6.0	7.0	7.0
Japan	11.4	9.3	5.7
Yugoslavia	0.5	2.5[e]	4.3
Italy	8.8	9.7	10.8
Poland	0.5	0.5	0.5
Total	311.8	321.1	297.6

Source: Metal Statistics 1971-1981, 69th Edition, 1982, Metallgesellschaft, AG.
[e] Estimated.

Although expansion plans are subject to market conditions for magnesium, the project is expected to be completed in 1984.

Much of the magnesium metal consumed in Brazil is used in the manufacture of Volkswagen engines and other automobile parts. Since vehicle production fell sharply in 1981, due to depressed economic conditions, consumption of magnesium at 5 300 t was down about 60 per cent during the year. On a more positive note, Latin America's first magnesium smelter in the Brazilian state of Minas Gerais was brought into production by Brasiliera de Magnesio (Brasmag) in October. Magnesium metal is produced by reducing calcined dolomite with ferrosilicon using technology similar to the Magnetherm process. The plant, which is situated close to dolomite deposits, has access to low-cost hydroelectric power. Brasmag started up one of the twelve 450 tpy furnaces at the new $20 million smelter, which is expected to reach full 5 400 tpy capacity by 1984.

Magnohrom Oour Bela Stena, which began production in January 1980 at its 5 400 tpy magnesium smelter at Baljevac Na Ibru in Serbia, Yugoslavia, has decided to expand capacity by adding a third kiln. The smelter uses the Magnetherm silicothermic process.

Italy's production of primary magnesium increased by 11 per cent in 1981, but consumption, after reaching a high of 6 100 t in 1980, fell by 33 per cent in 1981. Soc. Italiana Per il Magnesio which is the only magnesium producer in the country, operates a 15 000 tpy plant at Bolzano. Plans to increase capacity have been delayed by increased energy costs and weak magnesium demand; however, the company has recently improved the energy efficiency of its silicothermic process.

Japanese demand for new magnesium metal remained steady for several years but then rose by 9 per cent in 1981 to 20 956 t, due largely to increased use of magnesium as a reducing agent in the production of titanium. However, domestic production fell by 39 per cent in 1981 to 5 667 t, as a result of high energy costs, removal of import duties in April, and the high value of the yen compared to other currencies. These conditions favoured imports over production, and imports increased to 66 per cent of the domestic market during the year. The United States is by far the largest supplier of magnesium to Japan, accounting for 63 per cent of Japan's imports of primary metal in 1981, while Canada supplied about 11 per cent. Japan's two primary magnesium producers, Furukawa Magnesium Company and Ube Kosan KK, each with a capacity of 5 600 tpy, reduced output to 43 per cent of capacity during the year.

ENERGY-SAVING PRODUCTION TECHNOLOGY

Because magnesium production is energy-intensive, major producers continue to develop methods that reduce energy consumption. Dow and Amax have reduced the energy required for their electrolytic operations by 22 and 15 per cent to lows of less than 302 380 kJ/kg (130 000 Btu/lb) and less than 279 120 kJ/kg (120 000 Btu/lb), respectively. Norsk Hydro is replacing its old cells with larger, energy efficient ones and, in Italy, the amount of energy required for the silicothermic process at the Bolzano smelter has been reduced to 279 120 kJ/kg to (120 000 Btu/lb). In France, SOFREM has improved the energy efficiency of its Magnetherm process by 10 per cent during the past two years.

Although considerable energy is required to produce magnesium, Professor D.R. Sadoway writes in the October 1982 issue of Chemtech that "the energy required

TABLE 3. PRIMARY MAGNESIUM SUPPLY/DEMAND PATTERN

	Production		Capacity		Consumption	
	1980	1981	1980	1981	1980	1981
	(000 tonnes)					
North America	163.4	138.4	180	171	92.3	88.4
Western Europe	65.9	70.0	81	82	66.4	57.2
Latin America	0	0	0	1	20.5	10.3
Asia-Oceania	9.3	5.7	13	13	24.6	26.4
Africa-Middle East	0	0	0	0	2.6	2.2
Western countries	238.6	214.1	274	267	206.4	184.5
Eastern countries	82.5	83.5	..	..	80.1	81.6
Total World	321.1	297.6	..	..	286.5	266.1

Sources: Metal Statistics 1971-81, 69th Edition, 1982; Metallgesellschaft AG, Chase Econometrics.
.. Not available.

to produce a cubic inch of primary aluminum in today's facilities is 20 per cent more than that to produce the same volume of magnesium."

New processes, currently under development, could have a dramatic impact on energy conservation. For example, Dow is operating a pilot plant using new technology that is reported to consume less than 162 820 kJ/kg (70 000 Btu/lb).

Recycling scrap, such as beverage cans, consumes considerably less energy than the amount used to produce primary metal. Magnesium was commercially recycled from aluminum beverage can scrap for the first time in 1981. About 50 per cent of all beverage cans shipped from U.S. producers in 1981 were recycled, yielding considerable quantities of aluminum. The scrap contained 7 800 t of recoverable magnesium, and recoveries are expected to rise to 10 400 t by 1986.

USES

Magnesium is used primarily to form alloys with other metals such as aluminum and cast iron. Aluminum-magnesium alloys account for almost half the magnesium market. The addition of up to 10 per cent magnesium plus other alloying agents endows aluminum with increased strength, hardness, ductility, and resistance to corrosion. The alloy used to manufacture beverage cans contains about 1.9 per cent magnesium.

Lightweight structural parts made from magnesium, including diecastings, account for approximately 25 per cent of the magnesium market. The automobile and aircraft industries continue to find new applications for the metal based on magnesium's lightweight, about two-thirds that of aluminum. However, for magnesium alloys to remain competitive in structural applications, development must remain vigorous. New alloys are needed to improve resistance to corrosion, to increase strength to weight ratio in aircraft applications, and to improve heat distortion resistance of automatic transmission parts. Automobile parts cast from magnesium include wheels, covers, housings, brackets, crankcases and internal transmission parts. In other industries magnesium is used in portable products such as tools, luggage and electronic equipment.

Magnesium is also used as a deoxidizing and desulphurizing agent in the ferrous industry and as a reducing agent in the production of titanium, zirconium and other reactive metals. Pure magnesium metal is used frequently for cathodic corrosion protection of steel structures, especially of underground pipes and tanks. There are many uses for magnesium in the chemical industry including the making of Grignard reagents used in the production of tetraethyl lead for gasoline.

A current research project is investigating the magnesium-hydrogen system. Because magnesium has potential for energy storage, the application of this principal to the development of hydrogen-powered vehicles has interesting possibilities.

PRICES

A 7 to 10 per cent rise in magnesium prices in 1981 ran counter to the general downward trend of metal prices. Moreover, the fall in the price of aluminum increased the magnesium/aluminum price ratio to almost 2.8:1. Due to the wide price spread, aluminum is favoured over magnesium in many applications, although the automotive use of magnesium is reported to be cost-effective at current prices over the life of a vehicle.

The Canadian price in commercial grade magnesium (99.8 per cent pure) in carload lots fob Haley, Ontario, was \$1.43 a pound early in 1981, until it was changed to \$1.47 in March and to \$1.59 in May. The price then held for the remainder of the year.

United States producer prices in United States currency, as quoted in Metals Week, were:

	\$/lb
Magnesium metal, in 10,000-lb lots:	
Primary ingot 99.8%	
January 1 to May 31, 1981	1.25
June 1 to December 31, 1981	1.34
Diecasting alloy AZ91B ingot	
January 1 to December 31, 1981	1.21

OUTLOOK

Magnesium markets will remain depressed until demand improves for major metals such as aluminum, on which magnesium sales depend. As interest rates are lowered in the United States, the economy is expected to gradually improve, resulting in increased consumption of aluminum and magnesium by the transportation and construction industries. Present production capacity should be sufficient to meet demand through 1986. The longer term outlook for magnesium consumption appears very favourable, with diecasting and steel desulphurization offering the greatest potential for growth. Aluminum alloys will remain the major use but the automobile industry is becoming increasingly interested in cast magnesium components in its efforts to produce fuel-efficient, lightweight vehicles. If magnesium is to remain competitive, however, the large price difference between magnesium and aluminum must be narrowed. Low prices for many secondary aluminum casting alloys are of particular concern for magnesium diecasters, and the initiation of magnesium recovery from recycling beverage cans poses market problems for primary magnesium producers, especially if the practice is extended to other forms of aluminum scrap. The magnesium industry must continue its research and development efforts to improve costs of production, design new products, and find new markets to ensure growth of the industry.

Although magnesium reserves are abundant, production of the metal is comparatively energy intensive and industry expansion will favour areas such as Canada with competitive energy supplies.

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
35105-1	Magnesium metal, not including alloys, in lumps, powders, ingots or blocks	5	5	25	3
34910-1	Alloys of magnesium; ingots, pigs, sheets, plates, strips, bars, rods and tubes	4.8	4.8	25	3

CANADA (cont'd)

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
34911-1	Magnesium alloy ingots, for use in the production of magnesium castings (expires 30/6/82)	free	free	25	free
34912-1	Hardener alloys for use in the manufacture of magnesium castings (expires 30/6/82)	free	free	25	free
34915-1	Magnesium scrap	free	free	free	free
34920-1	Sheet or plate, of magnesium or alloys of magnesium, plain, corrugated, pebbled, or with a raised surface pattern, for use in Canadian manufactures (expires 30/6/82)	free	free	25	free
34925-1	Extruded tubing, of magnesium or alloys of magnesium, having an outside diameter of five inches or more, for use in Canadian manufactures (expires 30/6/82)	free	free	25	free

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

Item No.		1981	1982	1983	1984	1985	1986	1987
					(%)			
35105-1	Magnesium metal, not including alloys, in lumps, powders, ingots or blocks	5.0	4.8	4.7	4.5	4.3	4.2	4.0
34910-1	Alloys of magnesium; ingots, pigs, sheets, plates, strips, bars, rods and tubes	4.8	4.6	4.5	4.4	4.3	4.1	4.0

UNITED STATES

Item No.		1981	1982	1983	1984	1985	1986	1987
					(%)			
628.55	Magnesium, unwrought, other than alloys and waste and scrap	18	16.5	15	13.5	12	10	8
628.57	Magnesium, unwrought, alloys, per pound of magnesium content	7.2	7.1	7	6.8	6.7	6.6	6.5
		¢ per lb. of magnesium content + % ad valorem						
628.59	Magnesium metal, wrought, per pound on magnesium content	6.0¢ 3.3%	5.7¢ 3.1%	5.5¢ 3.0%	5.2¢ 2.9%	5.0¢ 2.8%	4.7¢ 2.6%	4.5¢ 2.5%

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.

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.

Early in 1981 Union Carbide Canada Limited signed an agreement with a consortium headed by Elkem A/S (formerly Elkem Spigerverket A/S of Norway). 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 interests in order to obtain approval of the sale by the Foreign Investment Review Agency. Concurrently Union Carbide Corporation announced the sale of its ferromanganese and silicomanganese operations in the United States and Norway to the same Elkem-led group.

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

World manganese ore production in 1981, estimated at 26 million t, was approximately the same as the previous year.

South Africa remained the largest supplier of manganese in the western world. During 1981 several large South African mining companies announced new discoveries of manganese ore. S.A. Manganese Amcor Ltd. (Samancor) found two high-grade deposits, one near its Wesels mine and the other on Samancor's Rissik property near its Mamatwan mine.

General Mining Union Corporation Limited (GENCOR) announced the discovery of substantial reserves grading more than 50 per cent manganese, about 16 km west of Hotazel, South Africa. The Iron and Steel Industrial Corporation (Iscor) also discovered high-grade reserves near the GENCOR property. However, the extent and potential of both of these properties is still to be fully determined.

TABLE 1. CANADA, MANGANESE, TRADE AND CONSUMPTION, 1980 AND 1981

	1980		1981P	
	(tonnes)	($000)	(tonnes)	($000)
Imports				
Manganese in ores and concentrates[1]				
Gabon	36 346	6,577	59 118	11,241
South Africa	23 507	2,994	43 388	5,594
Brazil	15 360	2,977	12 468	2,512
United States	8 010	2,590	5 147	2,194
Mexico	-	-	4	1
French Africa	11 938	2,432	-	-
Total	95 161	17,570	120 125	21,542
Manganese metal				
South Africa	6 413	7,775	9 684	11,990
United States	440	690	383	582
People's Republic of China	102	134	224	333
Other countries	2	2	80	132
Total	6 957	8,601	10 371	13,037
Ferromanganese, including spiegeleisen[2]				
United States	4 793	3,777	15 995	18,190
South Africa	12 284	5,946	16 344	8,314
Norway	9 468	5,103	3 798	3,351
France	102	133	290	296
Mexico	20	10	229	126
Sweden	35	69	-	-
West Germany	2	1	-	-
Total	26 704	15,039	36 656	30,277
Silicomanganese, including silicospiegeleisen[2]				
United States	12 088	7,995	4 396	3,740
South Africa	3 043	1,424	4 563	2,167
Norway	1 720	1,589	2 476	1,601
Other countries	4 050	2,430	1 234	588
Total	20 901	13,438	12 669	8,096
Exports				
Ferromanganese[2]				
United States	11 189	3,753	56 584	24,989
Puerto Rico	-	-	217	99
Jamaica	-	-	92	72
Other countries	89	49	147	85
Total	11 278	3,802	57 040	25,245
Consumption				
Manganese ore				
Metallurgical grade	159 243	..	..	..
Battery and chemical grade	3 333	..	..	..
Total	162 576	..	..	..

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

[1] Mn content; [2] Gross weight.
P Preliminary; - Nil; .. Not available.

In Brazil, Industria e Comercio de Minerios S.A. (ICOMI), the country's largest manganese producer, has shown interest in developing the huge manganese reserves of the Carajas area in Para State. The reserves are reported to contain some 45 million t of ore grading more than 40 per cent manganese. However, at year-end, no firm development commitments had been announced.

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 makingthese 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.

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 thus most batteries contain a blend of natural ore and synthetic manganese dioxide.

TABLE 2. CANADA, MANGANESE IMPORTS, EXPORTS AND CONSUMPTION, 1970, 1975-81

	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
1976	118 972	25 098	12 056	9 861	238 629	83 687
1977	57 644	29 404	4 835	23 104	182 157	82 467
1978	136 446	26 812	15 842	19 924	201 320	69 349
1979	45 150	83 700	21 876[r]	12 043	64 699	89 429
1980	95 161	26 704	20 901	11 278	162 576	95 796
1981[p]	120 125	36 656	12 669	57 040	..	..

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

[1] Mn content.
[p] Preliminary; [r] Revised; .. Not available.

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, 1978-80

	Mn	1978[r]	1979[p]	1980[e]
	(%)		(000 tonnes)	
U.S.S.R.	35	9 058	10 244	10 251
Republic of South Africa	30-48+	4 318	5 182	5 695
Brazil	38-50	1 917	2 259	2 177
Gabon	50-53	1 661	2 300	2 147
Australia	37-53	1 249	1 666	1 961
India	10-54	1 619	1 755	1 645
People's Republic of China[e]	20+	1 270	1 497	1 588
Mexico	35+	523	493	447
Ghana	30-50	316	271	252
Morocco	53-50	126	135	150
Hungary	30-33	114	83	88
Japan	26-22	104	88	78
Thailand	46-50	72	35	49
Bulgaria	30-	40	42	40
Other countries[1]	..	150	149	129
Total	..	22 537	26 199	26 697

Source: U.S. Bureau of Mines, **Mineral Yearbook**, 1979-80.

[1] Includes 16 countries, each producing less than 30 000 tpy.
[p] Preliminary; [e] Estimated; [r] Revised; .. Not available.

PRICES

Price negotiations for ore delivered during 1981 were not completed until the end of the first quarter when producers agreed to hold prices unchanged at 1980 levels $US 1.66 - 1.75/ltu. Most manganese ore is sold on a long ton unit (ltu) of contained manganese basis (ltu = 22.4 lb of Mn). Standard ferromanganese prices remained unchanged from the previous year, as did manganese metal prices.

OUTLOOK

The outlook for manganese is closely linked to steel production forecasts since 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 because of the slow recovery expected in the world steel industry. Large consumer inventories of manganese ore and ferromanganese at year-end indicated that contract negotiations for 1982 ore delivery could be as difficult as those in 1981 when prices remained unchanged.

There is a growing trend in expanding ferroalloy production capacity 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 reuired 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 1980	December 1981
	(cents)	(cents)
Manganese ore, per long ton unit (22.4 lb) cif U.S. ports, Mn content		
Min. 48% Mn (low impurities)	166.00-175.00	166.00-175.00
Ferromanganese, fob shipping point, carload lots, lump, bulk	($)	($)
Standard 78% Mn, per long ton	490.00-530.00	490.00-530.00
	(cents)	(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	24.50	26.50
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	70.00-80.00

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

TARIFFS (concl'd)

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
37502-1	Silicomanganese, silicospiegel and other alloys of manganese and iron more than 1% Si, on the Mn content, per lb.	free	0.75¢	1.75¢	free

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

	1981	1982	1983	1984	1985	1986	1987
			(cents)				
37501-1	0.5	0.5	0.5	0.4	0.4	0.4	0.4
37502-1	0.75	0.74	0.73	0.74	0.72	0.71	0.70

UNITED STATES (MFN)

Item No.		
601.27	Manganese ore, including ferruginous manganese ore and manganiferous iron ore, all the foregoing containing over 10 per cent by weight of manganese	free
632.30	Manganese metal, unwrought	14.0

		1981	1982	1983	1984	1985	1986	1987
		(per cent, unless otherwise specified)						
606.26	Ferromanganese, not containing over 1% C	0.3¢ +2%	2.6	2.6	2.5	2.4	2.4	2.3
606.28	Ferromanganese containing 1 to 4% C, per lb. manganese content	0.46¢	1.4	1.4	1.4	1.4	1.4	1.4
606.30	Ferromanganese containing over 4% C, per lb. manganese content	0.3¢	1.6	1.6	1.6	1.5	1.5	1.5
632.28	Manganese metal waste and scrap (suspended until June 30, 1981)	11.9	10.9	9.8	8.8	7.7	6.7	5.6

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

Mercury

J.J. HOGAN

The mercury market was relatively stable during 1981. Prices ranged between $US 10.30 and $13.05 per kilogram (kg), which was not high enough to encourage former producers to reopen their mines. Mercury production from the principal mercury producing countries was about the same as in the previous year. Chlor-alkali plants throughout the world continue to be phased out, and the resulting recovery of mercury makes substantial contributions to mercury supply. At the end of the year, the United States began to sell mercury declared surplus to its strategic metals stockpile goal.

CANADIAN DEVELOPMENTS

There has been no mine output of mercury in Canada since July 1975, when the Pinchi Lake mine of Cominco Ltd., 48 km north of Fort St. James, British Columbia, suspended operations indefinitely. Its closure resulted from a significant decline in mercury prices caused by a sharp drop in demand for the metal but the property is being kept on standby pending an improvement in demand and price.

Canadian imports of mercury metal declined 4 per cent to 48 000 kg (1,392 flasks*), in 1981 (Table 1). Consumption by reporting companies rose 38.4 per cent to 36 326 kg (761 flasks) in 1980, but equivalent data are not yet available for 1981.

WORLD REVIEW

The United States Bureau of Mines (USBM) estimated world production of mercury at 7 122 260 kg in 1981, about the sames as in 1980 (Table 3). The U.S.S.R. is the world's largest mine producer of mercury. Its production in 1981 has been estimated at 2 171 800 kg. Spain, the world's second largest producer in 1981, had an output of 1 723 650 kg. Following behind Spain were the United States and Algeria with estimated production of 961 940 kg and 861 830 kg, respectively. Other countries which produced a significant amount of mercury were the People's Republic of China, Czechoslovakia and Turkey. The mercury mines of Yugoslavia and Canada have been substantial contributors to the world's output in the past, but operations at these mines have been suspended pending market improvements. Italy resumed production in 1981 on a greatly reduced basis and Mexico's production continued at a much reduced rate, amounting to an estimated 137 890 kg in 1981.

The Almadén mine of Minas de Almadén in Spain is the largest producer of mercury in the non-communist world. Output in 1981 was estimated to be about 83 per cent of normal annual capacity of 2 068 000 kg. The company's new open-pit mine, El Entredicho, located about 17 km from the present plant, came into production in late 1981 and it is expected that most of Almadén's ore will come from this operation by 1985.

United States production of mercury in 1981 is estimated to have been slightly lower than in 1980. Mercury production came from only two mines, one in Nevada and one in California, but the McDermitt mine in northwestern Nevada accounted for most of the production. It is a joint venture in which Placer Amex Inc., a wholly owned subsidiary of Placer Development Limited of Vancouver, British Columbia, has a 51 per cent interest, and Minerals Exploration Company of New Jersey has the remaining 49 per cent.

In Italy, production was resumed at the Monte Amiata mine of SAMIN S.p.A. in the first half of 1981, to supply the country's domestic market. After passing through a series of government agencies, the Monte

* One flask of mercury weighs 34.473 kg.

Amiata mine came under the control of SAMIN S.p.A., a member company of the state-controlled holding company, Ente Nazionale Idrocarburl (ENI). Production will be at an annual rate of 172 350 kg until at least March 1983. The mine ceased production in 1976 because of increased costs and low mercury prices. Italy for years had been one of the world's major producers of mercury.

In late 1981, the Yugoslavian government announced that it would not re-open its Idrija mercury mine because a feasibility study indicated that it could not be operated profitably at existing mercury prices. The mine closed in 1977 because of low-grade ore and low mercury prices. Subsequent exploration in the area of the mine led to the discovery of a new mercury deposit estimated to contain about 5 000 000 kg of mercury.

Japan is not, at present, a primary producer of mercury but has a large stock obtained from caustic soda plants following a change in techniques away from the use of mercury. Stocks are estimated to be about 1 985 000 kg and a further 999 000 kg should become available with the conversion of remaining caustic soda plants. Japan's large stockpile of mercury is available for export but the metal reportedly will be released in such a manner as to avoid unduly disrupting the market.

The United States is the largest non-communist consumer of mercury and, in recent years, has produced less than its requirements. The USBM reported total consumption by the United States at 2 043 974 in 1981, slightly higher than in 1980 (Table 4). The shortfall between primary production and consumption was made up by mercury from secondary sources, imports and the draw down of consumer and dealers stocks. Production from secondary sources amounted to 389 028 kg in 1981. Imports of mercury totalled 427 380 kg in 1981. Spain,

TABLE 1. CANADA, MERCURY PRODUCTION AND TRADE, 1980 AND 1981 AND CONSUMPTION, 1979 AND 1980

	1980		1981P	
	(kilograms)	($)	(kilograms)	($)
Mine Production	-	-	-	-
Imports (metal)				
United States	43 000	497,000	45 000	593,000
Spain	-	-	2 000	26,000
People's Republic of China	-	-	1 000	21,000
Netherlands	-	-	...	2,000
West Germany	-	-	...	2,000
United Kingdom	-	-	...	...
Japan	7 000	92,000	-	-
Total	50 000	589,000	48 000	646,000[2]
	1979		1980	
Consumption[1] (metal)				
Heavy chemicals	3 237		9 682	
Electrical apparatus	15 834		3 041	
Gold recovery	379		334	
Miscellaneous	6 799		23 269	
Total	26 249		36 326	

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

[1] Available data, as reported by consumers. [2] Individual items do not add up to total shown because of rounding.
P Preliminary; - Nil; ... Amount too small to be expressed.

Yugoslavia and Japan were the major suppliers accounting for 171 916 kg, 100 006 kg and 81 770 kg, respectively.

Statistical data on world consumption of mercury in 1981 are not yet available. Total world consumption probably exceeded 1981 world primary production of 7 122 260 kg by a small margin. Some mercury is available from secondary sources and stocks.

In 1975, five of the world's major producers (Spain, Turkey, Yugoslavia, Algeria and Peru) established the International Association of Mercury Producers (ASSIMER) with headquarters in Geneva. At that time, member countries accounted for about 90 per cent of non-communist exports of mercury. Canada and the United States did not join the organization.

The major objectives of the Association are to stabilize prices by controlling production or by withholding supplies from the market during periods of low demand, to develop new uses for mercury, and to improve the environmental situation of mercury. Meetings are held at least once a year to discuss the world's mercury situation and to determine what action is necessary to ensure a viable market. Generally, ASSIMER does not divulge the subjects discussed but it is believed that price setting is a major topic.

TABLE 2. CANADA, MERCURY PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975-1981

	Production, Metal	Imports, Metal	Consumption, Metal
		(kilograms)	
1970	841 141	69 536	154 474
1975	413 676	73 527	32 869[1]
1976	-	62 641	26 039[1]
1977	-	21 908	30 447[1]
1978	-	43 046	29 904[1]
1979	-	50 711	26 249[1]
1980	-	50 000	36 326[1]
1981p	-	48 000	..

Sources: Energy, Mines and Resources Canada; Statistics Canada; 1970 metal production was obtained directly from Cominco Ltd. and represents output from Pinchi Lake mine in British Columbia.

[1] Available data, as reported by consumers.
p Preliminary; - Nil; .. Not available.

In 1981, the General Services Administration (GSA) sold 7,000 flasks (241 311 kg) of surplus mercury from the Department of Energy stockpile at an average price of $US 406.73 per flask ($11.80 per kg). The amount of mercury offered at the monthly auctions was increased from 1,000 flasks to 1,500 flasks beginning in April. Producer countries objected to this increase. Sales from this source were discontinued in October 1981.

At the end of October 1981, the United States National Defense Stockpile contained 191,391 flasks. The stockpile goal has been set at 10,500 flasks, leaving a stockpile surplus of 180,891 flasks. Under the "Omnibus Budget Reconciliation Act of 1981" Congress in October authorized the disposal of 50,000 flasks of this surplus. The GSA announced in November that it would offer 1,500 flasks for sale on a monthly basis starting on November 17, 1981, for domestic consumption only. Response to the GSA sales was poor, no awards being made in November and only 501 flasks in December.

Stocks held by United States' producers, consumers and dealers on December 31, 1981 were 27,645 flasks compared with 33,069 flasks on December 31, 1980.

USES

Mercury's two major uses in recent years have been in the manufacture of electrical apparatus and in the electrolytic production of chlorine and caustic soda, although the use in the latter application is declining. Together, these two applications accounted for about 52 per cent of mercury consumed in the United States in 1980. Electrical uses include mercury lamps, batteries, rectifiers, bulbs, oscillators and various kinds of switches, including silent switches for use in residences. Because mercury lamps are more adaptable to higher voltage supply lines than are incandescent lamps, they are widely used for industrial and street lighting purposes. The mercury battery, invented in 1944, has a relatively long shelf life and can withstand high temperatures and high humidity. It is widely used in portable metering, photography, communication devices and other uses where reliability is important.

Other applications of mercury are in mildew-proofing paints, industrial and control instruments, pharmaceuticals, insecticides, fungicides, bactericides and dental preparations, although in some countries some of

TABLE 3. WORLD PRODUCTION OF MERCURY, 1977, 1980 AND 1981

	1977	1980P	1981e
		(kilograms)	
U.S.S.R.	1 999 435	2 137 327	2 171 800
Spain	925 635	1 696 004	1 723 650
United States	973 656	1 056 839	961 940
Algeria	1 048 980	842 004	861 830
People's Republic of China	689 460	689 460	689 460
Czechoslavakia	183 017	158 990	158 570
Turkey	161 541	152 957	151 680
Italy	13 996	3 309	137 890
Mexico	333 009	144 994	137 890
Finland	21 718	74 806	68 950
West Germany	99 006	55 984	41 370
Dominican Republic	17 064	17 237	17 230
Other countries	108 729	-	-
Total	6 575 246	7 029 911	7 122 260

Sources: Preprint from the 1981 U.S. Bureau of Mines, Minerals Yearbook.

P Preliminary; e Estimated; - Nil.

TABLE 4. UNITED STATES MERCURY CONSUMPTION BY USES, 1977, 1980 AND 1981

	1977	1980	1981P
		(kilograms)	
Agriculture[1]	20 132	..	2 723
Catalysts	53 261	9 135	..
Dental preparations	42 402	32 645	60 155
Electrical apparatus	1 005 923	1 100 620	1 035 811
Electrolytic preparation of chlorine and caustic soda	370 378	326 460	249 757
General laboratory use	13 996	12 514	3 861
Industrial and control instruments	179 983	108 349	178 398
Paint, mildew proofing	288 367	297 192	254 756
Pharmaceuticals	..	-	-
Other[2]	89 251	1 793	-
Total known uses	2 063 693	1 888 708	1 785 461
Total unknown uses	48 090	144 614	123 931
Grand total	2 111 783	2 033 322	2 043 974[3]

Sources: Preprint from the 1980 U.S. Bureau of Mines, Minerals Yearbook for 1977 statistics; U.S. Bureau of Mines, Mineral Industry Surveys, "Mercury in the Third Quarter of 1981" for 1980 statistics; U.S. Bureau of Mines, Mineral Industry Surveys, "Mercury in the Fourth Quarter 1981" for 1981 statistics.

[1] Includes fungicides and bactericides for industrial purposes. [2] Includes mercury used in the manufacture of chemicals and allied products and lubricating oils. [3] The individual items do not add to the total which has been increased to cover approximate total consumption.
P Preliminary; .. Not available; - Nil.

these uses have been restricted or banned by governments. Several mercury compounds, especially the chloride, oxide and sulphate, are good catalysts for certain chemical reactions, including those involved in the making of plastics. Because of its capacity to absorb neutrons, the metal has been used as a shield against atomic radiation. New technologies could open up areas of use in the nuclear, metal-chloride vapour, plastic, chemical, amalgam and ion exchange fields. Substitutes for mercury include nickel-cadmium or other battery systems for use in electrical apparatus, diaphragm cells for mercury cells in the chlor-alkali industry, organotin compounds in paint, and solid-state devices for industrial and control instruments.

ENVIRONMENTAL REGULATIONS CONCERNING MERCURY

In the United States, mercury is one of 42 hazardous chemicals and petroleum products which come under the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980. According to the legislation mercury sold by producers, manufacturers or importers is subject to a tax which will go into a fund to be used for the clean up of hazardous chemicals and waste sites. The tax levied against the U.S. mercury producers came into effect on April 1, 1981 and will continue until September 30, 1985.

The E.E.C. Council of Ministers has approved proposals to establish standards on the discharge of mercury into water from the community's chlor-alkali plants. These standards when adopted are expected to result in a reduction in mercury consumption in the chlor-alkali industry by a trend away from mercury cell methods or by improved technology in the present mercury cell plants to meet the standards.

The 1980 review outlines other environmental regulations pertaining to mercury in the United States and Canada.

PRICES

Although the price of mercury showed considerable variation in 1981, price movements took place gradually and the range during the year was moderate. The opening price and the low for the year was $US 10.30 per kg, increasing to a high of $12.91 per kg by the end of August and closing for the year at $11.83 per kg. The metal firmed in the first part of the year on reported shortages of metal. In mid-year sales were slow and producers cut back on exports rather than dump metal on the market. The price increased in August when Placer did not make sales to the spot market. The mercury market was quiet for the rest of the year and the price declined moderately. At year-end, the price firmed on reported sale of 3,000 flasks to India and on Spain, a leader in determining mercury prices, setting its list price, effective the beginning of 1982, at $13.34 per kg ($460 per flask). These events are expected to strengthen or stabilize the price in early 1982.

The average dealer price of mercury in New York for 1981, as quoted in **Metals Week,** was $US 12.00 per kg ($413.88 per flask) compared with $11.30 per kg ($389.45 per flask) in 1980. The cif main European port price, as quoted in **Metal Bulletin,** London, ranged from a low of $US 10.30 per

TABLE 5. AVERAGE MONTHLY PRICES OF MERCURY IN 1981

	New York[1]		cif Main European port[2]	
			Low	High
	($US/ flask)	($US/ kilogram)	($US/flask)	
January	364.52	10.57	363.13	372.50
February	381.39	11.06	384.38	393.63
March	409.77	11.89	407.78	419.44
April	417.96	12.12	415.71	428.57
May	413.75	12.00	421.25	431.25
June	419.32	12.16	425.00	435.00
July	433.17	12.56	424.56	434.11
August	441.67	12.81	426.13	435.00
September	430.52	12.49	426.13	434.25
October	426.14	12.36	423.67	431.89
November	418.22	12.13	419.50	425.50
December	410.18	11.90	419.00	424.25
1981 avg. price	413.88	12.00		

Sources: **Metals Week; Metal Bulletin** (London).

[1] Consensus of fixed price prompt sales of 20 or more flasks of prime virgin metal in the United States. Price includes delivery, United States import duty, and any applicable surcharges. [2] Prices are cif main European port, minimum 99.99 per cent. cif: Cost, insurance and freight.

kg ($355.00 per flask) on January 12, 1981 to a high of $12.62 per kilogram ($435.00 per flask) first obtained on May 21.

OUTLOOK

Historically, the performance of the mercury market has been erratic, numerous mines opening when the price is at a high level and closing when the price declines. Only the more solid companies were able to operate continuously. It is considered that the producers' association (ASSIMER) has brought a degree of stability to the market, through better control of production, sales and prices. The mercury price level along with indications of improved stability led some former producers to review the possibility of reopening their mines but, with the exception of an Italian producer, they concluded that the price was still too low. However, the prospects of these mines reopening, new mines coming into production and sales from the United States stockpile should constrain any sharp price increases in 1982.

With ample mercury stocks in the hands of producers, consumers and dealers, large stocks declared surplus to United States requirements in its strategic metals stockpile, and many of the recently closed mines on a standby basis, no problems are envisaged in meeting the demand for mercury in the medium term. Consumption is not expected to change greatly from the present level. Declining demand for mercury in the chlor-alkali industry, once one of the major consumers, should be offset by increased usage in electric apparatus, electronic devices and industrial control instruments, applications which are not expected to be affected to any degree by substitutes. Recycled mercury, especially from phased-out chlor-alkali plants which used mercury cells in the process, will continue to be an important source of supply.

TARIFFS

CANADA

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
92805-2	Mercury metal	free	free	free	free
92828-4	Mercuric oxide for manufacture of dry-cell, primary batteries (expires June 30, 1982)	free	free	25	free

UNITED STATES

Item No.		1981	1982	1983	1984	1985	1986	1987
				(cents per pound)				
601.30	Mercury ore	Remains free						
632.34	Mercury metal, unwrought and waste and scrap[1]	11.3	10.6	10.0	9.4	8.8	8.1	7.5

EUROPEAN ECONOMIC COMMUNITY: (MFN)

Item No.		1981	Base Rate	Concession Rate
			(%)	
28.05	Mecury, in flasks of a net capacity of 34.5 kg, of a fob value, per flask, not exceeding 224 EUA[2]	6.72 EUA per flask		
28.28	Mercury oxides	5.2	5.6	4.1

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; Official Journal of the European Communities, Vol. 23, No. L315, 1980.
[1] The suspension of duty on waste and scrap was extended until June 30, 1981. [2] EUA - European unit of account.
fob Free on board.

Mineral Aggregates

D.H. STONEHOUSE

SUMMARY

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.

During 1981 the Ontario Ministry of National Resources released a report, **Mineral Aggregate Transportation Study,** commissioned to determine the feasibility of supplying mineral aggregates to major urban communities from remote sources.

Public awareness of the contribution made to the construction industry by the mineral aggregates has been heightened in recent years by an appreciation of the extent and rate of urban expansion. The problems associated with the aggregate industries are perhaps more evident in Ontario than in other provinces. Urban growth has been both rapid and large-scale, and although there is no absolute shortage of aggregate in Ontario, a shortage of aggregate at reasonable prices could result from growing opposition to the industry. Already, large deposits of accessible aggregate material have been removed from the "reserves" category by legislation. The industry has been hesitant to invest in new plant sites, which would increase the reserves base, until the impact of new legislation is known.

Demand for aggregates has continued to increase in close relation to population increase and construction spending. Per capita consumption in Canada is about 15 tpy.

CANADIAN SCENE

SAND AND GRAVEL

During 1981, production of sand and gravel was about 280 million tonnes (t) and per capita consumption remained in the range of 11 tpy. Higher labour and transportation costs are reflected in the increased average unit value assigned to the 1981 shipments of sand and gravel.

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. Housing starts, although considerably down from the record level achieved in 1976, were up 12 per cent over 1980 to 177,973.

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 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

TABLE 1. CANADA, SHIPMENTS OF SAND, GRAVEL AND CRUSHED STONE BY PROVINCE, 1979-1981

	1979		1980		1981	
	(000 tonnes)	($000)	(000 tonnes)	($000)	(000 tonnes)	($000)
Sand and gravel						
Newfoundland	8 962	15,709	3 279	6,066	2 818	9,074
Prince Edward Island	774	1,994	889	2,340	330	1,616
Nova Scotia	9 441	23,280	9 578	24,424	9 548	23,047
New Brunswick	5 256	9,642	6 492	12,399	6 282	9,450
Quebec	79 576	83,784	64 806	77,592	74 729	99,471
Ontario	91 385	153,680	102 174	191,000	77 975	146,751
Manitoba	12 193	26,279	9 794	22,454	11 716	25,425
Saskatchewan	10 232	16,869	9 828	18,204	7 909	18,405
Alberta	25 727	56,044	24 334	55,219	26 465	97,323
British Columbia	41 675	69,839	45 278	98,666	42 362	87,604
Canada	285 221	457,120	276 452	508,364	260 134	518,166
Crushed stone						
Newfoundland	1 262	2,923	947	2,688	859e	2,777e
Nova Scotia	1 937	5,547	1 603	5,426	1 455e	5,617e
New Brunswick	2 864	7,662	2 420	7,230	2 204e	7,489e
Quebec	62 371	174,352	53 836	149,980	48 944e	155,312e
Ontario	31 162	90,604	26 553	87,100	24 140e	90,217e
Manitoba	1 813	5,954	1 254	6,834	1 140e	7,084e
Alberta	80	311	23	130	17e	125e
British Columbia	2 515	9,285	1 748	7,985	1 591e	8,270e
Canada	104 004	296,638	88 384	267,373	80 350e	276,891e

Source: Energy, Mines and Resources, Canada.
e Estimated.

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 construction industry utilizes 95 per cent of total stone output as 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.

Over 70 per cent of annual production of limestone is used as crushed stone. This includes about 50 per cent used as road metal (broken, screened stone for asphalt roads), about 20 per cent as concrete aggregate and about 2 per cent as railroad ballast.

Detailed information can be obtained through the individual provincial departments of mines or equivalent. Most provinces have

TABLE 2. SHIPMENTS OF SAND, GRAVEL AND CRUSHED STONE BY USES AND BY AREAS, 1979 AND 1980

		Atlantic Provinces	Quebec	Ontario	Western Provinces	Canada
				(000 tonnes)		
Sand and gravel						
Road	1979	16 923	47 853	50 530	54 290	169 596
	1980	16 686	39 788	60 785	50 450	167 708
Concrete aggregate	1979	2 753	4 829	15 007	8 673	31 262
	1980	1 083	3 627	14 621	11 875	31 206
Railroad ballast	1979	274	421	76	7 557	8 328
	1980	113	393	329	3 379	4 214
Mortar sand	1979	43	390	1 536	243	2 212
	1980	48	429	1 393	413	2 283
Backfill for mines	1979	-	118	1 135	417	1 670
	1980	30	93	2 182	865	3 170
Other fill	1979	867	10 542	13 796	8 943	34 148
	1980	344	16 373	13 720	13 896	44 333
Other uses	1979	3 573	15 423	9 305	9 704	38 005
	1980	1 934	4 104	9 144	8 356	23 538
Total sand and gravel	1979	24 433	79 576	91 385	89 827	285 221
	1980	20 238	64 806	102 174	89 234	276 452
Crushed stone						
Road	1979	1 760	14 162	7 927	1 021	24 870
	1980	1 348	14 480	8 519	988	25 335
Concrete aggregate	1979	505	4 977	5 297	122	10 901
	1980	719	3 596	2 897	-	7 212
Asphalt aggregate	1979	963	3 262	2 181	326	6 732
	1980	792	2 727	1 357	-	4 876
Railroad ballast	1979	215	1 236	1 664	175	3 290
	1980	180	913	610	413	2 116
Crushed stone for	1979	-	20	--	-	21
artificial stone	1980	-	17	17	-	34
Roofing granules	1979	-	12	330	--	342
	1980	-	15	291	-	306
Poultry grit	1979	3	31	2	60	96
	1980	3	19	23	8	53
Stucco dash	1979	-	4	-	23	27
	1980	-	--	-	25	25
Terrazzo chips	1979	-	5	3	-	8
	1980	-	3	2	-	5
Rock wool	1979	17	-	-	--	17
	1980	-	-	-	2	2
Rubble and riprap	1979	16	24 812	389	860	26 077
	1980	232	13 944	330	438	14 944
Other uses	1979	2 584	13 850	13 369	1 820	31 623
	1980	1 696	18 122	12 507	1 151	33 476
Total crushed stone	1979	6 063	62 371	31 162	4 408	104 004
	1980	4 970	53 836	26 553	3 025	88 384

Source: Energy, Mines and Resources.
- Nil; -- Amount too small to be expressed.
Note: Columns may not add due to rounding.

TABLE 3. CANADA, EXPORTS AND IMPORTS OF SAND AND GRAVEL AND CRUSHED STONE, 1979-81

	1979		1980		1981P	
	(tonnes)	($)	(tonnes)	($)	(tonnes)	($)
Exports						
Sand and gravel						
United States	323 432	789,000	344 660	744,000	239 641	649,000
Bermuda	-	-	25 800	85,000	78 888	262,000
Indonesia	-	-	-	-	5	25,000
St. Pierre and Miquelon	24	5,000	25	2,000	37	11,000
Other countries	184	20,000	13 048	93,000	62	6,000
Total	323 640	814,000	383 533	924,000	318 633	953,000
Crushed limestone						
United States	2 296 280	5,638,000	2 214 036	6,175,000	1 758 290	6,007,000
St. Pierre and Miquelon	15	1,000	454	1,000	-	-
Total	2 296 295	5,639,000	2 214 490	6,176,000	1 758 290	6,007,000
Imports						
Sand and gravel						
United States	1 188 956	4,085,000	1 206 228	4,469,000	1 439 686	6,068,000
West Germany	5 060	8,000	3 354	11,000	7 178	16,000
Other countries	7 898	91,000	-	-	-	-
Total	1 201 914	4,184,000	1 209 582	4,480,000	1 446 864	6,084,000
Crushed limestone						
United States	3 215 538	12,223,000	2 418 210	12,136,000	2 526 401	14,763,000
France	179	4,000	100	2,000	215	8,000
West Germany	-	-	20	6,000	179	4,000
Total	3 215 717	12,227,000	2 418 330	12,144,000	2 526 795	14,775,000
Crushed stone, nes						
United States	78 892	3,602,000	38 088	1,434,000	33 108	1,266,000
Sweden	-	-	-	-	342	66,000
Other countries	437	38,000	313	32,000	676	49,000
Total	79 329	3,640,000	38 401	1,466,000	34 126	1,381,000

Source: Statistics Canada.
P Preliminary; - Nil; nes Not elsewhere specified.

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 by-product aggregates.

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

TABLE 4. LIGHTWEIGHT AGGREGATE PLANTS IN CANADA

Company	Location	Product
Atlantic Provinces		
Avon Aggregates Ltd.	Minto, N.B.	Expanded Shale
Quebec		
F. Hyde & Company, Limited	Montreal	Vermiculite
Masonite Canada Ltd.	Gatineau	Perlite
Perlite Industries Reg'd.	Ville St. Pierre	Perlite
V.I.L. Vermiculite Inc.	Lachine	Vermiculite
Ontario		
Canadian Gypsum Company, Limited	Hagersville	Perlite
Johns-Manville Canada Inc.	North Bay	Perlite
Domtar Inc.	Caledonia	Perlite
	Mississauga	Expanded Shale
	Cornwall	Perlite
W.R. Grace & Co. of Canada Ltd.	St Thomas	Vermiculite
	Ajax	Vermiculite
National Slag Limited	Hamilton	Slag
Prairie Provinces		
Aerlite Products Limited	Namao, Alta.	Expanded Clay
Cindercrete Products Limited	Regina, Sask.	Expanded Clay
Genstar Corporation	Calgary, Alta.	Expanded Shale
Domtar Inc.	Calgary, Alta.	Perlite
Genstar Corporation, Edcon Block Division	Edmonton, Alta.	Expanded clay
W.R. Grace & Co. of Canada Ltd.	Winnipeg, Man.	Vermiculite
	Edmonton, Alta	Vermiculite
Kildonan Concrete Products Ltd.	St. Boniface, Man.	Expanded Clay
Northern Perlite & Vermiculite Limited	St. Boniface, Man.	Vermiculite
British Columbia		
W.R. Grace & Co. of Canada Ltd.	Vancouver	Vermiculite
Westroc Industries Limited	Vancouver	Perlite

TABLE 5. CANADA, IMPORTED RAW MATERIALS PURCHASED, 1980 AND 1981

	1980		1981	
	(tonnes)	($)	(tonnes)	($)
Pumice, perlite and vermiculite[1]	72 864	7,283,949	63 285	7,271,988

Source: Company data.
[1] Combined to avoid disclosing confidential company data.

TABLE 6. CANADA, PRODUCTION OF LIGHTWEIGHT AGGREGATES, 1980 AND 1981

	1980		1981	
	(m^3)	($)	(m^3)	($)
From domestic raw materials				
Expanded clay, shale and slag	624 069	10,261,145	519 809	7,091,079
From imported crude materials				
Expanded perlite and exfoliated vermiculite[1]	478 099	15,709,581	417 372	13,213,713
Total	1 102 168	25,970,726	937 181	20,304,792

Source: Company data.
[1] Combined to avoid disclosing confidential company data.

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, U.S.A., 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 substitiute 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.

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 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,

TABLE 7. CANADA, CONSUMPTION OF SLAG, PERCENTAGE BY USE, 1979-81

Use	1979	1980	1981
Concrete block manufacture	61.0	52.0	46.0
Ready-mix concrete	2.0	2.0	2.0
Loose insulation	1.0	1.0	1.0
Slag cement	36.0	45.0	51.0

Source: Company data.

TABLE 8. CANADA, CONSUMPTION OF EXPANDED CLAY AND SHALE, PERCENTAGE BY USE, 1979-81

Use	1979	1980	1981
Concrete block manufacture	74.7	79.2	76.7
Precast concrete manufacture	6.4	4.3	6.5
Ready-mix concrete	13.7	13.3	14.6
Horticulture and miscellaneous uses	5.2	3.2	2.2

Source: Company data.

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.

TABLE 9. CANADA, CONSUMPTION OF EXPANDED PERLITE, PERCENTAGE BY USE 1979-81

Use	1979	1980	1981
Insulation			
in gypsum products	20.4	17.5	11.3
in other construction materials	45.8	42.4	46.9
Horticulture and agriculture	12.4	23.8	23.9
Loose insulation and miscellaneous uses	21.4	16.3	17.9

Source: Company data.

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 siliceous 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 characterisitic 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 10. CANADA, CONSUMPTION OF EXFOLIATED VERMICULITE, PERCENTAGE BY USE 1979-81

Use	1979	1980	1981
Insulation			
loose	53.2	57.7	55.2
in concrete and concrete products	25.3	10.2	8.8
in gypsum products	3.0	3.4	3.0
Horticulture	5.3	19.8	23.3
Miscellaneous uses	13.2	8.9	9.7

Source: Company data.

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 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 tonnes of fly ash a year from three coal-fired stations. Experimentation continues towards 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 main uses for sand and gravel are: as fill, granular base and finish coarse material

TABLE 11. ROCK-MINERAL- AND GLASS-WOOL PRODUCERS, CANADA, 1981

Company	Location	Remarks
Atlantic Provinces		
Fiberglas Canada Inc.	Moncton, N.B.	New 1975, $4 million, 15 000 tpy. Limestone, dead-burned magnesia, silica, borax
Quebec		
Fiberglas Canada Inc.	Candiac	Expanded 1977, $6 million
Manville Canada Inc.	Brossard	15 000 tpy capacity
Ontario		
Fiberglas Canada Inc.	Sarnia	Expanded 1978, $6 million. New electric furnace is largest of kind
	Toronto	New plant by 1979, $25 million
Manville Canada Inc.	West Hill (Toronto)	Closed in 1981
Canadian Gypsum Co. Ltd.	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, $10 million, 10 000 tpy
Roxul Company	Milton	A division of Standard Industries Ltd.
Prairie Provinces		
Fiberglas Canada Inc.	Clover Bar, Alta. (Edmonton)	Expanded 1977, $5 million
Manville Canada Inc.	Innisfail, Alta.	New 1978, $11-$18 million, 6 000 t per month. New energy-efficient mechanical fiberizing technology
Alberta Rockwool Corporation	Calgary, Alta.	
British Columbia		
Fiberglas Canada Inc.	Mission	New for 1980, $25 million, 45 000 tpy
Pacific Enercon Inc.	Grand Forks	

for highway construction, coarse and fine aggregates in concrete manufacture, coarse aggregate in asphalt production, and fine aggregate in mortar and concrete blocks. 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. 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

TABLE 12. CANADA, VALUE OF CONSTRUCTION[1] BY PROVINCE, 1980-82

	1980			1981			1982		
	Building Construction	Engineering Construction	Total	Building Construction	Engineering Construction	Total	Building Construction	Engineering Construction	Total
					($000)				
Newfoundland	443,916	406,244	850,160	443,529	507,551	951,080	423,573	690,893	1,114,466
Nova Scotia	631,654	551,663	1,183,317	760,986	739,683	1,500,669	756,979	1,143,079	1,900,058
New Brunswick	539,095	418,957	958,052	557,600	450,986	1,008,586	643,761	524,621	1,168,382
Prince Edward Island	98,322	77,677	175,999	84,931	66,585	151,516	100,200	67,522	167,722
Quebec	4,949,915	4,402,459	9,352,374	5,812,142	4,865,982	10,678,124	5,961,929	5,144,329	11,106,258
Ontario	8,347,796	4,089,665	12,437,461	9,329,979	5,237,744	14,567,723	9,688,874	6,398,642	16,087,516
Manitoba	882,855	514,989	1,397,844	883,939	697,113	1,581,052	876,595	733,599	1,610,194
Saskatchewan	1,237,980	1,040,434	2,278,414	1,226,220	1,530,801	2,757,021	1,258,552	1,671,868	2,930,420
Alberta	5,033,629	6,659,848	11,693,477	6,252,396	7,566,664	13,819,060	7,074,819	9,577,830	16,652,649
British Columbia, Yukon and Northwest Territories	4,374,953	3,624,755	7,999,708	5,919,000	4,023,461	9,942,461	5,854,103	4,965,945	10,820,048
Canada	26,540,115	21,786,691	48,326,806	31,270,722	25,686,570	56,957,292	32,639,385	30,918,328	63,557,713

Source: Statistics Canada.

[1] Actual expenditures 1980, preliminary actual 1981, intentions 1982.

TABLE 13. CANADA, VALUE OF CONSTRUCTION[1] BY TYPE, 1980-82

	1980	1981	1982
		($ millions)	
Building Construction			
Residential	13,872	16,360	16,397
Industrial	3,005	3,425	3,524
Commercial	5,912	7,163	7,945
Institutional	2,157	2,451	2,751
Other building	1,594	1,872	2,023
Total	26,540	31,271	32,640
Engineering Construction			
Marine	269	336	419
Highways, airport runways	3,731	4,313	4,429
Waterworks, sewage systems	1,997	2,127	2,396
Dams, irrigation	202	257	336
Electric power	4,297	4,981	5,900
Railway, telephones	1,851	2,165	2,612
Gas and oil facilities	6,709	7,718	9,675
Other engineering	2,731	3,789	5,151
Total	21,787	25,686	30,918
Total construction	48,327	56,957	63,558

Source: Statistics Canada.
[1] Actual expenditures 1980, preliminary actual 1981, intentions 1982.

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.

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.

TABLE 14. CANADA, VALUE OF CONSTRUCTION WORK PERFORMED[1], BY PRINCIPAL TYPES OF CONSTRUCTION, BY INDUSTRY, 1980-1982

Industry	1980			1981			1981		
	Building	Engineering	Total	Building	Engineering	Total	Building	Engineering	Total
					($000)				
Agriculture and fishing	878,403	477,788	1,356,191	1,054,393	573,145	1,627,538	1,109,512	603,759	1,713,271
Forestry	41,196	210,040	242,236	30,880	171,765	202,645	36,199	201,500	237,699
Mining, quarrying and oil wells	647,614	7,048,084	7,705,698	714,994	7,627,324	8,342,318	785,458	9,331,273	10,116,731
Construction	199,050	2,666	201,716	231,705	3,093	234,798	262,971	3,498	266,469
Manufacturing	2,393,160	634,205	3,027,365	2,776,250	893,257	3,669,507	2,718,419	1,356,300	4,074,719
Utilities	943,558	7,039,952	7,983,510	1,120,822	9,161,384	10,282,206	1,277,148	11,527,747	12,804,895
Trade	667,271	47,666	714,937	704,360	37,810	742,170	750,923	46,487	797,410
Finance, insurance and real estate	3,041,093	404,634	3,445,727	3,855,035	481,602	4,336,637	4,324,210	460,554	4,784,764
Commercial services	772,346	10,847	783,193	870,582	15,987	886,569	841,734	15,826	857,560
Housing	13,872,008	-	13,872,008	16,359,859	-	16,359,859	16,396,688	-	16,396,688
Institutional services	1,894,006	23,564	1,917,570	2,143,819	24,007	2,167,826	2,365,301	27,179	2,392,480
Government departments	1,180,410	5,896,245	7,076,655	1,408,023	6,697,196	8,105,219	1,770,822	7,344,205	9,115,027
Total	26,540,115	21,786,691	48,326,806	31,270,722	25,686,570	56,957,292	32,639,385	30,918,328	63,557,713

Source: Statistics Canada.

[1] Actual expenditures 1980, preliminary actual 1981, intentions 1982.

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.

TABLE 5. PRINCIPAL MOLYBDENUM PRODUCERS IN THE WESTERN WORLD, 1981

Company	Country	Per cent of production
AMAX Inc.	United States	43
Corporacion Nacional del Cobre de Chile (Codelco-Chile)	Chile	15
Duval Corporation	United States	10
Placer Development Limited	Canada	6
Noranda Mines Limited	Canada	5
Kennecott Corporation	United States	4
Southern Peru Copper Corporation	Peru	3
Lornex Mining Corporation Ltd.	Canada	2
Others		12
		100

Sources: Company annual reports; Energy, Mines and Resources Canada; Market impact of byproduct molybdenum, 1982, by A. Sutulov.

billion t is expected to produce 54 000 tpd of ore and about 18 000 tpy of molybdenum. The company plans to spend $US 870 million to bring the mine into production by 1987. When it is in full operation, U.S. Borax will rate as the world's second largest molybdenum producer, after Climax.

In Chile, Codelco-Chile produced about 15 360 t of molybdenum in 1981 from four state-owned copper-molybdenum mines. Total output increased by 12 per cent compared with 1980. The company is completing an expansion program at the giant Chuquicamata mine which, when fully operational in 1982, will increase milling capacity from 70 000 tpd to 82 000 tpd. Although copper recovery is projected to increase only marginally because of falling copper grade in the ore, molybdenum output is expected to increase as a result of the expansion. Codelco-Chile plans to complete a roaster at the Chuquicamata mine by mid-1982, that will treat about 5 400 tpy of molybdenum and will produce about 10 000 tpy of technical grade molybdic oxide.

Mexico's first molybdenum mine, Cumobabi, was brought on-stream in October 1980 and produced about 1 400 t of MoS_2 in 1981. The mine, owned by Minera Frisco S.A. de C.V., is located near Cumpas, Sonora, Mexico. Production capacity at the mine is about 1 800 tpy of MoS_2. However, the company intends to reduce 1982 production to 1 130 t to cope with the weak molybdenum market.

Erdeinetyn Obo mine, Mongolia's only molybdenum producer, commenced production in December 1979 and produced 661 t of molybdenum in 1981. The mine is expected to reach full capacity production of 1 225 tpy in 1983. Reserves at the Erdeinetyn mine were reported to be 272 million t grading 0.85 per cent copper and 0.012 per cent molybdenum.

Two major copper-molybdenum mines in Peru, Toquepala and Cuajone, which are owned by Southern Peru Copper Corporation (SPCC), produced 2 985 t of molybdenum contained in concentrates in 1981 compared with 2 670 t in 1980. Molybdenum output at the two mines has increased significantly during the last two years as a result of changes in the flotation circuit. The injection of nitrogen in place of air in the flotation cells has improved molybdenum recovery and reduced operating costs.

PRICES

The weak demand for molybdenum and a sharp increase in producer inventories set off a series of price cuts during 1981. On March 2, Noranda and Placer reduced the producer price for technical-grade molybdic oxide, the benchmark product of the industry, to $US 21.38 per kg from $22.49. The price was further reduced to $18.96 per kg on August 1 and again to $15.43 on October 1. Corporacion Nacional del Cobre de Chile (Codelco-Chile) announced a $US 3 reduction to $US 12.15 per kg for technical-grade oxide, beginning December 1. Although the last price cut was not formally adopted by other producers, some did conduct sales at competitive prices although their published prices remained unchanged. Dealer prices, which softened at an even faster rate, started the year in a range from $US 18.74 to $US 18.96 a kg, dropped to a low of $US 7.28 to $US 9.04 per kg at the beginning of December, and rebounded to $US 9.78-$US 10.47 per kg by the end of the year.

PRICES

Prices in U.S. currency, per kilogram of contained molybdenum, fob shipping point, December 31.

	1980	1981
	($)	
Molybdenum concentrates[1] 95% MoS_2	20.28	17.42
Molybdic oxide[1] (MoO_3) in cans	21.38	18.74
Ferromolybdenum, minimum 60% Mo		
Climax[1]	25.40	20.72
Dealer export[2] (fas port)	17.64-19.84	11.13-12.13

[1] Climax quotes; [2] **Metals Week** quote.
fob Free on board, fas Free alongside ship.

OUTLOOK

The medium-term outlook for molybdenum is for continuing soft markets and excess supply. Current large producer inventories coupled with considerable new capacity are likely to delay for some time any major improvement in the current market situation. Renewed growth in demand for molybdenum will have to await an upturn in the demand for steel which, in turn, will depend on an improvement in general world economic conditions. With present molybdenum inventories building rapidly, continued production restraints by major producers will be the key factor in overcoming further weakening of the market. In the longer-term, molybdenum will continue to be a growth metal. However, the expected growth in consumption will be moderate compared with the impressive historical rate of 8 per cent.

TARIFFS

CANADA:

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
32900-1	Molybdenum ores and concentrates	free	free	free	free
33505-1	Molybdenum oxides	10.0	14.4	25.0	9.5
37506-1	Ferromolybdenum	free	5.0	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	13.6	25.0	9.0
	Temporary reduction, June 3, 1980 to June 30, 1982	free			free
92856-1	Molybdenum carbides	10.0	11.3	25.0	8.5
	Temporary reduction, June 3, 1980 to December 31, 1986	free			free

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

	1981	1982	1983	1984	1985	1986	1987
			(%)				
33505-1	14.4	14.1	13.8	13.4	13.1	12.8	12.5
37506-1	5.0	4.8	4.7	4.5	4.3	4.2	4.0
92847-1	13.6	12.8	12.1	11.4	10.7	9.9	9.2
92856-1	11.3	9.4	7.5	5.6	3.8	1.9	free

TARIFFS (cont'd)

UNITED STATES (MFN) Item No.		1981	1982	1983	1984	1985	1986	1987
				(%)				
601.33	Molybdenum ore (per lb on Mo content)	11.3¢	10.9¢	10.5¢	10.1¢	9.8¢	9.4¢	9.0¢
419.60	Molybdenum compounds	3.9	3.8	3.7	3.5	3.4	3.3	3.2
606.31	Ferromolybdenum	10¢/ lb on Mo content + 3	6.3	5.9	5.6	5.2	4.9	4.5
628.70	Molybdenum metal, waste and scrap (on or before June 30, 1981)	9.4	8.8	8.3	7.7	7.1	6.6	6.0
628.72	Molybdenum metal, unwrought	9¢/ lb on Mo content +2.7	8.6¢/ lb on Mo content +2.6	8.1¢/ lb on Mo content +2.5	7.6¢/ lb on Mo content +2.3	7.2¢/ lb on Mo content +2.2	6.7¢/ lb on Mo content +2.0	6.3¢/ lb on Mo content +1.9
628.74	Molybdenum metal, wrought	11.0	10.3	9.6	8.8	8.1	7.3	6.6
417.28	Ammonium molybdate	5.7	5.5	5.3	5.0	4.8	4.5	4.3
418.26	Calcium molybdate	4.8	4.8	4.8	4.8	4.8	4.7	4.7
421.10	Sodium molybdate	4.8	4.6	4.4	4.2	4.1	3.9	3.7
423.88	Molybdenum carbide	3.4	3.3	3.2	3.1	3.0	2.9	2.8

EUROPEAN ECONOMIC COMMUNITY (MFN)

Item No.		1981	Base Rate	Concession Rate
			(%)	
26.01	Molybdenum ores and conc.	free		
28.28	Molybdenum oxides and hydroxides	7.3	8.0	5.3
73.02	Ferromolybdenum	7.0	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	10.1	11.2	6.6
28.56	Molybdenum carbides	8.6	9.6	8.0

JAPAN (MFN)

Item No.				
26.01	Molybdenum ores and conc.			
	A. Quota	free		
	B. Other	5.6	7.5	free
28.28	Molybdenum trioxide	3.9	5.0	3.7
73.02	Ferromolybdenum	5.7	7.5	4.9
81.02	Molybdenum metal			
	A. Unwrought, powders and flakes	3.9	5.0	3.7
	B. Waste and scrap	3.9	5.0	3.7
	C. Other	5.7	7.5	4.9
28.47	Molybdates	5.7	7.5	4.9
28.56	Molybdenum carbides	3.9	5.0	3.7

Sources: The Customs Tariff and Commodities Index, 1981, Revenue Canada; Tariff Schedules of the United States Annotated 1981, USITC publication 1111; U.S. Federal Register, Vol. 44, No. 241; Official Journal of the European Communities, Vol. 23, No. L315, 1980; Customs Tariff Schedules of Japan, 1981.

Nepheline Syenite and Feldspar

B.W. BOYD

SUMMARY

From 1978 through 1981, shipments of Canadian nepheline syenite have been maintained at about 600 000 tpy. Apparent consumption in Canada was down 14 per cent from the previous year but exports, which increased by 6 per cent, more than made up the difference in absolute terms.

Feldspar sales were again limited to a few hundred t for use in manufacturing artificial teeth and about 1 000 t for use in tiles.

CANADIAN SCENE

Nepheline syenite is produced at two operations on Blue Mountain in Methuen

TABLE 1. CANADA, NEPHELINE SYENITE PRODUCTION, EXPORTS AND CONSUMPTION, 1980 AND 1981

	1980		1981P	
	(tonnes)	($)	(tonnes)	($)
Production (shipments)	600 000	15,936,000	606 000	17,834,000
Exports				
United States	406 205	12,255,000	399 068	13,423,000
Italy	15 601	550,000	12 203	435,000
Australia	8 954	337,000	11 295	408,000
Netherlands	9 181	253,000	8 654	358,000
United Kingdom	3 758	170,000	3 740	175,000
France	1 341	95,000	1 149	121,000
Taiwan	670	34,000	311	72,000
Other countries	2 758	163,000	39 856	266,000
Total	448 468	13,857,000	476 276	15,258,000
Consumption[1]				
Glass and glass fibre	56 401			
Ceramic products	13 676			
Insulation	10 174			
Paints	2 893			
Rubber products	896			
Others[1]	833			
Total	84 873	..	..	..

Sources: Statistics Canada; Energy, Mines and Resources, Canada.
[1] Includes frits and enamel, foundry, plastics, electrical apparatus and other minor uses.
P Preliminary; .. Not available.

Township, Peterborough County, Ontario. Indusmin Limited, a subsidiary of Falconbridge Nickel Mines Limited is the larger producer, expansions in 1979 raised capacity to 420 000 t annually, with a large range of product sizes. Finished products are transported by rail.

IMC Industry Group (Canada) Ltd., a wholly-owned subsidiary of International Minerals & Chemical Corporation (IMC) works the northeast end of the same mountain as Indusmin. IMC completed a $5 million expansion in 1981 which increased capacity by 25 per cent to about the same size as Indusmin's operation. The range of products was also increased and some higher value grades are now available.

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.

TABLE 2. CANADA, NEPHELINE SYENITE PRODUCTION AND EXPORTS, 1970, 1975-81

	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[r]
1980	600 000	448 468
1981[p]	606 000	476 276

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

[1] Producers' shipments.
[p] Preliminary; [r] Revised.

TABLE 3. CANADA, ESTIMATED FELDSPAR CONSUMPTION, 1979 and 1980

	1979	1980
	(tonnes)	
Consumption		
Whiteware	4 499	3 981
Other products[1]	89	70
Total	4 588	4 051

Source: Energy, Mines and Resources Canada.

[1] Includes porcelain enamel, artificial abrasives and other minor uses.

TABLE 4. CANADA, IMPORTS AND CONSUMPTION OF CRUDE OR GROUND FELDSPAR, 1975-80

	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

Sources: Statistics Canada; Energy, Mines and Resources Canada.
.. Not available.

TABLE 5. WORLD PRODUCTION OF FELDSPAR, 1980 and 1981

	1980	1981[e]
	(tonnes)	
United States	644 000	626 000
West Germany	370 000	363 000
Brazil	367 000	363 000
Italy	295 000	272 000
France	200 000	181 000
Mexico	127 000	118 000
Spain	125 000	118 000
Other countries	1 303 000	1 270 000
Total	3 431 000	3 311 000

Source: United States Bureau of Mines (USBM), Mineral Commodity Summaries, 1982.
[e] Estimated.

The recent recession reduced glassmaking in the United States, and high interest rates prolonged the situation in 1981, keeping sales down.

PRICES

The value of exports of nepheline syenite increased by 12 per cent in response to an average price increase of the same amount. The price per t ranges from about $14 to over $100, 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	46.00
20 mesh, flotation	27.50
200 mesh, flotation	41.25-65.00
Georgia	
200 mesh	64.00
40 mesh, granular	46.00
Connecticut	
200 mesh	46.75
20 mesh, granular	34.50

Source: Engineering and Mining Journal, December 1981.
fob - Free on board.

TRADE

In 1981, 79 per cent of Canada's nepheline syenite output was exported. Sales to the United States dropped for the second year in a row but unusually large exports to West Germany (36 051 t) resulted in a net increase in export sales. The change in export volume represented a recovery to the 1979 level.

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. 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 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	7.0	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)

	1981	1982	1983	1984	1985	1986	1987
				(%)			
29625-1	7.0	6.8	6.5	6.3	6.0	5.8	5.5

UNITED STATES

Item No.		
522.31	Crude feldspar	free

		1981	1982	1983	1984	1985	1986	1987
				(%)				
522.41	Feldspar, crushed, ground or pulverized	3.3	3.2	3.2	3.1	3.0	2.9	2.8

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

Nickel

R. TELEWIAK

High interest rate policies instituted by major industrialized nations in 1981 had the effect of reducing capital and consumer spending, and this resulted in noncommunist world nickel consumption being lowered by an estimated 5 per cent from the 530 000 t of 1980. Consumption in 1980 had been nearly 12 per cent below 1979 levels, and while there was some recovery in nickel demand early in 1981, it dropped sharply in the second half of the year as economic activity contracted in the United States and western Europe. It was the first time since World War II that consumption had declined in two consecutive years.

The high cost of financing inventories, along with expected low demand for nickel products, caused consumers to maintain inventories throughout the year near the "bare-bones" level. Producers generally kept their inventories at a workable level by continuing to operate well below capacity. Average capacity utilization in the industry was just under 70 per cent. While producer inventories rose by nearly 25 000 t to 205 000 t, they remained well below the onerous level of 340 000 t which burdened the industry at the end of 1977. Profit margins declined to unsatisfactory levels for the lowest cost producers' while a substantial proportion of the remainder recorded losses. Laterite producers, as compared to sulphide producers, generally incur higher production costs, primarily because of higher energy requirements, and these producers were especially hard hit by rising costs and depressed prices. Declining demand in the stainless steel market, the principal use for ferronickel, had a significant negative impact on revenues.

CANADIAN DEVELOPMENTS

Producers reacted to the weak nickel markets by continuing to maintain tight control over production. Besides operating well below capacity, Inco Limited also instituted temporary production shutdowns. The Sudbury and Shebandowan mining and processing operations were closed for four weeks starting on July 6, 1981, the Port Colborne refinery for four weeks starting July 20, and the Thompson operations for three weeks starting July 13. Falconbridge Nickel Mines Limited did not institute any shutdowns but maintained production near the 70 per cent rate of 1980. In early December, Inco announced that the Coleman mine would be placed on standby by March 1, 1982.

At Thompson, a strike by 1,900 members of the United Steelworkers of America began on September 16 and continued until December 16. Inco had been operating the facilities, which have an annual capacity of about 54 000 t, at a rate of about 40 000 t prior to the stoppage. The two main issues of dispute involved wages and length of contract. A 33 month contract was signed and it was calculated by the company to be worth an additional $7.80 an hour, including benefits, over the life of the agreement.

Further testing of the modified fluid-bed roaster-electric furnace process was carried out in 1981 at Thompson, with about 14 000 t of Copper Cliff concentrate being processed in May and June. All major objectives were reported met. The major advantage of the process lies in the potential to recover 80 per cent of the sulphur in the concentrate in a high-strength, continuous SO_2 gas stream suitable for the production of sulphuric acid. If the process proves viable the company has indicated that implementation of the process at Sudbury, along with the new pyrrhotite separation facilities under construction, would reduce atmospheric emissions of sulphur to 11 per cent of the sulphur contained in the ore.

TABLE 1. CANADA, NICKEL PRODUCTION, TRADE AND CONSUMPTION, 1980 AND 1981

	1980		1981P	
	(tonnes)	($)	(tonnes)	($)
Production[1]				
All forms				
Ontario	145 608	1,154,861,786	127 206	1,159,747,000
Manitoba	39 194	342,556,574	27 969	254,996,000
Total	184 802	1,497,418,360	155 175	1,414,743,000
Exports				
Nickel in ores, concentrates and matte[2]				
Norway	25 094	157,389,000	31 437	233,563,000
United Kingdom	17 552	135,256,000	22 394	168 034 000
Japan	1	6,000	10	30,000
Total	42 647	292,651,000	53 841	401,627,000
Nickel in oxides				
United States	7 632	65,484,000	7 678	60,308,000
EEC	5 292	48,843,000	2 031	19,811,000
Other countries	4 065	30,452,000	4 681	41,229,000
Total	16 989	144,779,000	14 390	121,348,000
Nickel and nickel alloy scrap				
United States	1 662	5,634,000	2 188	8,191,000
West Germany	412	2,768,000	264	1,299,000
Japan	46	131,000	50	166,000
South Korea	-	-	36	164,000
Other countries	308	791,000	240	525,000
Total	2 428	9,324,000	2 778	10,345,000
Nickel anodes, cathodes, ingots, rods				
United States	50 317	387,402,000	49 937	378,906,000
EEC	21 047	149,654,000	14 753	96,575,000
Other countries	16 761	122,206,000	15 245	107,229,000
Total	88 125	659,262,000	79 935	582,710,000
Nickel and nickel alloy fabricated material, n.e.s.				
United States	10 317	88,507,000	10 156	83,202,000
Belgium-Luxembourg	1 316	8,493,000	1 008	8,100,000
Netherlands	461	4,580,000	509	6,850,000
United Kingdom	637	4,748,000	326	2,580,000
India	-	-	315	2,535,000
Japan	299	2,316,000	266	2,107,000
Other countries	5 832	50,443,000	798	6,455,000
Total	18 862	159,087,000	13 378	111,829,000
Imports				
Nickel in ores, concentrates and scrap				
Australia	4 254	19,878,000	4 580	28,368,000
United States	11 902	36,001,000	9 095	15,393,000
Belgium-Luxembourg	1 286	2,261,000	5 488	7,503,000
South Africa	1 453	4,778,000	1 936	4,668,000
Other countries	7,254	3,750,000	2 661	3,274,000
Total	26 149	66,668,000	23 760	59,206,000

TABLE 1. (cont'd.)

	1980		1981P	
	(tonnes)	($)	(tonnes)	($)
Nickel anodes, cathodes, ingots, rods				
Norway	1 708	15,370,000	1 266	9,970,000
United States	2 409	4,075,000	816	6,664,000
U.S.S.R.	200	1,210,000	191	1,428,000
United Kingdom	5	31,000	51	316,000
Other countries	22	186,000	11	94,000
Total	4 344	20,872,000	2 335	18,472,000
Nickel alloy ingots, blocks, rods and wire bars				
United States	829	6,550,000	545	5,145,000
United Kingdom	-	-	43	142,000
West Germany	21	114,000	2	33,000
Belgium-Luxembourg	30	196,000	-	-
Total	880	6,860,000	590	5,320,000
Nickel and alloy plates, sheet, strip				
United States	955	12,639,000	617	8,532,000
West Germany	328	2,648,000	498	4,118,000
Netherlands	-	-	15	33,000
Other countries	112	1,137,000	1	16,000
Total	1 395	16,424,000	1 131	12,699,000
Nickel and nickel alloy pipe and tubing				
United States	591	8,432,000	973	13,587,000
Sweden	75	1,907,000	600	9,282,000
West Germany	173	3,528,000	227	5,142,000
Other countries	33	500,000	23	445,000
Total	872	14,367,000	1 823	28,456,000
Nickel and alloy fabricated material, n.e.s.				
United States	788	18,525,000	784	25,750,000
West Germany	47	339,000	59	741,000
United Kingdom	12	497,000	21	444,000
Austria	-	-	27	320,000
Other countries	19	364,000	10	76,000
Total	866	19,725,000	901	27,331,000
Consumption[3]	9 638	..	..	..

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.

Presently 30 per cent is emitted. Construction costs would be "hundreds of millions of dollars" and sulphuric acid production would be approximately doubled.

Inco also announced the development of a new open-pit mine at Thompson. The mine is expected to come on-stream in 1984 to replace the Pipe open-pit mine which will be depleted at that time. The $85 million first phase will permit mining of a portion of the orebody to a depth of about 125 metres; and a $75 million second phase to develop the remainder of the orebody is expected to begin in 1988, with production by 1991.

Inco announced late in 1981 that, with weak nickel markets persisting, temporary production shutdowns would again be instituted at its Ontario operations in 1982. A four-week shutdown would begin at the Sudbury and Shebandowan operations on July 5, 1982 and at Port Colborne on July 19. The Shebandowan mine and concentrator would also be reduced from two shifts to one by February 1, 1982.

Sherritt Gordon Mines Limited's nickel refinery at Fort Saskatchewan, Alberta operated during the year near its rated capacity of 17 500 tpy despite being deprived of matte supplies from Thompson during the Inco strike. Sherritt Gordon has a long-term contract with Inco for refinery feed and Thompson has been the normal source. During the strike Sudbury material was used and the difference in the type of feed, primarily in the amount and kind of associated products, did not pose any major technical problems. The company has not had a substantial internal source of refinery feed since the closure of its Lynn Lake mine in 1976.

On September 12, Falconbridge officially opened the new $200 million Fraser mine located at the west end of the Sudbury Basin. Production will be stepped up as market conditions require, and the company forecasts that this will mean a production rate of 2 300 tpd by 1983. Full production is expected by the late 1980s. Development work commenced at the Craig deposit, also at the west end of the Basin, and initial production from this mine is scheduled for as early as 1987.

Late in 1981, Falconbridge announced that a five-week summer shutdown will take place from June 27 to August 1 at its Sudbury operations. This action was being undertaken to maintain a prudent balance between production and deliveries. To conserve cash, the company also announced that certain development work at the Craig, Lockerby and Onaping mines will be suspended in early 1982.

New Quebec Raglan Mines Limited drilled a total of 15 565 metres on its Donaldson nickel-copper property in the Ungava area of northern Quebec. Re-estimation of the tonnage and grade, along with metallurgical testwork, were reported in progress near the end of 1981. New Quebec Raglan owns several relatively small but high-grade nickel deposits in the Ungava area and the focus of the 1981 drilling program was to increase tonnage at one or two central localities.

Preliminary indications are that Canadian consumption of nickel in 1981 was down somewhat from the 9 600 t in 1980. Specialty steel production, including stainless steel, is the largest use for nickel in Canada. The operating rate in this industry reflected the effects of the recession, and was down significantly. The use of nickel in nonferrous alloys was not affected to the same extent by the economic conditions. Nickel-copper alloys, primarily for use in coinage, are a major component of the nonferrous alloys group and their consumption is not as dependent upon economic activity.

WORLD DEVELOPMENTS

Major nickel producers in various parts of the world operated well below capacity levels for most of 1981, and some reduced production further as demand weakened in the second half. Given the experience of the onerous inventory buildup which developed in 1977 and 1978, producers wanted to avoid excessive inventory levels.

Falconbridge Dominicana, C. por A. closed one of its two operating electric furnaces on June 22 and remained in this operating mode for the remainder of the year. Production was reduced to about 20 000 t of contained nickel in ferronickel from a current capacity of 30 800 t. Falconbridge estimated that it could have the second furnace operational within three weeks if market conditions warranted.

In New Caledonia, Société Métallurgique Le Nickel (SLN), shut down two of its three operating 11 000 kilowatt (kw) nickel smelting units in late-November, 1981. This action, in addition to cutbacks taken in 1980, left only two of the three 33 000 kw units and one of the eight 11 000 kw units still in operation. Production in 1981 was

TABLE 2. CANADA, NICKEL PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975, 1977-81

	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
1977	232 512	80 546	35 005	74 629	190 180	2 406	9 033
1978	128 310	39 077	27 792	105 663	172 532	1 439	11 790
1979	126 482	42 735	17 190	84 809r	144 734r	2 516r	8 336
1980	184 802	42 647	16 989	88 125r	147 761r	4 344	9 638
1981p	155 175	53 841	14 390	79 935	148 166	2 335	..

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.

close to 43 000 t and is expected to be about 35 000 t in 1982.

AMAX Nickel, Inc. announced in November that it had requested a 25 per cent reduction in nickel matte deliveries from BCL Ltd. in Botswana over the next 27 months. AMAX holds a 30 per cent equity interest in Botswana RST Ltd. which owns 85 per cent of BCL Ltd., and all of the nickel matte production is treated at the company's Port Nickel refinery in Louisiana. The company had already instituted an aggressive marketing campaign and this requested reduction was another part of its strategy to reduce an inventory which had reached 45 000 t - more than a year's supply - of refined nickel and nickel in matte.

In Australia, Western Mining Corporation Limited operated well below capacity during 1981 but the Greenvale operation of Queensland Nickel Pty. Ltd. operated close to full capacity. The small Windarra nickel mine in Western Australia, which was placed on a care and maintenance basis in 1978, was brought back on-stream in mid-year by Western Mining at an annual rate of about 8 000 t of contained nickel. At Greenvale, work proceeded on converting from oil to coal for process energy. The cost competitiveness of Greenvale should be significantly improved by the conversion which is expected to reduce oil consumption by close to one-half.

Inco announced in late October that its Guatemala subsidiary, Exploraciones y Explotaciones Mineras Izabal, S.A. (Exmibal), would be closed indefinitely. The laterite producer with a capacity for 11 800 tpy of nickel contained in nickel matte had been closed since September 1980 due to the depressed nickel market and the high operating costs of the facility. The plant is based wholly on fuel oil and studies conducted for the company indicated that conversion to coal or some other less costly energy source was not feasible.

A fire in late October at Falconbridge's refinery in Norway caused about $5 million in damages and put the matte leach plant out of operation. That part of the refinery produces about 6 800 tpy of granular and active nickel and repairs were expected to take about four months. The remainder of the refinery, which produces electrolytic nickel, copper, cobalt and precious metals, was not affected.

The World Bank granted a $4.8 million loan to Burundi to further evaluate the country's Musongati laterite nickel deposits. The deposits are low-grade and would require substantial investments in infrastructure. A United Nations sponsored prefeasibility study conducted on the deposits in 1978 indicated they were not economic at that time. Included in the new project will be the boring of additional test holes and the examination of local peat supplies as a source of power.

TABLE 3. PRODUCING CANADIAN NICKEL MINES, 1981 AND (1980)

Company and Location	Mill or Mine Capacity (tonnes ore/day)		Grade of Ore: Nickel (%)	Grade of Ore: Copper (%)	Ore Milled (tonnes)	Contained Nickel in Ore Milled (tonnes)	Remarks
Ontario							
Falconbridge Nickel Mines	12 650		..	..	2 754 690	29 480	The Fraser mine
Limited	(12 650)		(..)	(..)	(2 967 632)	(30 162)	officially opened in
East, Falconbridge, Fraser,	2 700	(Falconbridge)					September.
North, Lockerby, Onaping	7 600	(Strathcona)					
and Strathcona mines	2 300	(Fecunis Lake)					
Falconbridge							
Inco Limited	69 300		..	..	9 220 048[1]	138 493[2]	In December, Inco
Coleman, Copper Cliff	(69 300)		(..)	(..)	(10 608 827)[2]	(166 962)[3]	announced Coleman
South, Creighton, Frood,	31 800	(Clarabelle)					mine would be placed
Garson, Levack, Little	21 800	(Frood-Stobie)					on standby by March
Stobie, McCreedy West	5 400	(Levack)					1, 1982.
and Stobie mines	10 300	(Creighton)					
Sudbury							
Shebandowan mine	2 250		..	..	See above[1]	See above[2]	
Shebandowan	(2 250)		(..)	(..)	(See above)[1]	(See above)[2]	
Umex Inc.	3 600		..	..	..	..	1981 production data
Thierry mine	(3 600)		(0.11)	(1.20)	(1 080 000)	(238)	not available prior
							to publication.
Manitoba							
Inco Limited	12 700		..	..	1 801 391	See above[2]	
Pipe No. 2 and Thompson	(12 700)		(..)	(..)	(2 557 454)	(See above)[2]	
Thompson							

[1] Includes Shebandowan. [2] Includes Shebandowan and Thompson.
.. Not available.

TABLE 4. PROSPECTIVE CANADIAN NICKEL MINES

Company and Location	Tonnage and Ore Grade (%)	Year Production Expected	Destination of Nickel Concentrates	Remarks
Quebec				
New Quebec Raglan Mines Limited	10.9 million Ni(3.11) Cu(0.79)	..	..	A total of 16 105 m of drilling completed in 1981.
Renzy Mines Limited, Hainault Township	1.2 million Ni(0.69) Cu(0.72)	..	..	Operations ceased after crushing plant destroyed by fire in 1974.
Ontario				
Falconbridge Nickel Mines Limited, Falconbridge	.. Ni(..) Cu(..)		Falconbridge	
Craig		1987		Development work commenced in 1981.
Onex mine				Development deferred.
Thayer Lindsley mine				Development deferred.
Inco Limited, Sudbury	.. Ni(..) Cu(..)		Sudbury	
Copper Cliff North mine		..		Placed on standby, 1978.
Crean Hill mine		..		Placed on standby, 1978.
Fecunis mine				Acquired in an exchange with Falconbridge, on standby.
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 to bring property on at a rate of 2.25 million tpy has been suspended and the 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(..)		Thompson	
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		1984		Thompson crown pillar being developed to replace Pipe No. 2 mine which will be exhausted in 1984.

Source: Energy, Mines and Resources Canada.
.. Not available.

TABLE 5. CANADIAN PROCESSING CAPACITY, 1981

	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.

In the United States, Ni-Cal Developments Ltd. conducted a $1.0 million feasibility study on its large low-grade nickel-cobalt-chromium deposit in northern California. The study was scheduled for completion in December, 1981, and if positive, could mean the construction of a $300 million mine and processing plant capable of handling 4 500 tpd of ore.

Outokumpu Oy announced plans to bring a new nickel mine at Enonkowski, near Savonlinna, Finland, into production in 1985. Ore at the company's nearby Kotalahti mine is expected to be depleted by 1985 and the new mine may use the Kotalahti site for concentrating the ore. Expansion of the Hajavalta smelter from 13 000 tpy to 16 500 tpy is scheduled for completion in the next two years in preparation for development of the Enonkowski mine.

Outokumpu Oy also reported that work was almost complete at the Nadezhda project in the Norilsk mining complex of the Soviet Union. The plant, which is capable of producing 550 000 tpy of nickel concentrate and 650 000 tpy of copper concentrates, was being readied for full production by the end of 1981. Outokumpu has been involved in a Finnish consortium with Rauma-Repola and Ahlstroem in constructing flash furnaces at the complex. The majority of Soviet nickel production originates from the high grade nickel-copper-cobalt sulphide deposits in the Norilsk region and plans are to continue to expand production in this area of the country.

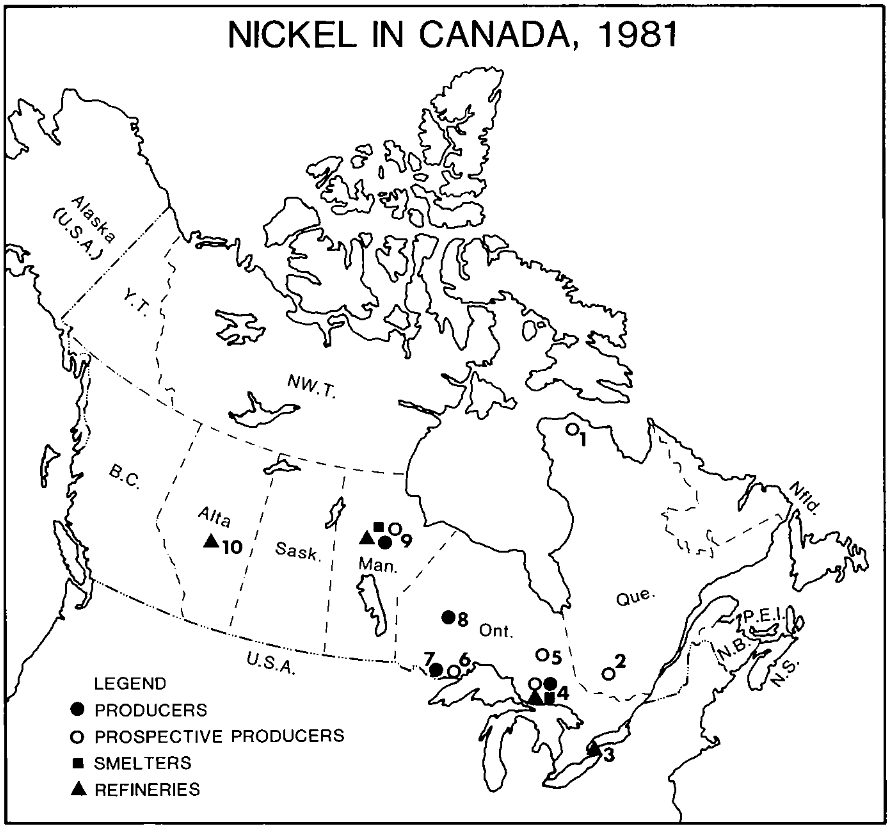
Significant progress was reported in construction at the Cerro Matoso S.A. nickel-laterite project in Columbia where initial production is expected in mid-1982 and full production in 1985. Reserves averaging 2.7 per cent nickel are sufficient to last for 25 years at the 22 600 tpy annual capacity rate. The entire production will be purchased and marketed by Billiton B.V., which has a 35 per cent equity interest in the project.

Nickel consumption in the non-communist world was at a level of about 500 000 t in 1981 compared to 530 000 t a year earlier.

TABLE 6. WORLD PRODUCTION OF NICKEL, 1980 AND 1981

	1980	10 months 1981
	(tonnes)	
Canada	184 802	155 200[1]
U.S.S.R.[e]	143 000	..
New Caledonia	86 300	64 700
Australia	69 800	55 800
Indonesia	40 600	35 300
Philippine Republic	38 300	31 100
Cuba[e]	38 200	..
South Africa	25 700	22 000
Dominican Republic	15 500	15 400
Zimbabwe	14 600	12 700[2]
Botswana	15 400	13 000
Greece	14 600	12 000
United States	14 700	15 600[3]
People's Republic of China	11 000	..
Other	31 000	..
Total	743 300	700 000[3e]

Sources: Energy, Mines and Resources Canada; World Bureau of Metal Statistics; United States Bureau of Mines (USBM).
[1] 12 months production, all forms; [2] January to July; [3] 12 months.
[e] Estimated; .. Not available.



Producers, prospective producers, smelters and refineries
(numbers refer to locations on map above)

Producers

4. Falconbridge Nickel Mines Limited (East, Falconbridge, Fraser, Lockerby, North, Onaping, Strathcona)
   Inco Limited (Clarabelle, Coleman, Copper Cliff South, Creighton, Frood, Garson, Levack, Little Stobie, McCreedy West and Stobie)
7. Inco Limited (Shebandowan mine)
8. Umex Inc. (Thierry mine)
9. Inco Limited (Pipe No. 2 and Thompson mines)

Prospective Producers

1. New Quebec Raglan Mines Limited
2. Renzy Mines Limited (Hainault Township)
4. Falconbridge Nickel Mines Limited (Craig, Lindsley, Onex and Thayer mines)
   Inco Limited (Copper Cliff North, Crean Hill, Fecunis, Murray, Totten)
5. Teck Corporation (Moncalm Township)
6. Great Lakes Nickel Limited (Pardee Township)
9. Inco Limited (Thompson open pit, Soab mine, Birchtree, Pipe No. 1)

Smelters

4. Falconbridge Nickel Mines Limited (Falconbridge) Inco Limited (Sudbury)
9. Inco Limited (Thompson)

Refineries

3. Inco Limited (Port Colborne)
4. Inco Limited (Sudbury)
9. Inco Limited (Thompson)
10. Sherritt Gordon Mines Limited (Fort Saskatchewan)

TABLE 7. WORLD CONSUMPTION OF NICKEL, 1980 AND 1981

	1980	9 months 1981
	(tonnes)	
United States	141 800	131 500[1]
U.S.S.R.	132 000	..
Japan	122 000	67 300
West Germany	68 000	42 900
France	38 400	22 700
United Kingdom	22 800	17 100
Italy	27 100	10 900[2]
China	18 000	..
Sweden	20 000	9 300
Brazil	11 200	6 500
East Germany	10 500	..
Canada	9 600	..
Spain	8 900	6 300
Poland	8 000	..
Other	71 200	..
Total	709 500	690 000[1]

Sources: World Bureau of Metal Statistics; Energy, Mines and Resources; United States Bureau of Mines.
[1] 12 months; [2] January to August.
.. Not available.

Recessionary conditions in the major economies during the year, and particularly in the second half, resulted in this drop in consumption for a second consecutive year. Stainless steel production which accounts for about 50 per cent of the total nickel consumed was down about 10 per cent in 1981.

STOCKS

Despite producer cutbacks, non-communist producer inventories of finished nickel increased during the year, and at year-end stood at an estimated 210 000 t. Producers consider three months of supply to be normal levels of inventories, and in 1981, 125 000 t would have been normal. Inco reported year-end 1981 inventories of 65 300 t, compared to 70 300 t at the end of 1980. Inco's production cutbacks and the three month strike at Thompson were the main factors behind the decline. Falconbridge reported an increase in inventories to 22 100 t at year-end 1981 from 20 800 a year earlier.

During the year inventories were higher than normal for many producers but, as a percentage of production, AMAX recorded one of the highest levels of stocks. AMAX does not own controlling interest in any nickel mines, and it buys matte for its Louisiana refinery under long-term contracts from both BCL Ltd. in Botswana and Agnew Mining Co. Pty. Ltd. in Australia. AMAX has also obtained refinery feed when necessary from suppliers in South Africa and New Caledonia. In the first half of 1981 inventories were accumulating rapidly and this resulted in AMAX's decision to pursue an aggressive marketing program and to request a reduction in matte supplies from Botswana.

In response to the high carrying charges and the low expected demand for nickel products, consumers maintained their inventories at low levels during the year. In the United States, consumer inventories were relatively constant for most of the year and then in December, stocks (exclusive of scrap) increased by 70 per cent to 17 600 t. The increase in inventories largely reflected substantial purchases by a number of major consumers due to the availability of relatively low priced nickel.

TABLE 8. NICKEL PRICES IN UNITED STATES DOLLARS PER POUND, 1981

	Jan. 1	Nov. 25	Nov. 26	Dec. 3	Dec. 15
Cathodes	3.50	3.29	3.29	3.29	3.29
Pellets	3.45	3.20	3.20	3.20	3.20
Briquettes	3.45	3.45	3.45	3.20	3.20
Falconbridge, ferronickel[1]	3.41	3.41	3.18	3.18	3.18
Hanna, ferronickel[1]	3.40	3.40	3.40	3.40	3.16

Source: **American Metal Market.**
[1] Per pound of contained nickel.

LAW OF THE SEA

Resources of nickel, copper, cobalt and manganese occur in polymetallic nodules on the deep seabed of some oceans. Favourable areas in the Pacific have been prospected by five consortia for some years, and these companies have also been developing recovery technology. Four countries - the United States, United Kingdom, France and West Germany - have now passed interim legislation permitting recognition of exploration sites. Such legislation is to terminate or be superceded when a Law of the Sea Convention enters into force.

A Draft Convention on the Law of the Sea was prepared in 1980 by the Third United Nations Conference on The Law of the Sea. Progress was made on the delimitation of boundaries between coastal states for the Exclusive Economic Zone and Continental Shelf, and on participation of the European Economic Community. On mining issues, the conference as a whole has yet to determine the terms of reference for a preparatory commission that would allow the seabed mining regime to function. Jamaica has been chosen as the seat of the International Seabed Authority and Hamburg, West Germany, as the site of an international tribunal. This progress would normally suggest that negotiations were close to an end. However, a number of participants have expressed concerns about matters affecting mining, such as production policies and financial arrangements. In the United States, a major policy review was under way in 1981 and specific concerns are expected to be made known before the next meeting, to be held in New York in March 1982.

PRICES

The 6 per cent price discount offered in November 1980 by producers for deliveries through the first quarter of 1981 was altered in late January to orders placed before February 28 for delivery through June 30. A rise in producer inventories was a major factor in this decision. List prices (US funds) for melting nickel, plating nickel and ferronickel during this period were $3.45, $3.50 and $3.41 per pound, respectively, but producers continued to sell at effective prices significantly below this level throughout 1981 when demand did not strengthen. An abundance of stainless steel scrap contributed to lower prices, as did selling to western nations by the U.S.S.R. The Soviets demonstrated a desire to acquire foreign exchange, and they were reported to be selling some nickel in the range of $2.35 a pound.

The US Bureau of the Mint opened purchase bids at the end of August for 1 587 t of electrolytic nickel cathodes or briquettes. The lowest bid was $2.69 a pound but F.W. Hempel Inc. won the contract with an offer of $2.72 a pound, some $0.73 lower than the posted producer price. The publicizing of these bids served to lower prices and on November 25, Inco announced that, effective immediately, prices would be reduced for plating nickel to $3.29 a pound, melting nickel to $3.20 and charge nickel to $3.12. Other major producers followed suit. Falconbridge reduced its ferronickel prices to $3.18 a pound.

Prices on the LME were significantly below the producer price throughout 1981, with a yearly low of $2.22 being recorded in the first week of October. Prices averaged $2.85 a pound during the first six months and $2.54 for the remainder of the year.

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 steel, which accounts 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 steel 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 hull-plating for boats, and nickel-cadmium batteries for standby power applications. A potentially important market is the use of a zinc-nickel oxide battery in electric cars. General Motors Corporation has announced that an electric car utilizing this type of battery will be in production by 1985. However, competition from other battery types such as the zinc-chloride battery being developed by Gulf & Western Industries, Inc. could limit nickel growth in this application. 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 demand can be expected to rise only with real economic growth in the major consuming nations, and with recessionary conditions forecast to continue through the first half of 1982, weak nickel demand will persist through this period. The second half of 1982 has the potential to see a return to growth in nickel demand, if economic activity revives. Consumer inventories are at a low level and any upturn in GNP growth would precipitate a rebuilding of depleted inventories and orders to producers would be greater than actual consumption.

Nickel consumption grew at an average compound growth rate of 6 per cent from 1946 to 1973 but has averaged closer to zero since then. With the maturing of some major economies and changes in consumption patterns, a return to historic growth rates of 6 per cent is highly improbable. Some developing countries can expect to see 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. Their importance as markets will be growing, however.

Consumption growth in the next decade is expected to approximate real economic growth in the major OECD countries. An annual nickel growth rate of about 2 per cent seems possible. The critical aspect for nickel demand in the 1980s will be the pace at which major world economies grow and, as part of this, the effectiveness of various economic measures being undertaken in some of the major consuming nations.

TARIFFS

CANADA

Item No.		General Preferential	British Preferential	Most Favoured Nation	General
32900-1	Nickel ores	free	free	free	free
33506-1	Nickelous oxide	9.5%	10%	14.4%	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

CANADA (cont'd)

Item No.		General Preferential	British Preferential	Most Favoured Nation	General
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	5%	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.	6%	9.2%	9.2%	20%

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

	1981	1982	1983	1984	1985	1986	1987
			(%)				
33506-1	14.4	14.1	13.8	13.4	13.1	12.8	12.5
37506-1	5.0	4.8	4.7	4.5	4.3	4.2	4.0
44643-1	9.2	8.8	8.4	8.0	7.6	7.2	6.8

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

		1981	1982	1983	1984	1985	1986	1987
				(%)				
419.70	Nickel chloride	4.7	4.5	4.4	4.2	4.0	3.9	3.7
419.74	Nickel sulfate	4.6	4.3	4.1	3.9	3.7	3.4	3.2
419.76	Other nickel compounds	4.7	4.5	4.4	4.2	4.0	3.9	3.7
426.58	Nickel salts: acetate	4.7	4.5	4.4	4.2	4.0	3.9	3.7
426.62	Nickel salts: formate	4.7	4.5	4.4	4.2	4.0	3.9	3.7
426.64	Nickel salts: other	4.7	4.5	4.4	4.2	4.0	3.9	3.7

TARIFFS (cont'd)

UNITED STATES (cont'd)

		1981	1982	1983	1984	1985	1986	1987
				(%)				
620.08	Nickel plates and sheets, clad	10.5	9.8	9.0	8.3	7.5	6.8	6.0
620.10	Other wrought nickel, not cold worked	4.6	4.4	4.3	4.1	3.9	3.7	3.5
620.12	Other wrought nickel, cold worked	6.4	6.1	5.9	5.6	5.3	5.0	4.7
620.16	Nickel, cut, pressed or stamped to nonrectangular shapes	8.1	7.7	7.3	6.8	6.4	5.9	5.5
620.20	Nickel rods and wire, not cold worked	4.7	4.5	4.4	4.2	4.0	3.9	3.7
620.22	Nickel rods and wire, cold worked	6.4	6.1	5.9	5.6	5.3	5.0	4.7
620.26	Nickel angles, shapes and sections	8.1	7.7	7.3	6.8	6.4	5.9	5.5
620.30	Nickel flakes, per pound	3.7¢	3.1¢	2.5¢	1.9¢	1.2¢	0.6¢	free
620.40	Pipes, tubes and blanks, not cold worked	2.9	2.8	2.8	2.7	2.6	2.6	2.5
620.42	Pipes, tubes and blanks, cold worked	3.8	3.6	3.5	3.4	3.3	3.1	3.0
620.46	Pipe and tube fittings	7.7	7.0	6.3	5.6	5.0	4.3	3.6
620.50	Electroplating anodes, wrought or cast, of nickel	4.7	4.5	4.4	4.2	4.0	3.9	3.7
642.06	Nickel wire strand	6.4	6.1	5.9	5.6	5.3	5.0	4.7
657.50	Articles of nickel, not coated or plated with precious metal	8.1	7.7	7.3	6.8	6.4	5.9	5.5

Sources: The Customs Tariff and Commodities Index, January 1981, Revenue Canada; Tariff Schedules of the United States Annotated 1981, USITC Publication 1111; 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, (commonly referred to in the trade as "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. Phosphate rock production decreased 1.8 per cent to 137.8 million t and producer stocks increased significantly. Countries that experienced the largest cutbacks were the traditional producers: Algeria, Christmas Island, Israel, Nauru, South Africa, Togo, Tunisia, United States and the U.S.S.R. Moderate increases were attributed to countries with new mine production on-stream during 1981 such as Morocco, and Jordan.

Western world export sales of phosphate rock decreased 14.5 per cent from 47.0 to 40.2 million t between 1980 and 1981. Of the 11 principal exporters not one increased exports 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. Sherritt Gordon is currently conducting detailed production feasibility studies and examining the various options, including partnership proposals. The decision on whether to proceed to production

TABLE 1. CANADA, PHOSPHATE ROCK IMPORTS, 1980 AND 1981, AND CONSUMPTION, 1979 AND 1980

	1980		1981P	
	(tonnes)	($)	(tonnes)	($)
Imports				
United States	3 816 444	132,680,000	3 245 397	132,982,000
Other countries	70	56,000	33	20,000
	3 816 514	132,736,000	3 245 430	133,002,000

	1979	1980
	(tonnes)	(tonnes)
Consumption[1]		
Eastern Canada	1 342 200	1 602 484
Western Canada	1 861 200	1 944 152
Total	3 203 400	3 546 636

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

[1] Breakdown by Energy, Mines and Resources Canada.
P Preliminary.

expected in early 1982 was postponed for a few months because of general economic conditions.

In December 1981 and early 1982 Shell Canada Resources Limited completed a drilling program on a large carbonatite deposit near Martison Lake, north of Hearst, Ontario. The deposit is mineralogically similar to the Cargill occurrence and has a potential for a very large operation.

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. Currently, Canada imports approximately 3.5 million t of phosphate rock per year. 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 USA) 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.

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 45 000 tpy. In total, the 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 unit value).

Production from Varennes, Quebec is 90 per cent or more oriented toward Canadian

TABLE 2. CANADA, PHOSPHATE FERTILIZER PLANTS, 1981

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			

Source: Energy, Mines and Resources Canada.

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.

present any problems for fertilizer production. In Canada, Earth Sciences Incorporated (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 recovered yellow cake is shipped to the United States. Since uranium prices are currently only about half of the peak 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. Efficient plants can consistently operate at 90 to 95 per cent of nameplate capacity. Most Canadian plants, however, 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 a nearby plant at Welland, Cyanamid Canada Inc.

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 1981 was estimated at 137.8 million t, a small decrease of 1.8 per cent from 1980. Western world production was 100.1 million t, a decrease of 3.1 per cent from the year before. Total deliveries by producers (a sum of home deliveries and exports) were 129.9 million t or 6.5 per cent lower than in 1980. The continuance of high levels of production resulted in a very major increase in phosphate rock inventories in producer's hands, particularly in the United States.

The decline in production in the United States is principally due to cutbacks in Florida which for the second half of the year affected all producers. Nevertheless total capacity will be 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 1983-84. A $350 million phosphate fertilizer plant near Rock Springs, Wyoming is 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 and will be completed in 1985.

Morocco increased production by 0.9 million tpy mainly on account of increased output from the new Ben Guerir mine but almost all of this increase went to stocks since deliveries remained constant at 19.1 million tpy.

Jordan continued its mine expansion program and increased output by 0.35 million tpy. Exports amounted only to 3.5 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 with start-up of commercial production scheduled for the beginning of 1982.

TABLE 5. WORLD PHOSPHATE ROCK PRODUCTION, 1979-81

	1979	1980	1981[e]
	(000 tonnes product)		
WORLD TOTAL	**132 462**	**140 335**	**137 840**
West Europe	**103**	**238**	**329**
Finland	2	125	201
France	12	10	..
Sweden	62	82	128
Turkey	27	21	..
East Europe	**24 733**	**25 452**	**25 200**
U.S.S.R.	24 733	25 452	25 200
North America	**51 611**	**54 415**	**52 242**
United States	51 611	54 415	52 242
Central America	**411**	**330**	**252**
Curacao	49	-	-
Mexico	362	330	252
South America	**1 705**	**2 939**	**2 791**
Brazil	1 695	2 921	2 764
Colombia	5	4	15
Peru	5	14	12
Venezuela	-	-	..
Africa	**34 017**	**33 383**	**33 200**
Algeria	1 084	1 036	858
Egypt	645	658	720
Morocco/Sahara	20 175	18 824	19 696
Senegal	1 804	1 752	1 927
South Africa	3 221	3 282	3 034
Togo	2 916	2 933	2 244
Tunisia	4 040	4 768	4 596
Zimbabwe	132	130	125
Asia	**17 591**	**21,483**	**22 290**
China	8 517	10 726	11 500
Christmas Island	1,357	1,638	1 423
India	645	523	429
Indonesia	5	5	..
Israel	2,216	2,611	2 373
Jordan	2,826	3,906	4 244
North Korea	450	450	500
Philippines	5	5	..
Syria	1,170	1,219	1 321
Vietnam	400	400	500
Oceania	**2,291**	**2,095**	**1 495**
Australia	7	8	15
Nauru	1,838	2,087	1 480
Banaba	446	-	-

Totals may not add due to rounding.
Sources: Phosphate Rock Statistics, 1981, ISMA Ltd.; United States Bureau of Mines (USBM), Mineral Commoditiy Summaries 1982.
[e] Estimated; .. Not available; - Nil.

Mexico began construction in 1981 on the 1.5 million tpy Santo Domingo mine in Baja California.

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 prevented increases during 1981 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 $3 to $5 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, 1980-82

Grade	January 1980	January 1981	January 1982
	($US per tonne fob Tampa or Jacksonville)		
73/75% BPL	47	57	57
70/72% BPL	44	53	53
68/70% BPL	41	50	50
66/68% BPL	39	48	48
64/66% BPL	37	46	46

Source: Phosphate Rock Export Association, Tampa, U.S.A.
[1] These prices do not include the charge for severance tax in Florida.

OUTLOOK

The outlook for 1982 is for a continuation of conditions that transpired in 1981. Soft phosphate markets will continue for all products as low agricultural prices, high interest rates and a rather slow general uptrend in economic conditions will compel farmers to be skimpy with fertilizer application. 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. A substantial turnaround in consumption may thus be expected in 1983. Most experts forecast a consumption growth fluctuating between 3.6 per cent and 5.0 per cent for the next few years.

TABLE 2. CANADA, PLATINUM METALS, PRODUCTION AND TRADE, 1970, 1975-81

	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
1976	12 964 582	50,143,112	13 726 089	45,319,000	383 972	1,618,233	1 325 319	3,570,000
1977	14 474 687	61,988,406	13 510 044	52,773,000	1 039 540	3,180,000	1 090 520	3,793,000
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
1981P	12 057 000	139,641,000	11 094 424	110,838,000	..	..	687 604	8,573,000

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; .. Not available.

TABLE 3. WORLD MINE PRODUCTION OF PLATINUM METALS, 1979-81

	1979	1980[e]	1981[e]
		(grams)	
U.S.S.R.[e]	99 531 000	101 086 000	101 086 000
Republic of South Africa[e]	93 839 000	96 421 000	96 421 000
Canada	6 156 716	12 776 000	12 057 000
Japan	1 077 331	1 325 000	..
Colombia	402 230	404 000	..
Australia	306 214	306 369	..
United States	227 055	104 134	187 000
Other countries	206 003	209 497	2 301 000
Total	201 745 549	212 632 000	212 052 000

Sources: U.S. Bureau of Mines, Minerals Yearbook Preprint 1980; U.S. Bureau of Mines, Mineral Commodity Summaries, January 1982; and Energy, Mines and Resources Canada.

[e] Estimated; .. Not available.

TABLE 4. CHANGES IN PLATINUM GROUP METALS PRICES[1] 1981

Date	Platinum		Palladium		Rhodium	
	Producer	Dealer	Producer	Dealer	Producer	Dealer
	Price per gram (per troy ounce) - $US					
January 2	$15.27 ($475)	$18.33 ($565-575)	$6.43 ($200)	$4.60 ($142-144)	$22.50 (700)	$20.25 ($620-640)
February 27			$4.50 ($140)	$3.75 ($116-118)		
May 29			$3.54-4.50[2] ($110-140)	$3.28 ($101-103)	$19.29[2]-22.50 ($600-700)	$16.72 ($510-530)
June 12					$19.29[3] ($600)	$16.08 ($490-510)
December 25	$15.27 ($475)	$12.54 ($389-391)	$3.54-4.50 ($110-140)	$2.30 ($71-72)	$19.29 ($600)	$12.70 ($385-405)

	Iridium		Osmium		Ruthenium	
	Producer	Dealer	Producer	Dealer	Producer	Dealer
	Price per gram (per troy ounce)					
January 2	$19.29 ($600)	$22.99 ($700-730)	$4.90 ($150-155)	$4.26 ($130-135)	$1.45 ($45)	$1.11 ($33-35)
December 25	$19.29 ($600)	$13.18 ($400-420)	$4.90 ($150-155)	$4.26 ($130-135)	$1.45 ($45)	$0.99 ($30-32)

[1] Prices are from **Metals Week.** [2] Impala Platinum Limited reduced its palladium prices and its rhodium price. [3] Rustenburg Platinum Holdings Limited matched Impala's rhodium price but maintained its palladium price. For the remainder of 1981 a differential existed in palladium producer prices.
To express the dealers price in dollars per gram, the middle of the range is used.

Matthey Public Limited Company, the marketing agent for Rustenburg's products. The latter's gross revenue from sales exceeded the record level of 1980 due primarily to higher prices achieved on contracted sales of platinum and to a higher volume of base metal sales. 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 plans to expand the Amandelbult section have been deferred.

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 its 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 were reduced by 10 to 15 per cent in 1981 as the market softened. Production is running at about 29 240 kg per annum. The mine expansion that was to bring production up to 31 000 kg in 1981 has been deferred.

In the Transvaal district of South Africa, Western Platinum Limited - jointly owned by Lonrho Limited, Falconbridge Nickel Mines Limited and Superior Oil Company - operates a mine-concentrator-smelter-refinery complex having an annual capacity of 4 666 kg of platinum metals. It is the only producer continuing with its expansion program despite the poor market. Production capacity will be increased to 7 620 kg. This will involve the mining, milling and treatment of ore from the UG 2 reef.

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 Norilsk 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 Norilsk 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 ratios 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.

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 was slightly below normal in 1981 due to the effect of weak economic conditions on the demand for and production of copper. The United States also recovered 10 886 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. This could not possibly begin producing until 1984, allowing time for permit clearances and construction. The permit process has begun but market and cost factors are 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 1983. Should the decision be to develop the property, production could not be achieved until 1987.

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.

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 is 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 just now being scrapped in substantial numbers. Due to the recession and higher car prices, cars are being 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 to the 1983 model year. 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 1981 are estimated to be substantially below the 16 085 kg and 5 490 kg, respectively, recorded in 1980. 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. It is possible, given the tone of the present administration in the United States, that the requirement to control 90 per cent of automotive exhaust emissions by 1983 will be relaxed, thereby at least temporarily relieving the rhodium supply situation.

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 applciation as a catalyst in the chemical industry, as 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. These latter applications are in expanding areas of high technology, so that the requirement for platinum-group metals is likely to increase.

Although the actual consumption of platinum may be small, a socially important recent development is the use of a platinum-based drug to combat advanced stages of certain forms of cancer.

PRICES [1]

During 1981, spot prices for all platinum-group metals went into a long slide that took them below producer prices. This in turn exerted pressure on producer prices. The platinum producer price was maintained at $475 per ounce despite the fact that, by year-end, steady erosion had brought the dealer price nearly $100 below that level. The two leading producers were able to do this largely because their customers are tied into long term contracts. Toward the end of the year, it was reported that customers were taking only the minimum amounts specified in the contracts. 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.

In February, producers lowered the palladium price to $140 from $200. This was still well above the dealer price of $116-$118 and at the end of May Impala lowered its palladium price to $110 per ounce. By that time, the dealer price had slipped further to $101-$103. It was generally assumed that Rustenburg would shortly match Impala's price but this did not occur and throughout the remainder of 1981 a split producer price prevailed. Meanwhile, the dealer price continued to weaken and closed the year at $71-$72. Some accumulation of inventories was reported, but dealer stocks did not build up substantially as, with the price so severely depressed, the U.S.S.R. largely stopped offering the metal. 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

[1] All prices are in United States dollars.

improvement in economic conditions leading to increased car sales. The rhodium producer price was lowered from $700 to $600 during the year and the dealer price fell from $620-640 to $385-405. 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 cyrstals 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 naptha into higher octane gas. The iridium producer price remained unchanged throughout the year, but the dealer price slipped from $700-$730 in January to $400-$420 in December. It remains the most expensive of the platinum group metals.

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.

There are very few uses for osmium and demand remains miniscule.

OUTLOOK

The growing demand that developed for platinum-group metals in the 1970s is expected to continue in the 1980s. Platinum has been mainly an industrial metal and large stocks have not been built up because over the years supply and demand have been maintained in balance. South African producers adjust their output according to market conditions rather than accept a glut on the market with the accompanying depressing effect on 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. Sales of platinum-group metals by the U.S.S.R. to the west apparently have been decreasing in recent years and this trend has given rise to concern about supply shortages and speculation that they are trying to use their dominant position in some commodities as an economic and political leaver. Other sources believe that as the level of Soviet technology improves, they require more of these materials for domestic consumption.

The price of platinum should recover during 1983-84. 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 elecrical 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 purchasing programs to build up the strategic reserves of platinum and palladium but timing of these programs has 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. 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)

Item No.		
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)

		1981	1982	1983	1984	1985	1986	1987
		(per cent)						
605.03	Other platinum metals, unwrought	17.1	15.6	14.1	12.6	11.2	9.7	8.2
605.05	Alloys of platinum, semi-manufactured, gold-plated	21.3	19.4	17.5	15.6	13.8	11.9	10.0
605.06	Alloys of platinum, semi-manufactured, silver-plated	10.6	9.9	9.3	8.6	7.9	7.2	6.5
605.08	Other platinum metals, semi-manufactured, including alloys of platinum	17.1	15.6	14.1	12.6	11.2	9.7	8.2
644.60	Platinum leaf	17.1	15.6	14.1	12.6	11.2	9.7	8.2

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

Potash

G.S. BARRY

Production and shipments of potash to all markets in 1981 were lower than in 1980 by 1.7 and 9.6 per cent respectively. Exports to the United States were 5.0 per cent lower than last year, with sales for the second half of the year showing an improvement over earlier levels. The offshore market, however, recorded a sharp decline from 1.16 million t in the first half to only 672 600 t in the second half. For the year, offshore exports were down by about 16 per cent which resulted in a substantial rise in stocks.

Producers' stocks peaked in November at a level of 1.39 million t. There was no significant production cutback during the year except for the normal summer decline, but toward the end of the year, particularly in December and through to January 1982, several mines curtailed output. However, these cutbacks were not sufficient. The small decline in stocks between the end of November and December 1981 was only a short pause and inventories continued to climb steeply in the first three months of 1982.

The average price received during 1981 by Canadian potash producers was \$C154 per tonne K_2O compared to \$C141 in 1980 and to \$C95 during 1979. In the last quarter of 1981 the average price was lower than at mid-year; the first decline in several years.

DOMESTIC DEVELOPMENTS

In Saskatchewan, the Potash Corporation of Saskatchewan (PCS), the largest producer in the province, continued an extensive expansion program announced in 1979 and 1980. Expansion was completed at Rocanville so that from the beginning of 1982 the mine will have a capacity of 1 090 000 tpy. A first stage at Lanigan to raise capacity to 830 000 tpy is under completion while ground was broken for a further major expansion that would more than double mine capacity to 1.74 million tpy. At Bredenbury, an environmental study was completed this year that will allow PCS and the Government of Saskatchewan to make the final production decision early in 1982. It is expected that the construction period will be 1983-86 with a peak employment of 1,400 for this new mine, targeted to have a capacity of almost 2 million tpy K_2O. In April, PCS announced the formation of Potash Corporation of Saskatchewan Transport Limited (PCS Transport) which will operate the company's fleet of 1,400 rail hopper cars and handle the entire transportation logistics for growing sales. PCS announced in June that it will withdraw from Canpotex Limited effective June 30, 1982 to pursue its own independent marketing strategy. PCS wants to establish itself as a strong long-term supplier in the developing countries.

In the private sector PPG Industries Canada Ltd. completed a 25 per cent capacity expansion on schedule at the end of 1981 and the Potash Company of America (PCA) is currently expanding its capacity to reach 635 000 tpy by the end of 1982. In mid-December 1981, it was announced that PCS and International Minerals & Chemical Corporation (IMC) intend to expand capacity at the Esterhazy mine on a 50-50 participation basis. It will be a large expansion of 720 000 tpy K_2O taking place in the 1983-85 period. Details and firm scheduling have not yet been finalized. Capital costs will be in excess of \$250 million.

On the other hand, Central Canada Potash (CCP) a division of Noranda Mines Limited announced in October a \$72 million expansion program slated for 1982 to 1983; the program was scheduled to raise capacity from 815 000 tpy to 1 035 000 tpy. However, it will not take place because the province has denied the necessary approval,

TABLE 1. CANADA, POTASH PRODUCTION, SHIPMENTS AND TRADE, 1980 AND 1981

	1980		1981P	
	(tonnes)	($)	(tonnes)	($)
Production, potassium chloride				
Gross weight	11 956 358	..	11 847 932	..
K_2O equivalent	7 302 901	..	7 236 026	..
Shipments				
K_2O equivalent	7 201 217	1,020,705,248	6 815 000	1,050,513,000
Imports, fertilizer potash				
Potassium chloride				
East Germany	-	-	7 003	883,000
United States	28 881	2,595,000	1 589	417,000
West Germany	-	-	2	x
United Kingdom	8	8,000	-	-
Total	28 889	2,603,000	8 594	1,300,000
Potassium sulphate				
United States	9 414	1,208,000	18 287	2,652,000
Potassic fertilizer, nes				
United States	44 549	4,660,000	52 865	5,835,000
Potash chemicals				
Potassium carbonate	1 140	673,000	1 265	788,000
Potassium hydroxide	4 174	2,022,000	3 144	2,090,000
Potassium nitrate	2 863	1,092,000	2 666	1,132,000
Potassium phosphate	1 030	1,083,000	1 432	1,508,000
Potassium silicates	851	461,000	828	617,000
Total potash chemicals	10 058	5,331,000	9 335	6,135,000
Exports, fertilizer potash				
Potassium chloride, muriate				
United States	7 157 368	599,345,000	6 797 239	647,387,000
People's Republic of China	346 841	37,416,000	551 883	61,613,000
Japan	629 972	61,816,000	529 967	61,571,000
Singapore	262 733	27,893,000	433 800	47,015,000
Brazil	787 892	81,023,000	406 453	45,659,000
South Korea	238 351	25,428,000	376 669	42,770,000
India	489 731	50,879,000	350 293	39,581,000
Australia	187 567	18,259,000	182 204	21,407,000
Taiwan	167 349	16,227,000	142 973	14,039,000
Mexico	42 000	4,319,000	81 909	9,268,000
Other countries	244 256	25,986,000	214 605	24,661,000
Total	10 554 060	948,591,000	10,067,995	1,014,971,000

Sources: Statistics Canada; Energy, Mines and Resources Canada.
P Preliminary; - Nil; .. Not available; x Too small to be expressed; nes Not elsewhere specified.

TABLE 2. CANADA, POTASH PRODUCTION AND SALES BY GRADE[1] AND DESTINATION, 1980 AND 1981

	1981						1980
	Standard[2]	Coarse	Granular	Soluble	Chemical[3]	Total	Total
	(tonnes K_2O equivalent)						
Production	2 049 124	2 624 939	1 712 575	719 309	68 650	7 174 596	7 300 234
Sales							
Canada	15 659	219 933	86 426	9 618	..	331 636	377 692
United States	585 591	1 901 146	1 173 633	521 561	..	4 181 931	4 563 048
Offshore							
Australia	4 407	55 668	40 473	-	..	100 549	102 210
Bangladesh	16 745	-	-	-	..	16 745	18 143
Brazil	64 734	75 079	98 242	-	..	238 054	491 819
Chile	-	-	-	12 585	..	12 585	20 306
China	420 868	-	-	-	..	420 868	246 805
Colombia	-	-	-	-	..	-	828
Costa Rica	8 640	5 352	-	-	..	13 992	8 111
Denmark	-	-	-	-	..	-	14 201
India	266 244	-	-	8 236	..	274 481	287 971
Indonesia	18 274	-	-	-	..	18 274	21 324
Italy	-	-	-	10 223	..	10 223	8 997
Japan	111 932	51 966	12 565	93 471	..	269 935	400 206
Korea	155 690	-	-	3 367	..	159 057	150 470
Malaysia	54 968	1 851	-	-	..	56 819	103 875
Mexico	25 349	-	-	-	..	25 349	49 786
Nepal	1 458	-	-	-	..	1 458	-
New Zealand	12 081	-	-	-	..	12 081	31 618
Nicaragua	-	-	9 238	-	..	9 238	3 640
Philippines	39 463	-	-	-	..	39 463	45 880
Romania	-	-	-	-	..	-	28
South Africa	9 245	12 209	11 733	-	..	33 187	30 174
Sri Lanka	12 147	-	-	-	..	12 147	30 127
Swaziland	-	-	10 640	-	..	10 640	9 260
Taiwan	81 003	-	-	-	..	81 003	93 612
Thailand	6 151	-	-	-	..	6 151	-
United Kingdom	653	-	-	-	..	653	626
Offshore total	1 310 055	202 125	182 890	127 884	..	1 822 954	2 170 019
Total sales	1 911 305	2 323 205	1 442 949	659 063	..	6 336 522	7 110 757

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, production of which was 188 580 t K_2O equivalent in 1980, and 72 642 in 1981, and sales of chemical grade. [3] Chemical sales are included in standard grade sales and totalled 64 082 t in 1981.
- Nil; .. Not available.

mainly on grounds that already-committed expansions along with the new PCS mine at Bredenbury are all the increase that the market and the general provincial economic conditions can sustain at present. CCP already had spent some $4.2 million on the project. It is possible that this expansion will eventually be reinstated given that the potash will be required and that incremental capacity increases are certainly more attractive in terms of cost than new mine development.

In June 1981 Canada Development Corporation (CDC) acquired the Canadian assets of Texasgulf Inc. Thus CDC, through its new subsidiary, Kidd Creek Mines Ltd., will now hold 40 per cent ownership of the Allan potash mine (PCS - 60 per cent).

In Manitoba, IMC and the provincial government signed a memorandum of agreement in May that could have led to the development of a 1.1 million tpy (K_2O) mine east of St. Lazare, Manitoba. Some two more years of exploration and development work were required to prove up the property. However the agreement was not ratified as expected by the end of December 1981 after the New Democratic government came to power.

In New Brunswick, PCA continued to make progress on its new mine near Sussex. Sinking of a second shaft commenced at year-end. It will take 24 to 28 months to complete it. Surface installations are in progress and production will probably start in the first half of 1983. At the Salt Springs property of Denison Mines Limited sinking of the first shaft took longer than expected because of water problems. In November 1981, the salt horizon was reached at a depth of more than 670 metres and further pilot drilling undertaken. Shaft sinking will be completed in early 1982. A pilot hole for the second shaft was completed. It is expected that capital costs will be in excess of the originally announced $150 million and that completion of the mine will be delayed to 1984.

British Petroleum Company Limited (BP) completed five drill holes on its Millstream potash concessions, encountering potash at the expected depth of about 1 km. Exploration will continue into 1982. Potash intersections are important but it is still too early to speculate on the viability of the deposit.

Early in the year the New Brunswick government offered for tender another area (Dorchester region) where salt-bearing structures may have a potash potential. Interest was disappointing and the area was not licensed for exploration.

In Nova Scotia, Chevron Canada Limited completed a drilling program on its Bras d'Or concession on Cape Breton Island. Potash was encountered but the structure is complex; details on this exploration program were not announced. Noranda Mines Limited also drilled two holes on its concession. Irving Oil Limited and Hallmark Mining Co. acquired concessions in 1981.

Canpotex reported strong offshore export markets in the first half of 1981 but the second half showed a decline to nearly half of potential levels. The largest decline was in the Brazilian market. At the beginning of the year Canpotex formed Canpotex Bulk Terminals Limited to participate in a consortium that bought Standard Aero Limited in Vancouver which will be operated

TABLE 3. CANADA, POTASH PRODUCTION AND SALES BY QUARTERS, 1981

	1st quarter	2nd quarter	3rd quarter	4th quarter	Total 1981
			(000 tonnes)		
Production	1 942.1	1 928.1	1 578.1	1 726.4	7 174.6
Sales					
North America	1 051.3	1 158.0	1 291.4	1 106.8	4 607.5
Offshore	528.5	623.9	361.6	309.0	1 823.0
Ending Inventory	925.8	1 072.0	997.1	1 307.7	1 307.7

Source: Potash and Phosphate Institute.


DISTRIBUTION,
CANADIAN POTASH SALES,
1981
ALASKA
N.W.T.
BRITISH COLUMBIA
8,934
ALBERTA
26,037
SASKATCHEWAN
14,819
Saskatoon
Regina
MANITOBA
19,823
ONTARIO
179,480
QUEBEC
60,645
PEI
8,623
NB
9,818
NS
3,456
OFFSHORE EXPORTS
1,822,953
31,088
WASHINGTON
MONTANA
10,200
NORTH DAKOTA
21,796
MINN
398,795
WISCONSIN
338,513
MICHIGAN
158,705
3,637
MAINE
7,150
Vt
NH
328
Mass
1,878
NEW YORK
121,678
R.I. 1,378
Conn. 3,611
7,046
Del. 45,146
Md. 22,172
OREGON
19,601
IDAHO
1,754
WYOMING
2,015
SOUTH DAKOTA
11,304
IOWA
479,482
NEBRASKA
25,282
ILLINOIS
685,075
INDIANA
359,903
OHIO
508,049
PENN
38,949
NEVADA
UTAH
42
COLORADO
760
KANSAS
6,859
MISSOURI
169,005
KENTUCKY
95,132
W.Va.
5,217
VIRGINIA
48,971
HAWAII
3,904
CALIFORNIA
ARIZONA
NEW MEXICO
OKLAHOMA
408
ARKANSAS
17,850
TENNESSEE
83,695
N CAROLINA
87,893
S.C
45,204
MISS
29,045
ALABAMA
106,570
GEORGIA
105,771
TEXAS
197
La
11,243
FLORIDA
59,645
LEGEND
SALES FIGURES IN METRIC TONS K_2O EQUIVALENT

TABLE 4. CANADA, POTASH SALES BY PRODUCT AND AREA, 1980 AND 1981

		Agricultural					Industrial			Total
		Standard	Coarse	Granular	Soluble	Total	Standard	Soluble	Total	Sales
		(tonnes K_2O equivalent)								
Alberta	1980	6 483	1 074	14 466	695	22 718	8 324	197	8 521	31 239
	1981	2 895	481	15 894	825	20 094	4 970	973	5 943	26 037
British Columbia	1980	350	1 998	7 115	24	9 486	659	-	659	10 145
	1981	26	2 071	6 720	97	8 914	20	-	20	8 934
Manitoba	1980	346	5 768	10 485	516	17 116	-	-	-	17 116
	1981	34	5 520	13 572	663	19 789	20	14	34	19 823
New Brunswick	1980	-	7 062	-	-	7 062	-	-	-	7 062
	1981	-	9 818	-	-	9 818	-	-	-	9 818
Northwest Territories	1980	-	-	-	-	-	-	-	-	-
	1981	-	-	-	-	-	-	-	-	-
Nova Scotia	1980	-	5 041	-	-	5 041	-	-	-	5 041
	1981	-	3 456	-	-	3 456	-	-	-	3 456
Ontario	1980	2 661	175 329	40 480	4 495	222 965	393	4 829	5 222	228 187
	1981	543	139 516	35 831	(2 463)	173 427	1 403	4 649	6 053	179 480
Prince Edward Island	1980	-	9 761	-	-	9 761	-	-	-	9 761
	1981	-	8 537	86	-	8 623	-	-	-	8 623
Quebec	1980	560	45 405	10 916	-	56 880	49	13	62	56 942
	1981	671	48 710	11 034	136	60 553	93	-	93	60 646
Saskatchewan	1980	1 786	828	2 579	3 099	8 293	3 140	766	3 906	12 199
	1981	1 618	1 823	3 288	4 652	11 382	3 366	73	3 438	14 819
Totals	1980	12 186	252 265	86 042	8 829	359 322	12 565	5 804	18 370	377 692
	1981	5 787	219 933	86 426	3 910	316 056	9 872	5 708	15 580	331 636

Source: Potash and Phosphate Institute.
\- Nil.

under the name Neptune Bulk Terminals (Canada) Ltd., handling sulphur, potash, phosphate and coal as its main line of commodities. The 1982 withdrawal of PCS from Canpotex, which contributed about 55 per cent of the 3.6 million t of KCl exported by Canpotex in the 1980-81 fertilizer year, will leave four partners in the marketing company. It was reported that other private companies including those preparing mines for production in New Brunswick have been asked to join the organization.

INTERNATIONAL DEVELOPMENTS

At the Sixth World Fertilizer Conference (September 1981) DR Gidney, President of PCA, described current and expected world capacity increases as almost exclusively dependent on Canadian and USSR commitments for the next decade (see **Fertilizer Progress** September-October issue). During 1981 Israel completed the expansion of its Dead Sea facilities to 1 million tpy K_2O. Good progress is also being made by the Arab Potash Co. Ltd. on its Dead Sea potash brine recovery project so that initial production is expected to be on schedule in 1983. In Brazil a start was made on a small sylvinite mine at Santa Rosa de Lima. The mine is expected to be in production by late 1983 or early 1984. Buoyed by much better potash prices in 1980 and 1981 some companies in the United States decided to examine opportunities for limited expansions. There is a possibility that Mississippi Chemical Corporation will double its production capacity. Great Salt Lake Minerals & Chemicals Corp. will increase output from lake brines by adding new solar evaporation ponds. AMAX Chemical Corporation is increasing the capacity of its New Mexico refinery by 15 per cent.

The U.S.S.R. apparently corrected its potash production problems, judging from exports which between 1980 and 1981 appear to have once again reached the 2.7 to 2.8 million tpy level. One third of the exports is marketed outside the Comecon bloc. In April the U.S.S.R. announced the discovery of the country's "biggest" potassium deposit in the Irkutsk region near Lake Baikal.

OUTLOOK

Low grain prices, bumper crops and high interest rates induced North American farmers to reduce the field application of potash during the fall fertilizer season. It was hoped therefore that early spring sales of 1982 in North America may show a strong recovery. However, as of May 1982, this turnabout did not occur and industry spokesmen now forecast that for the calendar year 1982 potash consumption may show a substantial decline. U.S. consumption may be as much as 15 per cent below last year levels and for Canada the decline could be between 5 and 10 per cent. It will be late 1982, or more likely early 1983, before a significant upturn takes place. One year of bad crops would quickly send grain prices soaring. This, of course, would result in a very dramatic up-turn in the prospects for the fertilizer industry.

TABLE 5. CANADA, POTASH PRODUCTION AND TRADE, YEARS ENDED JUNE 30, 1966, 1971, 1976-1981

	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
1981P	7 336 973	35 135	6 933 162

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.

Potash capacity in Canada will continue to increase as several expansions are well on their way. These will add about 3.2 million t of K_2O, an increase of 39 per cent between the end of 1981 and the end of 1985. Thereafter, schedules are not firmly committed and the completion of expansions and new mine construction may be stretched to be in step with concurrent demand. If growth of world potash demand remains normal, it would be reasonable to expect that the Canadian industry will achieve a capacity level of between 14.5 and 16.0 million tpy by the end of 1990. Such expansions require massive capital inputs; from the beginning of 1980 to 1985 (inclusive) capital expenditures are estimated to reach \$C3.3 billion (in current dollars) and about \$4.6 billion to the end of 1987. The latter assumes that the large new mine at Bredenbury will be constructed on schedule.

Rhenium

S.A. HAMILTON

Rhenium was first isolated in 1925 and produced commercially in small quantities in 1930. Output increased with improvements in recovery technology and the development of new uses. The only known commercial source for rhenium is molybdenum concentrates recovered from the treatment of low-grade porphyry copper ores. The rhenium content of such ores is relatively low, being only a few parts per million (ppm), whereas the molybdenite concentrates produced from these ores have a rhenium content ranging from 300 to 2 000 ppm. Rhenium has also been identified in certain manganese and uranium ores, but in concentrations too low to be of economic significance under present technology and price structure.

Canadian rhenium production comes from the copper-molybdenum ore of Utah Mines Ltd. (Island Copper mine) near Port Hardy, Vancouver Island, British Columbia. The ore occurs mainly in altered volcanic rocks and in this respect differs from the porphyry copper deposits which have been the major source of rhenium in the United States and Chile. Rhenium has also been identified in the porphyry copper ores of Lornex Mining Corporation Ltd. and Brenda Mines Ltd. in British Columbia.

The United States is the largest producer in the non-communist world of rhenium metal and rhenium salts, mainly through toll refining of foreign molybdenum concentrates. Kennecott Corporation, near Salt Lake City, Utah, M & R Refractory Metals, Inc., in Winslow, N.J. and Molycorp, Inc., in Washington Pa., recovered rhenium from domestic porphyry copper ores in 1980 but only Kennecott continued to produce from domestic ores in 1981.

S.W. Shattuck Chemical Co., Inc. in Denver, Colo. recovered rhenium from Canadian molybdenite concentrate on a toll conversion basis, the rhenium being returned to Utah Mines Ltd. for subsequent sale.

Chile, a substantial producer of rhenium, recovers rhenium from byproduct molybdenite concentrates produced from its large porphyry copper deposits. Prior to 1974 rhenium exported from Chile was contained in molybdenite concentrates shipped for treatment to the United States and elsewhere. In 1974 Chile began to export ammonium perrhenate (NH_4ReO_4) to the United States. Since 1979, the Corporacion Nacional del Cobre de Chile (CODELCO) has had a tolling contract with Molibdenos y Metales S.A. (MOLYMET), which provides for the recovery of rhenium. Under this agreement, both MOLYMET and CODELCO obtain 50 per cent of the recoverable rhenium in concentrates containing more than 350 ppm of rhenium. Other countries that have metallurgical plants for the recovery of rhenium are the U.S.S.R., Sweden, France, the United Kingdom and the Federal Republic of Germany (West Germany). With the exception of the U.S.S.R., these countries recover rhenium from molybdenite concentrates imported from producing countries. Ammonium perrhenate imported by the United States originated from Chile and the Federal Republic of Germany. The Federal Republic of Germany also supplied over 90 per cent of imports of rhenium metal.

In 1981 the Government of Papua New Guinea approved development of the Ok Tedi copper-gold-molybdenum deposit. The project is to be developed in three stages, with the first stage, when gold will be the main product, to be completed by early 1985. During the third stage a copper-molybdenum concentrate with possibilities for rhenium extraction, will be produced.

Recent reports indicate that the major source of rhenium in the U.S.S.R. is the Dezhezkazgan sedimentary copper deposit in Kazakhstan rather than from porphyry copper deposits as previously believed. Modifications have been made to the Dezhezkazgan copper smelter to improve recoveries of copper, lead, rhenium, sulphur, gold and silver.

PRODUCTION

Rhenium is a recent addition to the metals produced from Canadian ores, with production first being recorded in 1972 by Utah Mines. This company reported that the rhenium content of the molybdenite concentrate produced in 1980 and 1981 at its Island Copper mine ranged from 850 to 1 200 ppm, and averaged 1 040 ppm in 1980 and 1 000 ppm in 1981. This compares with an average of about 1 008 ppm in 1979. Shipments of molybdenite concentrates by Utah Mines to the United States and West Germany totalled approximately 2 703.4 t in 1980 and 3 084.4 t in 1981 compared with shipments of approximately 2 638 t in 1979. The rhenium contained in the concentrates was treated at the smelters on a toll basis and the recovered rhenium was returned to the company as perrhenic acid for subsequent sale. With present technology, the recovery of rhenium contained in the molybdenite concentrates is low, and ranges from 50 to 60 per cent. Based on 1980 and 1981 shipments and estimated grade and recovery as reported byUtah Mines, the rhenium recovered from Canadian ores was about 1 677 kilograms (kg) in 1980 and 1 839 kg in 1981. The material was sold at an average price of $3 960 per kg in 1980 and $1 606 kg in 1981.

Statistical data on world output and total value of rhenium are not available. In order to avoid disclosing company confidential data, rhenium production in the United States is not reported. World production of rhenium excluding United States production was estimated by the United States Bureau of Mines (USBM) at 9 526 kg in 1980 and 12 472 kg in 1981. Production in 1979 was estimated at 7 257 kg. Imports into the United States, the world's leading consumer, were 2 497 kg in 1980 and 3 629 kg in 1981. U.S. consumption of rhenium was 3 311 kg in 1980 and 3 175 kg in 1981.

TABLE 1. WORLD MINE PRODUCTION OF RHENIUM, 1980 AND 1981

	1980	1981e
	(kilograms)	
U.S.S.R.	1 361	4 536
Chile	3 856	3 629
West Germany	2 041	2 041
Canada	1 815	1 815
Peru	181	181
Other countries	272	272
Total[1]	9 526	12 474

Source: U.S. Bureau of Mines Mineral Commodity Summaries, 1982.

[1] The totals do not include U.S. production figures, which are withheld to avoid disclosing company data.
[e] Estimated.

Stocks of rhenium in the hands of dealers and consumers that were built up in the early 1970s have now largely been depleted.

In September 1981, Duval Corporation announced the opening of its rhenium recovery plant at its Sierrita property near Tucson, Ariz. Commercial production of ammonium perrhenate began in January 1982. Metallic rhenium and perrhenic acid will also be produced at the facility when market conditions improve.

TABLE 2. U.S. CONSUMPTION AND IMPORTS OF RHENIUM AS ESTIMATED BY USBM

1977	1978	1979	1980	1981
		(kilograms)		
Consumption				
3 311	5 670	4 309	3 311	3 175
Imports				
2 839	5 666	4 185	2 497	3 629[e]

[e] Estimated.

TECHNOLOGY

Rhenium has become an important industrial metal because of its special properties. The metal is highly refractory, having a melting point of 3 100°C, second to that of tungsten, and maintains strength and ductility at high temperatures. Its density is 21 grams per cubic centimetre (g/cm^3), exceeded only by that of the platinum-group metals. Rhenium has good corrosion resistance to halogen acids. Alloyed with tungsten or molybdenum, rhenium improves the ductility and tensile strength of these metals. Stable oxide film on rhenium does not appreciably increase electrical resistance and this property, plus good resistance to wear and arc corrosion, makes the metal ideally suited for electrical contacts.

Rhenium is recovered from flue gases emitted from the roasting of byproduct molybdenite concentrates. Under properly controlled temperature, rhenium volatilizes as rhenium heptoxide (Re_2O_7), a compound which is readily soluble in an aqueous solution and can be recovered by subjecting flue gases to wet scrubbing. The rhenium is extracted from this solution as ammonium perrhenate (NH_4ReO_4) by ion-exchange resins or by solvent extraction. Perrhenic acid ($HReO_4$) is also an important commercial product of rhenium. Rhenium metal (99.99 per cent pure) is produced by the reduction of (NH_4ReO_4) with hydrogen to produce rhenium powder. The powdered form is pressed and sintered into bars which are cold-rolled to form different shapes. The cost of producing rhenium metals and salts is high. Recent research has been directed toward the development of a hydrometallurgical process to recover molybdenum and rhenium from molybdenite concentrates in order to attain a higher rate of recovery and lower cost of production.

USES

The major use of rhenium is in petroleum-reforming catalysts used to produce high-octane gasoline without the addition of lead. Other important applications include electronic devices, high temperature thermocouples, temperature controls, heating elements, metallic coatings, and research and development. It is also used to produce ductile, high-temperature, tungsten-based alloys used in the electronic field.

Catalytic units employing platinum-rhenium catalysts account for about 80 per cent of total U.S. petroleum reforming capacity, up from about 25 per cent of capacity in 1973. Platinum-rhenium catalysts are also used in the production of benzene, toluene and xylenes, although this use is small compared with that in gasoline production. Over the past five years, use of rhenium in bimetallic catalysts has averaged 90 per cent of total rhenium demand.

OUTLOOK

Rhenium has been used as an industrial metal for a short period and has not developed a clearly defined growth pattern. The uncertainty of supply is a factor limiting the development of new uses. The potential supply of the metal is limited to the rhenium contained in byproduct molybdenite concentrates obtained from porphyry copper ores. Under present technology the overall recovery of molybdenite from the processing of copper ores varies considerably but is relatively low and the recovery of rhenium from the treatment of molybdenite concentrates is about 60 per cent. Any improvement in the recovery rate in either of these areas would increase the supply of available rhenium.

Not all of the molybdic oxide producers recover rhenium from the treatment of byproduct molybdenite concentrates because of the high capital costs involved in building a recovery plant. These molybdic oxide operations are a potential source of rhenium, given a stable price pattern that would justify committing funds for the construction of a recovery plant.

In the short-term the major use of rhenium will continue to be in bimetallic platinum-rhenium catalysts in the petroleum reforming industry. Use in this application could increase as more stringent standards for automotive emissions are introduced and the use of tetraethyl lead in gasoline is reduced. Substitutes are available and are being evaluated for catalytic applications.

Consumption of rhenium in the United States is forecast by the USBM to grow at an average annual rate of 0.4 per cent to the year 2000 when it is expected to total 4 100 kg. Consumption in the rest of the world is forecast to grow at a greater rate than in the United States, reaching 3 650 kg in 2000. The low growth rate forecast for U.S. consumption results from an expected decline in demand for rhenium in petroleum refining in the 1990s and an expected decrease in demand for gasoline beginning in the early 1980s.

PRICES

The **Metals Week** list price for rhenium was suspended in September 1978. The spot price of rhenium metals and compounds, which increased to \$2000 per pound at the end of 1979, continued to rise through the first four months of 1980, reaching \$2500 per pound in May. Thereafter, the price began to decrease reaching a range of \$800-\$1000 per pound by the end of the year. This trend persisted through the first half of 1981. About mid-year the price stabilized at about \$525 per pound where it remained at year-end. The price of perrhenic acid followed a similar pattern, beginning 1981 at about \$650 per pound, falling to \$460 per pound by mid-year and stabilizing there. The soft market was attributed to gasoline oversupply which reduced the need for reforming catalysts containing rhenium.

Salt

G.S. BARRY

Canada is self-sufficient in salt. Nova Scotia 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 1981 was 7.40 million t, a 4.0 per cent decline from last year (7.71 million t). Shipments at 7.32 million t however were lower than production, which resulted in a buildup of salt inventories to 970 832 t as of the end of 1981.

The average value of salt in all forms in 1981 is estimated at $19.5/t compared to $18.0/t in 1980. Milder winter conditions were responsible for a reduction in rock salt usage for de-icing purposes for the last two years but this reduction was not as severe in Canada as it was in the United States. There is no apparent 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 1981 were 1 480 057 t, a decline of 8.9 per cent compared to 1980. Imports however were 7.3 per cent higher. Normally, Canadian exports exceed imports by about a quarter of a million t but the production problems experienced in one of our mines resulted in a more balanced trade for 1981. Imports are 82 per cent from the United States; the remaining 18 per cent comes mainly from Mexico and Spain.

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 1981 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 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.

Quebec. Seleine Mines Inc., a subsidiary of Société québécoise d'exploration minière (SOQUEM), a provincial public company, is bringing a 1.25 million tpy underground salt mine into production on Madeleine Islands in the Gulf of St. Lawrence. Very good progress was made during 1981 and production is targeted to begin by mid-1982. The first vertical shaft was completed in 1979 and a second production shaft will be completed by June 1982. Surface installations including

TABLE 1. CANADA, SALT PRODUCTION AND TRADE, 1980 AND 1981

	1980		1981P	
	(tonnes)	($)	(tonnes)	($)
Production				
By type				
Mined rock salt	4 555 035	..	4 371 000	..
Fine vacuum salt	775 861	..	775 000	..
Salt content of brines used or shipped	2 134 010	..	2 138 000	..
Total	7 464 906	..	7 284 000	..
Shipments				
By type				
Mined rock salt	4 507 416	67,990,169	4 380 000	..
Fine vacuum salt	781 428	47,892,261	765 000	..
Salt content of brines used or shipped	2 134 010	6,892,715	2 138 000	..
Total	7 422 854	122,775,145	7 283 000	135,103,000
By province				
Ontario	5 207 838	71,417,105	4 963 000	77,121,000
Nova Scotia	1 017 820	26,894,787	1 053 000	30,057,000
Saskatchewan	331 961	13,458,058	329 000	14,502,000
Alberta	865 235	11,005,195	938 000	13,423,000
Total	7 422 854	122,775,145	7 283 000	135,103,000
Imports				
Salt and brine				
United States	729 517	9,189,000	1 002 876	13,878,000
Mexico	387 694	3,680,000	208 640	2,208,000
Spain	32 821	532,000	22 583	494,000
Portugal	858	47,000	894	56,000
Other countries	313	81,000	270	34,000
Total	1 151 203	13,529,000	1 235 263	16,670,000
Salt and brine by province of landing				
Newfoundland	33 364	553,185	22 110	474,000
Nova Scotia	596	67,894	1 363	73,000
New Brunswick	-	62	33	3,000
Quebec	223 068	2,410,813	334 948	4,577,000
Ontario	331 604	3,969,567	509 666	6,605,000
Manitoba	98	10,304	73	7,000
Saskatchewan	851	35,735	470	24,000
Alberta	964	17,454	302	14,000
British Columbia	615 088	6,463,619	366 298	4,893,000
Total	1 151 203	13,528,633	1 235 263	16,670,000
Exports				
Salt and brine				
United States	1 625 589	16,891,000	1 480 057	19,172,000
Cuba	4 001	252,000	13 680	831,000
Guyana	4 884	850,000	3 836	564,000
Zaire	-	-	5 333	220,000
Leeward-Windward Islands	1 428	102,000	2 235	158,000
Other countries	1 699	133,000	2 561	135,000
Total	1 637 601	18,228,000	1 507 702	21,080,000

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

TABLE 2. CANADA, SALT SHIPMENTS, 1971, 1976-81

	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
1976	4 354 684	676 191	1 356 892^{r}	6 387 767^{r}	1 523 407	9,558,000
1977	4 320 305	681 557	1 435 177^{r}	6 437 039^{r}	1 126 225	9,123,000
1978	4 625 528	719 472	1 542 932^{r}	6 887 932^{r}	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
1981P	4 380 000	765 000	2 138 000	7 283 000	1 235 263	21,080,000

Sources: Statistics Canada; Energy, Mines and Resources Canada.
P Preliminary; ^{r} Revised

the dock and the conveyors from mine to dock are completed. Dredging of a 10 km access channel was also completed. Total capital costs for the mine and port facilities will be in excess of $65 million. 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 contract to supply 300 000 tpy to Diamond Shamrock Corporation of NY. The company intends to export about 100 000 t in 1982. Reserves are sufficient to permit the expansion of this mine to 2 million tpy should market conditions warrant it in the future.

The Madeleine Islands salt domes are extensive and serious thought is being given to the utilization of the formations for storage of oil, gas and other products. Laduboro Oil Ltd. holds provincial permits to develop such a system of storage reservoirs. This possibility is still under consideration. Potash is known to occur in the southern part of the Islands.

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, implying low-cost mining.

During 1980, 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 is expected to be completed in 1982. The target date for the completion of the expansion is mid-1983, by which time total capital expenditures should reach about $35 million. A strike kept the Goderich mine closed from April 13 to June 29 and a hoist breakdown resulted in a shutdown from November 2 to almost the end of the year. Thus, production for 1981 was considerably below normal levels. By contrast, production reached record levels at the underground rock salt mine of The Canadian Salt Company Limited at Ojibway.

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

TABLE 3. CANADA, SUMMARY OF SALT PRODUCING AND BRINING OPERATIONS

Company	Location	Initial Production	Production* 1981P (1980) (000 tonnes)	Employment 1981P (1980)	Remarks
Nova Scotia & New Brunswick					
The Canadian Salt Company Limited	Pugwash	1959	825.6 (835.5)r	229 (236)	Rock salt mining to a depth of 253 metres (m).
	Pugwash	1962	93.2 (91.0)		Dissolving rock salt fines for vacuum pan evaporation.
Potash Company of America	Sussex	1980	114.8 (142.0)	- -	Development salt from a potash mine under construction for production in 1982.
Domtar Inc.	Amherst	1947	80.8 (92.2)	71 (72)	Brining for vacuum pan evaporation.
Ontario					
Allied Chemical Canada, Ltd.	Amherstburg	1919	585.0 (584.3)	8** (8)	Brining to produce soda ash.
The Canadian Salt Company Limited	Ojibway	1955	2 041.5 (1 679.7)	250 (246)	Rock salt mining at a depth of 300 m.
	Windsor	1892	144.8 (151.5)	139 (139)	Brining, vacuum pan evaporation and fusion.
Dow Chemical Canada Inc.	Sarnia	1950	(732.0 (761.3)	10** (10)	Brining to produce caustic soda and chlorine.
Domtar Inc.	Goderich	1959	1 360.0 (1 974.7)	240 (240)	Rock salt mining at a depth of 536 m.
	Goderich	1880	103.2 (102.5)	62 (62)	Brining for vacuum pan evaporation.
Prairie Provinces					
International Minerals & Chemical Corporation (Canada) Limited	Esterhazy, Sask.	1962	60.0 (63.2)	3 (3)	Byproduct salt from potash mine for use in snow and ice control.
The Canadian Salt Company Limited	Belle Plaine, Sask.	1969	68.5 (69.2)	27 (28)	Producing fine salt from byproduct brine from potash mine.
Prince Albert Pulp Company Ltd.	Saskatoon, Sask.	1968	36.0 (43.0)	5** (5)	Brining to produce caustic soda and chlorine.
Domtar Inc.	Unity, Sask.	1949	170.0 (161.4)	85 (81)	Brining, vacuum pan evaporation and fusion.
The Canadian Salt Company Limited	Lindbergh, Alta.	1968	129.3 (115.4)	82 (84)	Brining, vacuum pan evaporation and fusion.
Dow Chemical Canada Inc.	Fort Sask., Alta.	1968	809.0 (749.8)	8** (8)	Brining to produce caustic soda, chlorine, and ethylene storage.
			7 353.7 (7 616.7)r	1 229 (1 222)	

* Shipments; ** Employment part of a chemical complex.
P Preliminary; r Revised.

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.

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 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 1981. 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 in the past few years. Because of its low unit value and availability in most key market areas, salt is

TABLE 4. WORLD SALT PRODUCTION, 1978-81

	1978	1979p	1980p	1981e
		(000 tonnes)		
United States	38 915	41 567	36 607	35 800
People's Republic of China[e]	19 530	14 770	17 280	18 100
U.S.S.R.[e]	14 497	14 297	14 497	14 500
West Germany	12 658	15 089	12 973	13 200
India	6 700	7 036	7 262	7 300
France	6 394	6 909	7 465	7 284
Canada	6 283	8 058	7 103	7 100
United Kingdom	7 310	7 819	6 586	6 600
Mexico	5 635	5 624	5 987	5 900
Italy	4 931	4 669	5 267	5 400
Australia	5 766	5 800	5 315	5 300
Poland	4 393	4 429	3 356	3 300
Other countries	33 916	35 786	35 484	34 200
Total	166 298	171 853	165 182	163 984

Sources: U.S. Bureau of Mines, Preprints 1978-79 and U.S. Bureau of Mines Mineral Commodity Summaries, 1982; Energy, Mines and Resources Canada.
p Preliminary; e Estimated.

Selenium and Tellurium

A.G. JOHNSTON

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 produced each year from secondary sources.

CANADA

Production of selenium from blister copper treated at Canadian refineries plus refined selenium from domestic primary material declined to a low of 122 000 kilograms in 1978, and then increased substantially during the following three years. The 290 000 kg recovered in 1981 was the highest level of production from blister copper and primary sources in Canada since 1971. 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 1981 from both primary and secondary sources was 350 010 kg.

Canadian Copper Refiners Limited (CCR) at Montreal East, Quebec, operates Canada's largest selenium recovery plant. The refinery handles copper from the Noranda smelter of Noranda Mines Limited, the Murdochville smelter of Gaspé Copper Mines, Limited, (both in Quebec) and the Flin Flon smelter of Hudson Bay Mining and Smelting Co., Limited in Manitoba. The amount of selenium, from these sources, declined from 333 400 kg in 1975 to 235 900 kg in 1981. 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 scrap on a toll basis.

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).

Canada consumes only about 3 per cent of its refined selenium, primarily in the glass industry. Most of this country's 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 76 per cent of Canada's exports in 1981.

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 slightly to 1 415 900 kg in 1981. This growth can be partly accounted for by increased recovery rates in Japan and, possibly, by recovery of selenium from

TABLE 5. CANADA, PRODUCTION AND CONSUMPTION OF TELLURIUM, 1970, 1975, 1977-81

	Production		Consumption
	All forms[1]	Refined[2]	Refined[3]
		(kilograms)	
1970	26 459	29 317	399
1975	19 854	42 253	..
1977	35 116	37 021	..
1978	31 421	45 299	..
1979	42 433	47 204	..
1980	15 011	8 974	..
1981P	20 000	21 297	..

Source: Energy, Mines and Resources Canada.

[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, 1979-81

	1979	1980	1981e
		(kilograms)	
Japan	77 110e	79 830	81 600
Hong Kong	45 360	45 360e	45 400
Peru	15 870e	21 770	22 700
Canada	47 204	8 974	21 297
Fijie	22 680	11 300	11 300
India	...	...	...
Totale1	208 224	167 234	182 297

Sources: U.S. Bureau of Mines, Mineral Commodity Summaries, 1980 and 1981; 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.
e Estimated; .. Not available. ... Too small to be expressed.

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.

Two companies refine tellurium in the United States: AMAX Copper, Inc., at Carteret, N.J.; and ASARCO Incorporated, at Amarillo, Texas. As a result of falling prices, producers suspended published prices of tellurium on January 5, 1981. During 1980, the price for slab in 100 pound lots, according to Metals Week, was $US 18.00-20.00 per pound; however, in September 1981, one producer quoted a price of $US 14.00 per pound.

According to Metals Week, the 1981 tellurium price for slab in 100-pound lots, in United States currency was as follows:

	($US/lb)
January 1 to January 4	18 - 20
January 5 to December 31	LPS

LPS List Price Suspended.

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, the use of bismuth, as a substitute, continued to increase in 1981. Tellurium also performs an important role in the manufacture of rubber products, thermo-electric devices, catalysts, 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 which is 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, 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.

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)

	1981	1982	1983	1984	1985	1986	1987
			(%)				
92804-5	10.0	10.0	10.0	10.0	10.0	9.9	9.2

UNITED STATES (MFN)

Item No.		1981	1982	1983	1984	1985	1986	1987
				(%)				
427.12	Tellurium salts	4.8		- No change -				
421.90	Tellurium compounds	4.7	4.5	4.4	4.2	4.0	3.9	3.7
632.48	Tellurium metals, unwrought other than alloys, and waste and scrap	3.0	2.5	2.0	1.5	1.0	0.5	free
632.88	Tellurium metal alloys, unwrought	8.1	7.7	7.3	6.8	6.4	5.9	5.5
633.00	Tellurium metal, wrought	8.1	7.7	7.3	6.8	6.4	5.9	5.5

EUROPEAN ECONOMIC COMMUNITY

Item No.		1981	Base Rate	Concession Rate
28.04 C.111	Tellurium metal	2.3	2.4%	2.1%

Sources: The Customs Tariff and Commodities Index, January 1981, Revenue Canada; Tariff Schedules of the United States Annotated (1981), USITC Publication 1111; U.S. Federal Register Vol. 44, No. 241; Official Journal of the European Communities, Vol. 23, No. L315, 1979 GATT Documents, 1979.

Silica

H. WEBSTER

Economic conditions in the markets supplied by the silica industry were generally weak in 1981 and a concerted effort was made to increase productivity and reduce costs, thus maintaining profitability. As shown in Table 1, both production and export of Canadian materials increased during 1981, while imports of silica sand, silex and crystallized quartz decreased.

Silica deposits have been developed in virtually every province.

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 1981 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. The company had hoped to construct a washing plant at the pit head in 1981 in order that washed material only would be trucked the 18 km. to the drying and screening plant. However, general economic conditions delayed construction. A decision on a beneficiation process to improve the sands for the flint glass industry is pending.

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 is expected to result in increased tonnage in 1982. A drilling program to increase reserves is planned for 1982.

Quebec. Indusmin Limited continued to produce from their St. Donat and St. Canut operations. According to Indusmin's Annual Report for 1981, sales and revenues were higher than in 1980, but lower than expected, because of reduced requirements from the container glass and the silicon carbide industries.

Baskatong Quartz Inc. operated a high-purity silica deposit near La Galette in Charlevoix County, providing material for the SKW Canada Inc. ferrosilicon plant at Bécancour. In addition, Baskatong opened a new quarry at St. Ludger. This is a small deposit of high purity which is expected to be exhausted in 1982.

Armand Sicotte & Sons Limited produced about 190 000 t of coarse grade silica from their quarry near Ste-Clotilde.The company is considering penetration of new markets in northeastern United States.

The Union Carbide Canada Limited quartzitic sandstone quarry at Melocheville, Beauharnois County, was not operated during 1981 pending completion of negotiations for the sale of its two metallurgical plants at Beauharnois and Chicoutimi.

Montreal Silica Mines Ltd. continued to produce from unconsolidated Pleistocene sands near Ormstown.

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 1981 and prospects for new markets for this material are encouraging. The company confined its 1981 exploration efforts in the Badgeley Island area to locating further reserves of quartzite, and in eastern Ontario to bulk sampling of Potsdam sandstone.

The Comet Quartz Limited property near Madawaska in the Algonquin Park area did not produce in 1981. The company considers it a high-purity quartz deposit with potential for the cultured quartz market and for the solar grade silicon industry.

TABLE 1. CANADA, SILICA PRODUCTION AND TRADE, 1980 AND 1981

	1980		1981P	
	(tonnes)	($)	(tonnes)	($)
Production, quartz and silica sand				
By province				
Quebec	703 000	11,022,000	659 000	12,946,000
Ontario	936 000	9,565,000	1 013 000	11,079,000
Alberta	..	2,592,000	..	3,400,000
Manitoba	252 000	2,537,000	255 000	2,821,000
Nova Scotia	..	1,419,000	..	1,470,000
New Brunswick	..	509,000	..	1,100,000
Saskatchewan	105 000	870,000	102 000	982,000
Newfoundland	..	636,000	..	828,000
British Columbia	..	34,000	..	35,000
Total	2 252 000	29,184,000	2 321 000	34,661,000
By use				
Glass and fiberglass	225 000	4,943,000	..	..
Flux	906 000	3,599,000	..	..
Ferrosilicon	146 000	1,154,000	..	..
Other uses[1]	975 000	19,488,000	..	..
Total	2 252 000	29,184,000	2 321 000	34,661,000
Imports				
Silica sand				
United States	1 194 088	17,408,000	1 142 796	18,467,000
United Kingdom	..	-	79	3,000
Other countries	6 149	35,000	..	-
Total	1 200 237	17,443,000	1 142 875	18,470,000
Silex and crystallized quartz				
United States	277	274,000	251	319,000
United Kingdom	1	11,000	..	-
West Germany	3	4,000	..	-
Total	281	289,000	251	319,000
Firebrick and similar shapes, silica				
Japan	..	..	9 646	4,489,000
United States	3 535	1,951,000	3 679	2,189,000
France	408	104,000	106	133,000
West Germany	15	13,000	175	130,000
Other countries	817	195,000	156	146,000
Total	4 775	2,263,000	13 762	7,087,000
Exports				
Quartzite				
United States	63 161	601,000	110 409	1,002,000
South Africa	5	1,000	..	-
Total	63 166	602,000	110 409	602,000

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, 1975-81

	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
1976	2 395 948	1 337 138	863	10 850	47 944	3 077 594
1977	2 316 680	1 101 186	1 219	10 029	56 297	3 037 701
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	3 546 363
1980	2 252 000	1 200 237	281	4 775	63 166	..
1981P	2 321 000	1 142 875	251	13 762	110 409	..

Sources: Statistics Canada; Energy, Mines and Resources Canada.
P Preliminary; .. Not available.

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 in 1981 reflecting the drop in consumption by the glass, foundry and sandblasting industries. 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 1981 and the company remained fully operational throughout the year.

Alberta. Sil Silica Ltd. quarried Pleistocene dune sands at Bruderheim, 65 km northeast of Edmonton. The company remained operational in 1981 but production was affected by lower demand in the housing and fibreglass industries. Plans for expanding the drying facilities in 1981 were suspended because of unfavourable economic conditions.

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.

TABLE 3. CANADA, ESTIMATED CONSUMPTION OF SILICA, BY INDUSTRIES, 1979 AND 1980

	1979	1980
	(tonnes)	
Foundry sand	989 671	1 365 689
Glass manufacture (including glass fibre)	929 168	968 019
Smelter flux[1]	869 244	1 247 861
Refractory brick mixes, cements	405 070	512 416
Artificial abrasives	158 761	130 461
Metallurgical	64 142	67 812
Chemicals	24 632	38 603
Gypsum products	5 847	8 850
Concrete products	67 492r	63 254
Fertilizer, stock poultry feed	4 416	4 172
Other[2]	83 297r	50 506
Total	3 601 740r	4 457 643

Source: Energy, Mines and Resources Canada.
[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.

On a smaller scale, International Marble & Stone Company Ltd. in Sirdar and Pacific Silica Products of Osoyoos produced crushed and sized silica products. Mount Rose Mining Co. Ltd., an intermittent operation near Armstrong, did not report any shipments in 1981.

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 value of quartzite exported to the United States in 1981 increased by 75 per cent relative to 1980 (Table 1). Although this does not represent a large tonnage, it indicates a significant trend in the export market.

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

Item No.		
513.14	Sand, other	free
514.91	Quartzite, whether or not manufactured	free
523.11	Silica, not specially provided for	free

		1980	1981	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	22	19	16	12	9	6	3	free

Sources: The Customs Tariff and Commodities Index, January 1980, Revenue Canada; Tariff Schedules of the United States Annotated 1980, USITC Publication 1011; U.S. Federal Register Vol. 44, No. 241.

Silicon, Ferrosilicon, Silicon Carbide and Fused Alumina

D.G. LAW-WEST

Silicon is the second most abundant chemical 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 both hydroelectric power and raw materials are available. There are three producers of ferrosilicon, two of which also produce silicon metal. Ferrosilicon is produced in several grades expressed in terms of per cent contained silicon (Si).

Union Carbide Canada Limited operates ferroalloy plants at two locations in Quebec. At Beauharnois the company produced about 3 000 t of silicon metal and 27 000 t of 50 per cent grade ferrosilicon in 1981. The Chicoutimi plant produced some 22 000 t of 75 per cent grade ferrosilicon. At Becancour, SKW Canada Inc. operated its plant at capacity during 1981 and produced about 25 000 t of silicon metal and 25 000 of ferrosilicon. Most of the ferrosilicon, largely a 75 per cent grade, was exported to the United States, West Germany and Japan. The third Canadian producer, Chromasco Limited, operates a ferrosilicon plant at Beauharnois. During 1981 the company produced 36 000 t of ferrosilicon consisting of 50, 75 and 85 per cent grades.

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 principally as an alloying agent for aluminum. It increases fluidity 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

TABLE 1. CANADA, FERROSILICON, SILICON CARBIDE AND OTHER FERROALLOYS[1], EXPORTS AND IMPORTS, 1980 AND 1981

	1980		1981P	
	(tonnes)	($000)	(tonnes)	($000)
Exports				
Ferrosilicon				
Japan	21 290	15,697	24 717	18,595
United States	23 537	12,253	23 687	14,571
South Korea	-	-	1 102	1,149
Australia	786	756	388	437
United Kingdom	801	582	774	433
West Germany	1 297	1,339	286	335
Turkey	180	133	440	286
Thailand	16	15	276	210
Other countries	4 257	3,091	740	706
Total	52 164	33,866	52 410	36,722
Silicon carbide, crude and grains				
United States	69 718	31,908	65 810	33,772
Japan	2 446	1,208	1 334	823
Other Countries	249	128	-	-
Total	72 413	33,244	67 144	34,595
Ferroalloys, nes				
United States	2 302	5,036	3 098	8,570
Taiwan	4	3	31	425
United Kingdom	1 659	201	1 703	220
Algeria	-	-	122	169
Mexico	-	-	28	49
South Korea	27	20	27	33
Japan	1 741	236	144	32
Other countries	501	2,214	163	39
Total	6 234	7,710	5 316	9,537
Imports				
Ferrosilicon				
United States	17 177	12,320	14 419	12,072
Norway	442	416	3 209	2,292
France	409	609	451	642
Brazil	444	433	397	459
Venezuela	-	-	150	138
Other Countries	36	91	3	2
Total	18 508	13,869	18 629	15,605
Silicomanganese, including silico spiegel				
United States	12 088	7,995	4 396	3,740
South Africa	3 043	1,424	4 563	2,167
Norway	4 050	1,589	2 476	1,601
Brazil	-	-	1 200	567
Other Countries	1 720	2,430	34	21
Total	20 901	13,438	12 669	8,096
Ferroalloys, nes				
Greece	3 794	8,334	9 840	14,911
Brazil	909	8,164	1 172	11,839
United States	3 452	8,441	4 023	7,891
France	2 101	3,756	1 853	4,057
Chile	10	402	226	3,397
People's Republic of China	-	-	100	1,336
Other countries	240	505	576	2,650
Total	10 506	29,602	17 790	46,081

Source: Statistics Canada.
[1] Other important ferroalloys are discussed in the manganese, nickel and titanium reviews for 1981.
nes Not elsewhere specified; - Nil; P Preliminary.

TABLE 2. CANADA, CONSUMPTION, EXPORTS, IMPORTS AND PRODUCTION OF FERROSILICON, 1970, 1975-1981

	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
1976	61 734	34 673	11,416	10 424	7,121	85 983
1977	63 521	45 490	17,225	9 131	5,552	99 880
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	63 354	52 164	33,866	18 508	13,869	97 010
1981P	..	52 410	36,722	18 629	15,605	..

Sources: Energy, Mines and Reosurces Canada; Statistics Canada.
[1] Consumption as reported by consumers. [2] Consumption plus net exports equals derived production.
P Preliminary; .. not available.

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 the 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 market forecast for silicon metal and for ferrosilicon is closely related to the outlook for aluminum and steel respectively.

TABLE 3. CANADA, MANUFACTURERS' SHIPMENTS OF CRUDE SILICON CARBIDE 1970, 1975-80

	(tonnes)	($ 000)
1970	104 113	17,653
1975	89 346	24,597
1976	99 195	32,116
1977	104 011	36,965
1978	106 763	38,763
1979	101 265	44,108
1980	86 353	46,897

Source: Statistics Canada.

TABLE 4. CANADA, EXPORTS OF SILICON CARBIDE, CRUDE AND GRAINS 1970, 1975-81

	(tonnes)	($ 000)
1970	96 159	15,976
1975	78 615	17,441
1976	86 455	23,743
1977	86 016	28,511
1978	107 351	33,818
1979	84 436	31,258
1980	72 414	33,244
1981P	67 144	34,595

Source: Statistics Canada.
P Preliminary.

TABLE 5. CANADA, MANUFACTURERS' SHIPMENTS OF CRUDE FUSED ALUMINA 1970, 1975-80

	(tonnes)	($ 000)
1970	131 364	18,088
1975	110 736	26,162
1976	141 695	39,966
1977	139 859	41,977
1978	154 303	49,916
1979	152 118	51,206
1980	146 655	56,957

Source: Statistics Canada.

TABLE 6. CANADA, EXPORTS OF FUSED ALUMINA, CRUDE AND GRAINS, 1970, 1975-1981

	(tonnes)	($ 000)
1970	152 572	23,234
1975	127 658	26,650
1976	154 003	38,844
1977	154 291	43,087
1978	167 344	48,830
1979	183 124	55,138
1980	166 328	55,867
1981P	157 993	67,954

Source: Statistics Canada.
P Preliminary.

In the case of silicon metal, about 75 per cent is consumed by the aluminum industry which has been adversely affected by the current recession. Demand for silicon metal by the aluminum industry is not expected to recover until the large inventories of aluminum are worked down. Ferrosilicon demand for use in the iron and steel industry has also been adversely affected by the recession. With no firm evidence for recovery the outlook for ferrosilicon, continuing weak demand in the medium term and for only slow recovery in the longer term.

Potential areas of 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 1980 and 1981

		1980	1981
		(¢US)	
Ferrosilicon, U.S. producer, per pound of silicon content; lump bulk lots, fob shipping point			
High-purity 75% Si		46.25	53.25
Regular 50% Si		42.00	49.25
Silicon metal, per pound contained silicon, fob shipping point, lump, bulk and carload lots,			
(% max. Fe)	(% max. Ca)		
0.35	0.07	64.05	72.40
0.50	0.07	62.00	70.20
1.00	0.07	59.50	67.50

Prices published by **AMERICAN METAL MARKET** in December 1980 and 1981

	1980	1981
	(¢US)	
SMZ alloy: 60-65% Si, 5-7% Mn, 5-6% Zr, ½ in. x 12 M, per pound of alloy	45.50	53.25
Calcium-silicon and calsibar alloy, fob producer, 15-ton lots, per pound	71.00	82.00

PRICES (cont'd)

	1980	1981
	($US)	
Electric furnace silvery pig iron,		
fob Keobuck, Iowa		
16% Si, per ton	210.00	210.00
20% Si, per ton	237.00	237.00

Prices published by **INDUSTRIAL MINERALS** in December 1980 and 1981

(tonnes, cif main European port)	1980	1981
	(£)	
Fused alumina, 8-220 mesh, cif		
Brown, min. 94% Al_2O_3	380-400	380-400
White, min. 99.5% Al_2O_3	450-500	450-500
Silicon carbide, 8-220 mesh, cif		
Black, about 99% SiC - Grade 1	650-670	670-690
- Grade 2	no quote	620-640
Green, over 99.5% SiC	800-820	830-870

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	0.75	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	0.75	2.75	free

TARIFFS (cont'd)

CANADA (cont'd)

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(cents)		
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	2.5	5.5	free
92804-1	Silicon metal	10%	13.6%	25%	9.0%
92815-4	Silicon sulphide	10%	13.6%	25%	9.0%

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

	1981	1982	1983	1984	1985	1986	1987
			(cents)				
37502-1	0.75	0.74	0.73	0.73	0.72	0.71	0.7
37504-1	0.75	0.74	0.73	0.73	0.72	0.71	0.7
37505-1	2.5	2.4	2.3	2.3	2.2	2.1	2.0
			(%)				
92804-1	13.6	12.8	12.1	11.4	10.7	9.9	9.2
92815-4	13.6	12.8	12.1	11.4	10.7	9.9	9.2

UNITED STATES (MFN)

Item No.		
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%

		1981	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 0.5¢	1.1	1.1	1.1	1.1	1.1	1.1
606.37	Other ferrosilicon containing 60-80% silicon	0.5¢	1.6	1.6	1.6	1.6	1.5	1.5
606.39	Ferrosilicon containing 80-90% silicon	1.0¢	1.9	1.9	1.9	1.9	1.9	1.9
606.40	Ferrosilicon containing over 90% silicon	2.0¢	9.3	8.6	7.9	7.2	6.5	5.8
606.44	Ferrosilicon manganese	per lb. on Mn content .46¢ +3.5%	5.2	5.0	4.7	4.4	4.2	3.9

EUROPEAN ECONOMIC COMMUNITY (MFN)

Item No.		1981	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)

Item No.				
28.04	Silicon - single crystal	10.8	15.0	7.2
	- other	5.7	7.5	4.9
28.56	Silicon carbide	5.7	7.5	4.9
68.06	Abrasive paper	10.6	15.0	6.5
73.02	Ferrosilicon	3.9	5.0	3.7

Sources: The Customs Tariff and Commodities Index, January 1981, Revenue Canada; Tariff Schedules of the United States Annotated (1981), USITC Publication 1111; U.S. Federal Register Vol. 44, No. 241; Customs Tariff Schedules of Japan, 1981; Official Journal of the European Communities, L315, Vol. 23.

Silver

J.J. HOGAN

The world's silver producers saw a steady decline in the silver price from the highs at the end of 1979 and in 1980, but this should not materially affect the production of silver in the short term. Approximately 80 per cent of the world's primary silver comes as a byproduct from the treatment of base-metal ores, and output therefore depends on the demand for base metals. However, weakening silver prices may affect exploration and development on those properties in which silver is the main metal or a coproduct. Another important situation in the silver industry was the authorization by the United States Congress for the sale of 105.2 million ounces of silver declared surplus to the strategic stockpile requirements.

CANADIAN DEVELOPMENTS

Canada's primary production of silver in 1981 was estimated at 1 203 000 kilograms, 12 per cent higher than in 1980 (Table 1). Lower production from some of the base-metal mines in Ontario and from the silver mines in the Yukon Territory and the Northwest Territories was offset by increased production from new base-metal ores, some of the existing base-metal mines, and Equity Silver Mines Limited in British Columbia.

The dollar value of silver produced in Canada declined 41 per cent to $487.3 million in 1981, because of the sharp decline in the world silver price.

British Columbia replaced Ontario as the leading silver-producing province in 1981, primarily because Equity Silver Mines recorded its first full year of production while Ontario's byproduct silver producers had substantially lower production. British Columbia accounted for 32.2 per cent of Canada's total silver output and Ontario for 26.9 per cent. Other major producers were New Brunswick with 16.0 per cent and the Yukon with 14.3 per cent. Silver production in the Northwest Territories, one of Canada's major silver producers, continued its decline.

Canada's exports of silver in ores and concentrates and as refined metal totalled 1 461 249 kg in 1981, 14 per cent above 1981 (Table 1). Silver contained in the concentrates shipped by Equity Silver to Japan was largely responsible for the increase in exports. The United States continued to be the major market for Canadian exports, accounting for 71 per cent of total exports in 1981. Over 99 per cent of Canada's refined metal exports in 1981 were to the United States.

Canada's imports of refined silver in 1981 were 327 291 kg, slightly lower than in 1980. About 87 per cent of the imports were from the United States. It is believed that much of these imports reflects movement of silver on the international market for storage and other reasons. Imports of silver in ores and concentrates, at 125 347 kg, were off 15 per cent from 1980.

Consumption of silver in Canada in 1981 for all uses including coinage is estimated at 280 000 kg, slightly higher than in 1980. About 7 510 kg of silver was used by the Royal Canadian Mint in the production of a numismatic silver dollar coin to commemorate the 100th anniversary of the approval by the Canadian government for construction of the Trans-Canada railway. The coins assay 50 per cent silver and contain 11.66 grams of silver each.

The principal source of silver was as a byproduct of base-metal ores, which accounted for over 83 per cent of the total output. (Statistics on production by source in Table 1 group some predominantly silver mines in the base-metal category). The remainder was derived from mines whose primary product was silver and from lode and placer gold ores. The principal mine producers of silver in Canada are listed in Table 3 while the map "Silver Producers in Canada 1981" shows their approximate locations.

TABLE 1. CANADA, SILVER PRODUCTION, TRADE AND CONSUMPTION, 1980 AND 1981

	1980		1981P	
	(kilograms)	($000)	(kilograms)	($000)
Production[1]				
By province and territories				
British Columbia	204 000	157,905	388 000	156,712
Ontario	444 000	343,622	324 000	130 784
New Brunswick	117 000	90,646	192 000	77,702
Yukon	147 000	114,120	172 000	69,528
Quebec	59 000	45,881	49 000	20,936
Northwest Territories	53 000	41,331	37 000	14,956
Manitoba	31 000	23,647	28 000	11 277
Newfoundland	9 000	7 185	8 000	3,107
Saskatchewan	6 000	4,422	5 000	2,250
Alberta	..	24	..	2
Total	1 070 000	828,805	1 203 000	487,254
By source[2]				
Base-metal ores	1 031 000	798,970	1 001 000	405,707
Gold ores	5 000	3,951	4 000	1,712
Silver ores	33 000	25,461	198 000	79,835
Placer gold ores	1 000	423	..	..
Total	1 070 000	828,805	1 203 000	487,254
Refined silver[3]	985 051	..	875 121	..
Exports				
Silver in ores and concentrates				
Japan	119 639	57,096	218 631	67,556
United States	194 100	79,238	129 361	38,242
Belgium-Luxembourg	24 419	12,651	137 319	33,662
West Germany	13 623	4,557	17 704	4,001
Sweden	5 388	2,906	9 087	3,478
Italy	7 734	3,326	11 362	2,138
U.S.S.R.	9 264	4,615	8 432	1,715
Other countries	22 523	12,127	14 553	5,042
Total	396 690	176,516	546 449	155,834
Refined metal				
United States	870 605	696,374	908 245	389,428
United Kingdom	1 246	970	3 136	1,290
Japan	-	-	1 145	363
Other countries	9 910	7,566	2 274	848
Total	881 761	704,910	914 800	391,929
Imports				
Silver in ores and concentrates				
United States	31 237	26,356	58 927	20,976
South Africa	34 345	17,612	35 240	8,585
Peru	68 184	40,207	17 509	5,538
Other Countries	13 397	8,764	13 671	4,461
TOTAL	147 163	92,939	125 347	39,560
Refined metal				
United States	326 396	187,169	284 470	112,596
Mexico	10 015	9	15 070	5,878
Cuba	-	-	7 775	2,417
Chile	-	-	4 000	1,679
Others	2 769	15,139	16 013	2,187
Total	339 180	202,317	327 328	124,757

TABLE 1. (cont'd.)

	1980 (kilograms)	1980 ($000)	1981 (kilograms)	1981 ($000)
Consumption, by use				
Sterling	29 703		..	
Silver alloys	40 640		..	
Wire rod	3 590		..	
Others[4]	192 005		..	
Total	265 938	..	280 000[e]	

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; [e] Estimated; - Nil; .. Not available.

TABLE 2. CANADA, SILVER PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975-81

	Production: All Forms[1]	Production: Refined[2] Silver	Exports: In Ores and Concentrates	Exports: Refined Silver	Exports: Total	Imports, Refined Silver	Consumption[3] 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
1976	1 281 437	1 023 928	435 790	947 413	1 383 203	59 136	551 212
1977	1 313 684	987 510	464 075	1 141 857	1 605 932	33 004	298 724
1978	1 266 927	1 026 998	482 793[r]	1 070 284	1 553 077[r]	36 001	329 320
1979	1 146 908	949 778	415 726[r]	911 146	1 326 872[r]	38 308	251 985
1980	1 070 000	985 051	396 690	881 761	1 278 451	339 180	265 938
1981[p]	1 203 000	875 121	546 449	914 800	1 461 249	327 328	280 000[e]

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; [r] Revised; [e] Estimated.

The four largest producers of silver in Canada in 1981, in declining order of output, were the mines of 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 a major producer of silver, is now a relatively small producing area.

METAL PRODUCTION IN CANADA

Production of refined silver in 1981 at six Canadian primary silver refineries is shown in Table 4.

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 byproduct silver in the processing of its own, as well as custom lead and zinc 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 produced a high-purity silver metal with metallic impurities totalling one part per million or less. This specialty metal product was 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 increased in 1981, largely because silver output at Brunswick Mining and Smelting in New Brunswick had been reduced in 1980 by a four-month strike.

Silver production in Newfoundland is relatively small. Reserves at the Buchans mine of ASARCO Incorporated are limited. Consolidated Rambler Mines Limited, the only other byproduct silver producer in the province, announced closure because of depletion of reserves but the mine was expected to operate into 1982.

The expansion program at Brunswick Mining and Smelting to raise mill capacity from 9 000 to 10 000 tpd was completed in April 1981. Brunswick Mining is one of the major producers of silver in Canada, its annual silver output being in the range of 125 000 to 160 000 kg.

Quebec

Silver production in Quebec is derived mainly from base-metal ores. In early September, Les Mines Selbaie, owned two-thirds by Selco Inc. and one-third by Hudson's Bay Oil and Gas Company Limited, officially opened its copper-zinc-silver mine in northwestern Quebec, although the concentrator had been treating ore since July. Capital cost of bringing the mine into production at a designed capacity of 1 500 tpd was approximately $85 million. The mine has three zones, A1, A2 and B, but only the B zone, an underground operation, has been prepared for production at this time. Reserves of the B zone are estimated to be 3.8 million t averaging 3.6 per cent copper, 0.5 per cent zinc and 31.8 grams of silver per t. In early November Noranda Mines Limited brought its Les Mines Gallen Limitée open-pit mine, near Noranda, into production at a rate of 1 500 tpd. Capital costs were approximately $4.8 million to develop the mine and $5.1 million to modify the Horne concentrator to process the ore. Reserves have been estimated at 1.6 million t averaging 5.4 per cent zinc, 25.7 g/t of silver and some gold.

Ontario

Ontario is one of the major silver producing provinces in Canada but output in 1981 was substantially below that of 1980 because of lower production from three of the major silver producers and the closure of the copper-zinc-lead-silver mine of Corporation Falconbridge Copper in the Sturgeon Lake area at the end of 1980.

Canada Development Corporation, through a corporate agreement with Société Nationale Elf Aquitaine of France, acquired full control of the Kidd Creek copper-zinc-silver-lead mine operated by Texasgulf Canada Ltd. near Timmins. The new company, Kidd Creek Mines Ltd., has been formed to operate the Timmins complex. The Kidd Creek mine is one of the major silver producers in Canada. An expansion program to increase capacity of the plant to 4.5 million tpy was completed in 1981. Initial operation of the new copper smelter and refinery began during the summer and the company now plans to add a silver refinery. At the end of 1980 the company estimated its ore reserves to be 87.9 million t averaging 5.06 per cent zinc, 2.86 per cent copper, 0.18 per cent lead and 65.5 g/t of silver.

The three producing copper-zinc-lead-silver mines in the Sturgeon Lake district of Ontario, all controlled by Noranda Mines, produce substantial amounts of silver. Ore came from two underground and two open-pit deposits.

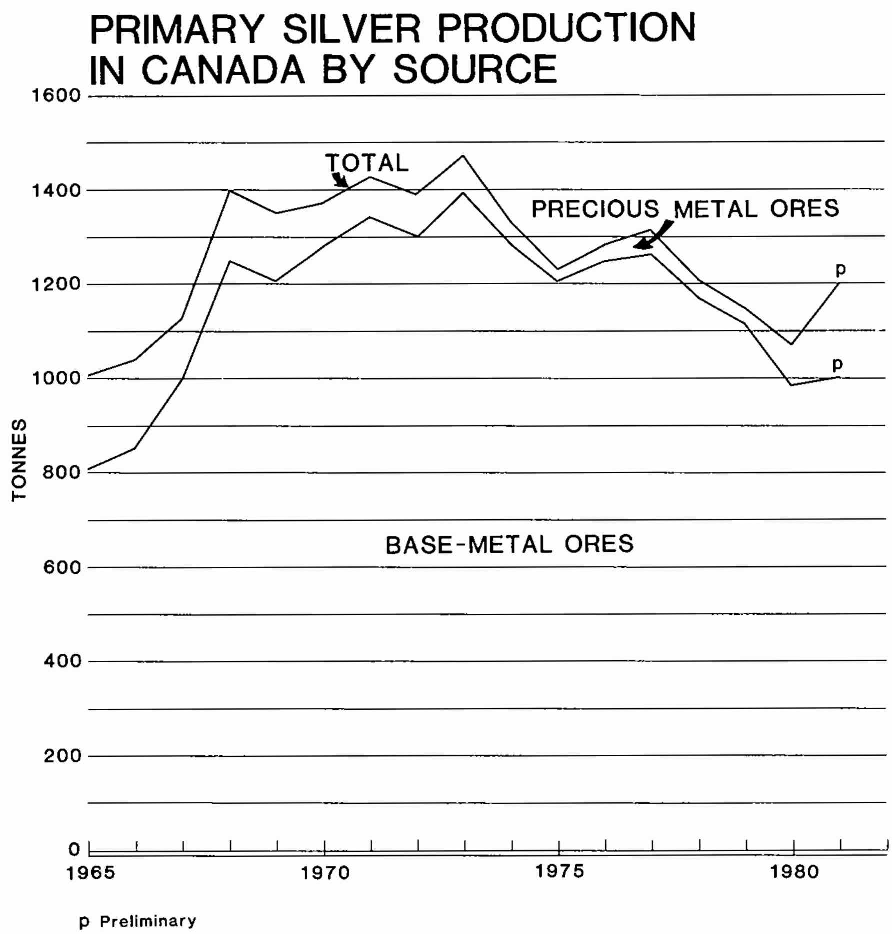
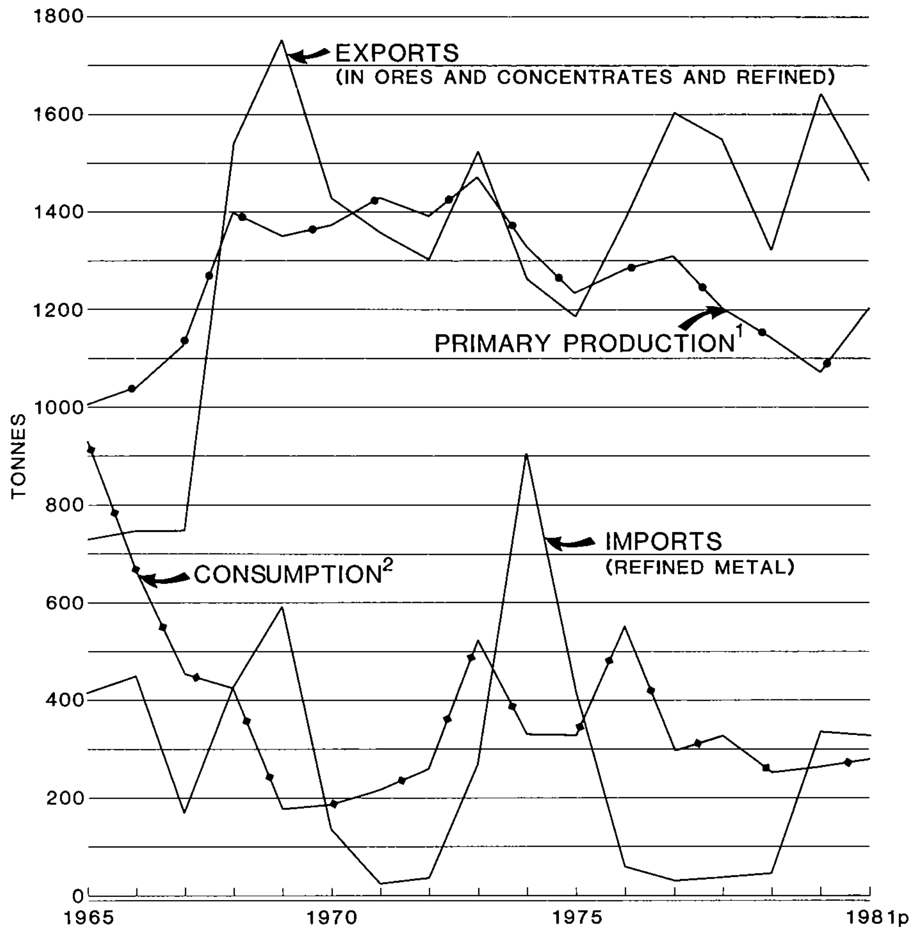


Figure 1

Silver produced by the three silver mines in the Cobalt district was estimated at about 23 000 kg in 1981 compared with 34 174 kg in 1980.

In April 1981 Sulpetro Limited, basically an oil and gas company, acquired the 92 per cent interest in CanDel Oil Ltd. held by St. Joe Minerals Corporation of New York. Included in the deal were two subsidiaries of CanDel: Canadian Smelting & Refining (1974) Limited (CSR), which operated a precious metal refinery in the Cobalt district; and Canadaka Mines Limited, which holds mining properties in the Cobalt district. Canadaka suspended mining and milling operations in April because of increasing costs. CSR had been treating gravity and flotation concentrates from the mining operations in the Cobalt district, but the Silverfields mine of Teck Corporation stopped shipping to CSR early in 1981 and Agnico-Eagle Mines Limited did not renew its contract when it expired at the end of July, this action being taken by both because of unsatisfactory smelter terms. The refinery, having no feed, therefore suspended its operations in September.

SILVER IN CANADA*



* As reported by Statistics Canada

1 As defined in Footnote 1 to Table 1.

2 Statistics for year 1965 to 1973 inclusive include consumption for coinage; 1974 to 1976 statistics include only partial consumption for coinage.

p Preliminary

Figure 2

TABLE 3. PRINCIPAL SILVER (MINE) PRODUCERS - CANADA, 1981 AND (1980)

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)	.. (102.51)	.. (0.85)	.. (5.42)	.. (9.38)	689 472 (75 296)	5 288 (6 796)	Limited reserves; recovering barite from tailings.
Consolidated Rambler Mines Limited, Baie Verte	1 100 (1 100)	.. (18.55)	3.82 (3.51)	- (-)	.. (0.67)	143 247 (164 281)	1 554 (1 905)	Announced closure.
New Brunswick								
Brunswick Mining and Smelting Corporation Limited, Nos. 12 and 6 mines Bathurst	10 000 (9 050)	97.9 (97.37)	0.35 (0.31)	3.50 (3.56)	8.74 (8.80)	3 423 000 (1 848 036)	195 710 (127 782)	Completed expansion program.
Heath Steele Mines Limited, Newcastle	3 600 (3 600)	.. (55.20)	.. (0.84)	.. (1.45)	.. (4.34)	1 251 936 (1 252 406)	29 766 (39 687)	
Quebec								
Campbell Resources Inc., Henderson and Cedar Bay, Chibougamau	3 650 (3 650)	.. (6.86)	.. (0.99)	- (-)	- (-)	393 725 (435 456)	.. (1 645)	
Corporation Falconbridge Copper, Lake Dufault Division, Corbet and Millenbach mines, Noranda	1 400 (1 400)	.. (28.80)	2.78 (2.70)	- (-)	1.19 (2.19)	452 960 (475 464)	5 972 (10 132)	Millenbach mine ore reserves depleted.
Corporation Falconbridge Copper, Opemiska Division, Perry, Springer and Cooke mines, Chapais	2 900 (2 900)	.. (10.29)	1.64 (1.57)	- (-)	- (-)	850 046 (964 052)	7 527 (8 046)	
Gaspé Copper Mines, Limited, Needle Mountain and Copper Mountain mines, Murdochville	30 400 (30 400)	.. (3.31)	.. (0.52)	- (-)	- (-)	10 120 723 (10 226 322)	.. (19 651)	

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
Quebec (cont'd)								
Lemoine Mines Limited, Chibougamau	300 (300)	69.58 (88.80)	3.70 (4.71)	- (-)	8.47 (10.00)	85 004 (104 326)	4 575 (7 312)	Limited reserves.
Les Mines Gallen Limitée (Noranda Mines Limited) Noranda	-	..	-	-	..	34 474	280	Came into production November 1981; ore treated at Noranda.
Les Mines Selbaie, (Selco Inc.) Joutel	1 500	..	..	-	..	..	..	Began production in 1981.
Louvem Mining Company Inc., (SOQUEM) Louvicourt	900 (900)	.. (30.38)	.. (0.15)	.. (0.11)	.. (3.89)	.. (224 530)	.. (3 196)	Closed in 1981.
Madeleine Mines Ltd., Murdochville	2 500 (2 500)	.. (5.14)	0.92 (0.94)	- (-)	- (-)	577 433 (564 738)	2 782 (2 693)	Limited ore reserves.
Noranda Mines Limited, Mattagami Division, Matagami	3 500 (3 500)	.. (21.39)	.. (0.77)	.. (..)	.. (4.81)	1 203 854 (1 328 360)	6 034 (15 189)	
Northgate Exploration Limited, (Former property of Patino Mines (Quebec) Limited) Chibougamau	2 700 (2 700)	9.12 (9.22)	1.64 (1.68)	- (-)	- (-)	670 765 (615 035)	4 202 (3 947)	Northgate purchased property in September 1981.
Ontario								
Agnico-Eagle Mines Limited, Cobalt district	350 (350)	310.92 (243.09)	.. (..)	- (-)	- (-)	43 786 (56 768)	12 759 (12 769)	
Canadaka Mines Limited, Cobalt district	275 (275)	.. (289.37)	- (-)	- (-)	- (-)	.. (22 220)	.. (6 037)	Acquired by Sulpetro Limited. Mill closed in early 1981.
Falconbridge Nickel Mines Limited, Ontario Mines, Sudbury district	11 200 (11 200)	.. (..)	.. (..)	- (-)	- (-)	2 759 702 (2 967 632)	.. (..)	Fraser mine officially opened in September 1981.

Inco Limited, Sudbury and Shebandowan, Ont., and Thompson, Man.	73 950 (73 950)	.. (..)	1.09 (1.07)	- (-)	- (-)	11 067 840 (13 166 281)	46 996[1] (42 353)[1]	Coleman mine closed.
Kidd Creek Mines Ltd., (Formerly Texasgulf Canada Ltd.) Timmins	12 250 (9 050)	64.8 (86.36)	1.90 (1.83)	0.70 (0.85)	5.27 (5.78)	4 076 323 (3 899 575)	186 817 (291 387)	Copper smelter and refinery completed.
Mattabi Mines Limited, Sturgeon Lake	2 700 (2 700)	.. (106.63)	.. (0.44)	.. (0.87)	.. (7.24)	472 651 (846 940)	23 421 (71 979)	All ore extracted from open pit operation.
Noranda Mines Limited, "F" Group Mine, Sturgeon Lake	270 (-)	.. (-)	.. (-)	.. (-)	.. (-)	97 978 (-)	3 950 (-)	Opened in 1981. Ore treated at Mattabi concentrator.
Noranda Mines Limited, Lyon Lake Divison, Sturgeon Lake	890 (252)	.. (..)	.. (..)	.. (..)	.. (..)	325 685 (83 462)	32 752 (..)	Ore treated at Mattabi concentrator.
Noranda Mines Limited, Geco Division Manitouwadge	4 550 (4 550)	.. (60.69)	.. (1.47)	.. (0.14)	.. (3.32)	1 329 955 (1 358 317)	43 109 (60 976)	
Selco Inc. South Bay Division Uchi Lake area	450 (450)	.. (65.49)	.. (1.48)	.. (-)	.. (8.79)	.. (117 290)	.. (5 954)	Mine closed in early 1981.
Teck Corporation, Silverfields Division, Cobalt district	250 (250)	229.68 (171.43)	.. (0.60)	- (-)	- (-)	77 930 (76 041)	16 956 (11 992)	Fiscal year ending September 30, 1981; limited ore reserves.
Umex Inc., Thierry mine, Pickle Lake area	3 650 (3 650)	.. (7.89)	.. (1.20)	- (-)	- (-)	.. (1 080 000)	.. (6 008)	
Manitoba-Saskatchewan								
Hudson Bay Mining and Smelting Co., Limited, Flin Flon mill and Snow Lake mill	10 700 (10 700)	16.66 (18.37)	2.01 (2.10)	- (-)	2.34 (2.61)	1 754 225 (1 701 689)	17 748 (20 938)	Rod, Spruce Point and Trout Lake properties being developed for production.
Hudson Bay Mining and Smelting Co., Limited, Snow Lake mill, Snow Lake	3 450 (3 450)	.. (16.66)	.. (2.65)	.. (0.23)	.. (3.23)	.. (756 283)	.. (8 819)	Silver production for 1981 included in above total.

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
Manitoba-Saskatchewan (cont'd)								
Inco Limited, Thompson		(Output included with company's listing for Ontario)						
Sherritt Gordon Mines Limited, Fox mine, Lynn Lake	2 600 (2 600)	.. (..)	1.42 (1.40)	- (-)	1.73 (1.56)	733 925 (784 011)	- (-)	Silver sales from Fox and Ruttan mines: 11 353 kg in 1981, 15 521 kg in 1980.
Sherritt Gordon Mines Limited, Ruttan mine, Ruttan	9 050 (9 050)	.. (..)	1.30 (1.36)	- (-)	1.25 (1.02)	1 702 814 (2 311 444)	.. (..)	Silver production included in above total.
British Columbia								
Afton Operating Corporation Dominion pit, Kamloops	6 350 (6 350)	.. (5.07)	0.93 (1.05)	- (-)	- (-)	2 553 060 (2 739 799)	7 656 (9 000)	Fiscal year ending September 30, 1981.
Brenda Mines Ltd. Peachland	27 000 (27 000)	.. (1.10)	0.137 (0.13)	- (-)	- (-)	10 199 300 (9 126 857)	5 877 (5 022)	
Cominco Ltd., Bethlehem Copper Division, Highland Valley	18 150 (18 150)	.. (1.78)	0.39 (0.38)	- (-)	- (-)	6 496 000 (6 281 347)	3 662 (5 577)	Limited reserves in Jersey mine.
Cominco Ltd., Sullivan mine, Kimberley	9 075 (9 075)	.. (44.57)	- (-)	4.4 (3.85)	3.2 (2.73)	2 210 000 (2 132 416)	98 939 (93 371)	
Dankoe Mines Ltd., Keremeos	150 (150)	.. (136.08)	.. (..)	.. (..)	.. (..)	32 755 (30 028)	3 498 (3 660)	Silver mining operations suspended in August 1981.
DeKalb Mining Corporation, Highland Valley	650 (650)	.. (20.19)	.. (1.93)	- (-)	- (-)	80 800 (48 234)	1 756 (866)	Closed latter part of 1981.
Dickenson Mines Limited, Silvana Division, Slocan district	100 (100)	429.19 (295.89)	- (-)	4.17 (3.21)	3.47 (3.03)	27 672 (28 223)	11 037 (7 724)	

Du Pont of Canada Exploration Limited, Baker Mine, north central British Columbia	90	..	-	-	-	16 689	4 884	Began production in early 1981.
Equity Silver Mines Limited, Houston	4 500 (4 500)	102.9 (126.86)	0.39 (0.38)	- (-)	- (-)	1 910 000 448 000)	228 000 (45 000)	Construction of leach plant completed.
Gibraltar Mines Limited, McLeese Lake	36 300 (36 300)	.. (..)	0.38 (0.38)	- (-)	- (-)	13 258 000 (12 643 870)	5 624 (..)	Ore being mined in East pit.
Lornex Mining Corporation Ltd., Highland Valley	68 000 (43 500)	.. (..)	0.41 (0.41)	- (-)	- (-)	20 739 392 (16 037 591)	18 351 (16 497)	Expansion program completed.
Newmont Mines Limited, Similkameen Division, Princeton	19 150 (19 150)	.. (1.47)	0.40 (0.46)	- (-)	- (-)	6 868 411 (6 612 581)	4 527 (4 861)	Ingerbelle pit mined out in 1981. Ore now coming from Copper Mountain orebody.
Noranda Mines Limited, Granisle mine, Babine Lake	14 300 (14 300)	.. (..)	.. (0.39)	- (-)	- (-)	3 832 920 (3 936 725)	3 235 (4 075)	At mid-year mining rate ore & waste) from 39 000 t to 25 400 t/d.
Northair Mines Ltd., Alta Lake	250 (250)	.. (32.33)	.. (0.50)	.. (1.38)	.. (2.15)	62 548 (71 478)	1 520 (1 800)	
Teck Corporation, Beaverdell mine, Beaverdell	100 (100)	294.81 (290.74)	- (-)	.. (0.23)	.. (0.56)	36 683 (38 550)	9 509 (8 979)	Fiscal year ending Septembe 30, 1981.
Utah Mines Ltd., Island Copper mine, Coal Harbour, Vancouver Island	34 450 (34 450)	.. (..)	0.44^{e} (0.42)	- (-)	- (-)	14 156 618 (13 757 175)	13 114 (12 409)	
Wesfrob Mines Limited, Tasu Harbour, Queen Charlotte Islands	4 650 (4 650)	.. (3.12)	.. (0.27)	- (-)	- (-)	1 008 806 (996 432)	2 347 (2 320)	
Westmin Resources Limited, (Formerly Western Mines Limited), Buttle Lake, Vancouver Island	900 (900)	127.18 (124.11)	1.13 (1.22)	1.22 (1.23)	7.35 (7.58)	246 154 (278 244)	24 354 (31 159)	Sinking shaft on H-W zone to a depth of 762 metres.

TABLE 3. (cont'd)

Company and Location	Mill Capacity (tonnes of ore/day)	Grade of Ore Milled: Silver (grams/tonne)	Grade of Ore Milled: Copper (%)	Grade of Ore Milled: Lead (%)	Grade of Ore Milled: Zinc (%)	Ore Milled (tonnes)	Silver contained in concentrates produced (kilograms)	Remarks
Yukon Territory								
Cyprus Anvil Mining Corporation, Faro	9 050 (9 050)	 (47.01)	 (-)	 (3.12)	 (4.68)	 (2 825 150)	 (87 035)	
Hudson Bay Mining and Smelting Co., Limited Whitehorse Copper Division, Whitehorse	2 250 (2 250)	.. (10.29)	1.42 (1.58)	- (-)	- (-)	726 103 (775 013)	.. (736)	Limited ore reserves.
United Keno Hill Mines Limited, Elsa	450 (450)	754.16 (787.20)	- (-)	.. (3.39)	.. (0.79)	60 713 (79 636)	36 020 (53 738)	Silver precipitate refinery completed in November 1981.
Northwest Territories								
Echo Bay Mines Ltd., Port Radium Great Bear Lake	100 (100)	.. (1 167.09)	.. (0.81)	- (-)	- (-)	38 102 (36 076)	34 867 (41 253)	Mine closed fourth quarter - all stockpiled will be milled early in 1982.
Nanisivik Mines Ltd., Strathcona Sound, Baffin Island	1 350 (1 350)	 (86.30)	 (-)	 (2.37)	 (14.28)	 (435 147)	 (30 936)	
Terra Mining and Exploration Limited, Silver Bear mine and Norex Joint Venture mine, Camsell River area Great Bear Lake	180 (180)	.. (376.80)	.. (0.90)	- (-)	- (-)	1 436 (27 011)	1 758 (9 659)	Mill closed in January 1981; emphasis on underground exploration.

Source: Company reports and technical press.
[1] Silver delivered to market.
- Nil; .. Not available.

In October the Ontario government approved Silverfields' application for permission to export its silver concentrates. Reserves at the present mine are limited but the company is continuing to explore the adjoining property of Consolidated Summit Mines Limited. Agnico-Eagle is stockpiling ore from its operation.

Manitoba-Saskatchewan

In Manitoba and Saskatchewan, silver was derived mainly 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 mine operated by Sherritt Gordon Mines Limited at Lynn Lake and Ruttan.

British Columbia

Silver production in British Columbia increased substantially because Equity Silver Mines Limited, now one of the major silver producers in Canada, recorded its first full year of production. Production at this mine began on October 1, 1980. The Sullivan lead-zinc mine of Cominco Ltd. at Kimberley is also a major silver producer. The copper mines of British Columbia are small contributors to the province's silver production.

Construction of the leach plant at the Sam Goosly mine of Equity Silver was completed in 1981. Leaching of the concentrates on a trial basis to remove antimony and other impurities began toward the end of the year. The plant is expected to be in full operation in the second quarter of 1982. In the meantime sale of unleached concentrates will continue.

Yukon Territory

Silver production in the Yukon increased in 1980. The labour strike at the Elsa operations of United Keno Hill Mines Limited, that started in September 1980 was settled on May 28, 1981. United Keno is one of the major silver producers in Canada. At a cost of about $7 million, United Keno brought the Venus mine, a former gold and silver producer near Carcross, into production at a rate of 90 tpd in the latter part of the year but soon closed it because of the low silver price and high production costs.

Northwest Territories

Silver production declined sharply in the Northwest Territories in 1981. Terra Mining and Exploration Limited at Great Bear Lake suspended milling operations in January 1981 and centred its efforts on an extensive exploration program to develop sufficient ore to resume milling. Funds for the program were provided by Procan Exploration Company of Calgary, controlled by the Hunt brothers of Texas. Terra expected to resume milling operations in 1982. Echo Bay Mines Ltd has put its silver mine near Port Radium, Great Bear Lake, on a salvage basis. By the end of November all ore had been hoisted and stockpiled on surface and the mine pumps lifted. Stockpiled ore should be sufficient to keep the mill operating until March 1982. Echo Bay is developing a gold property, the Lupin mine east of Port Radium at Contwoyto Lake, and workers from the silver mine are being transferred to this operation.

Cadillac Explorations Limited is preparing its underground silver-lead-zinc mine for production in early 1982 through funds made available by Procan Exploration. The property is located at Prairie Creek, a tributary of the South Nahanni River about 340 km north of Fort Nelson, British Columbia. Capital costs for the 900 tpd operation are estimated at $32 million. Reserves have been 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

World production of silver in 1981 was 10 933 t, up 14 per cent from 1980 (Table 5).

Based on preliminary data, Canada was the fourth largest mine producer in 1980, being surpassed by U.S.S.R., Mexico and Peru. United States production was slightly below that of Canada. These five countries accounted for about 60 per cent of the world's total primary silver production.

In 1981, non-communist world consumption of silver for both industrial and coinage uses, as estimated by Handy & Harman[1], was 11 487 t compared with 11 309 t in 1980. The gap between primary production and consumption in 1981 was 3 276 t compared with 3 443 t in 1980. The shortfall was made up largely from old scrap and demonetized coins.

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[1] The **Silver Market 1981**, compiled by Handy & Harman, a leading United States refiner and fabricator of precious metals and a large consumer of silver.

The Silver Institute, in its publication **Modern Silver Coinage 1980,** reported that silver used in official coins in 1980 was 429 468 kg compared with 759 313 kg in 1979. The leading consumers of silver in coinage in 1980 and the amounts used were: Mexico 157 259 kg, U.S.S.R. 67 495 kg, Austria 65 275 kg, Venezuela 17 550 kg and Italy 16 248 kg. These six countries accounted for 79 per cent of the total silver usage in coinage. All silver used by Mexico was in the minting of 5,056,000 "bullion coins" (onza troy) which contain one troy ounce of fine silver. The onza troy coin does not carry a currency denomination but has a mark stating it contains one troy ounce of silver.

According to United States Bureau of Mines (USBM), primary production of silver in the United States in 1981 was 1 168.3 t, an increase of almost 20 per cent from 1980 levels (Table 5). In the United States, the world's largest silver user, consumption for industrial purposes increased by 6.6 per cent to 4 133.9 t in 1981. Silver used in coinage was 5.58 t in 1981 compared with 2.24 t in 1980. The large difference between primary production and consumption was met by imports, largely from Canada, Peru and Mexico, demonetized coinage, secondary or scrap silver derived from discraded jewellery, silverware and films and withdrawal from existing stocks. Some of the requirements for United States coinage were obtained from Treasury stocks held by the Bureau of Mint, which declined slightly to 1 204.7 t.

According to Handy & Harman, Japan is the non-communist world's second largest consumer of silver. Silver consumption in 1981 amounted to 1 804.0 t compared with 1 919.1 t in 1980. The photographic industry in Japan consumed about 1 029.5 t, 57.1 per cent of the total, compared with 1 014.0 t in 1980.

Industrial consumption of silver in West Germany in 1981 was 746.5 t, a decrease of about 18 per cent from 1980 level.

The U.S.S.R. is the world's largest silver producer. Output for the year 1981 was 1 586 t (Table 5). 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.

TABLE 4. CANADA, SILVER REFINERY PRODUCTION AND CAPACITY

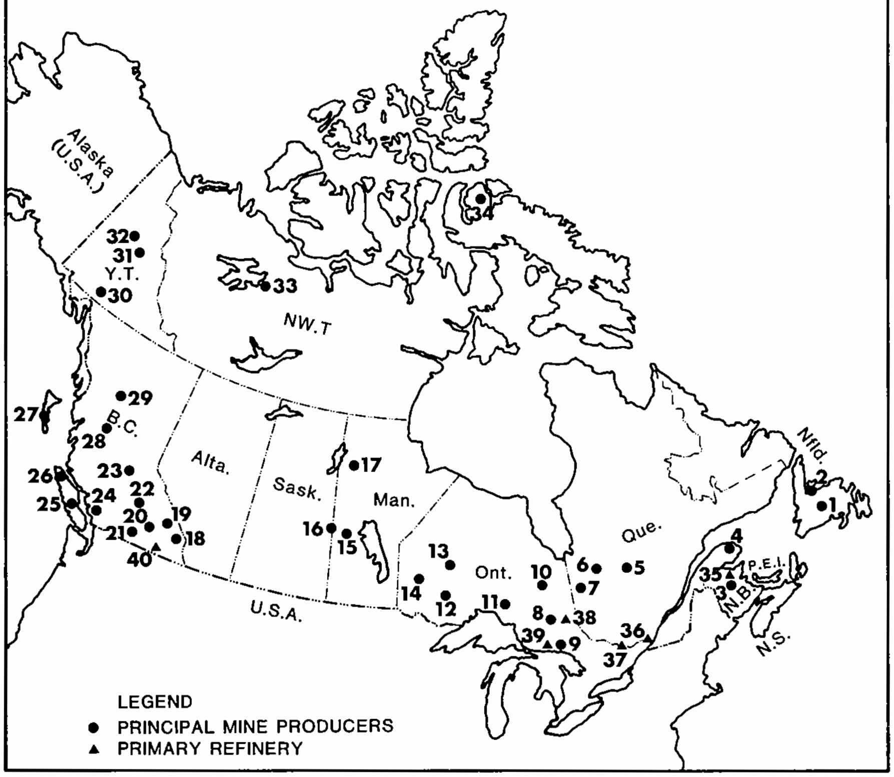
	Production[1] Refined Silver	Annual[2] Rated Capacity
	(kilograms)	
Brunswick Mining and Smelting Corporation Limited, Smelting Division, Belledune, New Brunswick	94 000[3]	125 000
Canadian Copper Refiners Limited, Montreal East, Quebec	589 909	777 600
Canadian Smelting & Refining (1974) Limited Cobalt, Ontario		186 600[4]
Cominco Ltd., Trail British Columbia	240 123	373 200
Inco Metals Company Copper Cliff, Ontario	46 996[5]	..
Royal Canadian Mint Ottawa, Ontario	3 638[6]	217 705[7]

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, 1981. [3] Bullion produced by Brunswick Mining and Smelting Corporation Limited was shipped to Canadian Copper Refiners Limited (CCR) for further refining and the 642 225 kg of silver reported as production for CCR includes all of that silver bullion produced by Brunswick and refined by CCR in 1981. [4] Up to this amount, depending on nature of material processed. [5] Silver delivered to market. [6] Silver derived from refining gold bullion. [7] Total capacity for producing refined gold and silver, of which about 10 per cent is silver.

.. Not available.

SILVER PRODUCERS IN CANADA, 1981



Principal mine producers
(numbers refer to numbers on map above)

1. ASARCO Incorporated (Buchans Unit)
2. Consolidated Rambler
Mines Limited
3. Brunswick Mining and Smelting
Corporation Limited,
(Nos. 12 and 6 mines)
Heath Steele Mines Limited
4. Gaspé Copper Mines, Limited
Madeleine Mines Ltd.
5. Campbell Resources Inc.
Corporation Falconbridge Copper,
Opemiska Division
Lemoine Mines Limited
Northgate Exploration Limited
(formerly Patino Mines (Quebec)
Limited)
6. Noranda Mines Limited,
Matagami Division
Les Mines Selbaie[2]
7. Corporation Falconbridge Copper,
Lake Dufault Division
Les Mines Gallen Limitée[2]
Louvem Mining Company Inc.[1]
(SOQUEM)
8. Agnico-Eagle Mines Limited
Canadaka Mines Limited[1]
Teck Corporation,
Silverfields Division
9. Falconbridge Nickel Mines Limited
Inco Limited
10. Kidd Creek Mines Ltd., (formerly
Texasgulf Canada Ltd.)
11. Noranda Mines Limited,
Geco Division
12. Mattabi Mines Limited
Noranda Mines Limited,
"F" Group mine[2]
Lyon Lake Division
13. Umex Inc.
14. Selco Inc.[1]
South Bay Division

15. Hudson Bay Mining and Smelting Co., Limited,
Snow Lake area (Anderson Lake, Chisel Lake, Ghost Lake, Osborne Lake and Stall Lake mines)
16. Hudson Bay Mining and Smelting Co., Limited,
Flin Flon area (Centennial, Flin Flon, Westarm and White Lake mines)
17. Sherritt Gordon Mines Limited,
Fox & Ruttan mines
18. Cominco Ltd. (Sullivan mine)
19. Dickenson Mines Limited,
Silvana Division
20. Brenda Mines Ltd.
Similkameen Mining Company Limited
21. Dankoe Mines Ltd.
Teck Corporation,
(Beaverdell mine)
22. Afton Operating Corporation
Cominco Ltd.
Bethlehem Copper Division
DeKalb Mining Corporation[1]
Lornex Mining Corporation Ltd.
23. Gibraltar Mines Limited
24. Northair Mines Ltd.
25. Westmin Resources Limited
(formerly Western Mines Limited)
26. Utah Mines Ltd.,
(Island Copper Mine)
27. Wesfrob Mines Limited
28. Equity Silver Mines Limited
Noranda Mines Limited,
(Granisle mine)
29. Du Pont of Canada Exploration Limited[2]
30. Hudson Bay Mining and Smelting Co., Limited
31. Cyprus Anvil Mining Corporation
32. United Keno Hill Mines Limited
33. Echo Bay Mines Ltd.
Terra Mining and Exploration Limited
34. Nanisivik Mines Ltd.

Primary refineries
(numbers refer to numbers on the map)

35. Brunswick Mining and Smelting Corporation Limited, Smelting Division
36. Canadian Copper Refiners Limited
37. Royal Canadian Mint
38. Canadian Smelting & Refining (1974) Limited
39. Inco Limited
40. Cominco Ltd.

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[1] Closed in 1981; [2] Opened in 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 1980 amounted to 1,240,720 contracts of 5,000 troy ounces each compared with 1,058,734 contracts in 1980. The volume of silver traded on the Chicago Board of Trade in 1981 was 214,236 contracts of 5,000 troy ounces each and 184,776 contracts of 1,000 troy ounces each compared with 341,000 contracts of 5,000 troy ounces in 1980. Trading volume on the Mid American Commodity Exchange at Chicago was 143,051 contracts of 1,000 troy ounces each compared with 209,000 contracts in 1980. Silver traded on the London Metal Exchange was 454.00 million troy ounces in 1981 compared with 434.24 million ounces in 1979.

Comex silver stocks at the end of 1981 were 77.60 million troy ounces compared with 86.65 million troy ounces at the end of 1980. Chicago Board of Trade silver in storage at the end of 1981 and registered for delivery against futures contracts was 34.20 million troy ounces compared with 34.15 million troy ounces in 1980. London Metal Exchange silver stocks at the end of 1981 were 32.23 million troy ounces compared with 26.85 million troy ounces at the end of 1980. United States industrial stocks on hand December 31, 1981 were reported to be about 20.69 million troy ounces compared with 17.01 million troy ounces in 1980.

One of the major silver mine developments under way in Mexico is that by Minera Real de Angeles, S.A. de C.V., a Mexican company in which Placer Development Limited of Vancouver, British Columbia, has a 34 per cent interest. Placer is managing the property and its partners are the Mexican government, through Comision de Fomento Minero, and Minera Frisco S.A. de C.V., a major mining company, each with a 33 per cent interest. The open-pit silver-lead-zinc mine, in the state of Zacatecos, will begin production in 1982. Concentrator capacity will be 10 000 tpd and annual production of silver is expected to be over 225 000 kg. Reserves are estimated at 59 million t averaging 73 g/t silver, 1.0 per cent lead and 0.9 per cent zinc.

TABLE 5. WORLD MINE PRODUCTION[1] OF SILVER, 1980 AND 1981

	1980p (kilograms)	1981e (kilograms)
U.S.S.R.e2	1 550 000	1 586 280
Mexico	1 472 600	1 555 170
Peru	1 232 000	1 244 140
Canada	1 070 000	1 203 000
United States	974 372	1 168 260
Australia	769 699	777 590
Polande	767 167	705 740
Chile	298 500	311 030
Japan	267 593	279 360
Republic of South Africa	220 835	223 940
Bolivia	189 700	192 840
Sweden	159 000	167 960
Yugoslavia[2]	149 000	149 300
Spain	102 641	105 750
Morocco	98 100	96 420
Zaire	78 800	77 760
Republic of Korea	71 298	71 540
Argentina	71 700	65 320
Philippines	60 723	62 920
People's Republic of Chinae	60 000	59 100
Greece	51 999	55 990
Italy	36 173	55 330
France	73 771	53 060
Other countriese	672 199	665 680
Total	10 497 870	10 933 480

Sources: Energy, Mines and Resources Canada; Nonferrous Metal Data 1981, American Bureau of Metal Statistics Inc.
[1] Recoverable content of ores and concentrates produced unless otherwise noted.
[2] Smelter and refinery production.
p Preliminary; e Estimated.

Avino Mines & Resources Limited of Vancouver has a 49 per cent interest in Minera Mexicana de Avino S.A., which operates an open-pit mine in the State of Durango. Additional equipment installed in 1981 raised capacity from 450 to 800 tpd, and a further increase to 1 500 tpd is planned for early 1982. Open-pit ore reserves have been estimated at 6.7 million t averaging 188 g/t of silver and over 0.4 per cent copper. The company also plans to construct a 2 000 tpd concentrator near the present operation.

In early 1980, following the sharp rise in the price of gold and silver, the Mexican government imposed a "windfall profit tax" on the sale of these metals. This levy was removed in June 1981 because the price of gold and silver had fallen below the base price set by the government for the tax imposition.

Mexico has good opportunities to develop properties in which silver is the main metal but the recent decline in the silver price is expected to lower exploration and development activity. Lower demand for zinc and lead will also discourage the development of base deposits which are a significant source of byproduct silver. Mexican silver production should increase in 1982 and 1983 as a result of developments now under way but may then level off for a period.

In August 1981, Gulf Resources & Chemical Corporation of Houston announced that it would close the operations of its wholly owned subsidiary, The Bunker Hill Co. at Kellogg, Idaho, because of substantial losses. Bunker Hill operated a mine-smelter-refinery complex and accounted for 25 per cent of the refined silver, 21 per cent of the primary lead and zinc and 11 per cent of the cadmium produced in the United States in 1980. In 1980, Bunker Hill produced about 311 000 kg of refined silver, approximately 21 per cent coming from its own mines and the remainder from other mines. Unsuccessful efforts were made to sell the complex to other base-metal refining companies, including two Canadian companies. In mid-December, Gulf Resources reached a tentative agreement to sell the Bunker Hill assets to a group of Idaho businessmen, who must proceed with the purchase by year-end. Hecla Mining Company, a substantial U.S. silver producer, shipped a large proportion of its silver concentrates to Bunker Hill smelter.

After an extended period of negotiations, shareholders of Day Mines, Inc. agreed to merge with Hecla Mining Company, both companies having mining properties in the Coeur d'Alene district of Idaho. The merger became effective in October when Day Mines became Hecla-Day Mining Corporation, a subsidiary of Hecla Mining. In 1980 these two companies produced 152 000 kg of silver. Production at the Lucky Friday silver mine of Hecla was suspended for nine weeks in the first half of 1981 because of a labour strike.

TABLE 6. UNITED STATES CONSUMPTION OF SILVER BY END-USE[1], 1980 AND 1981

	1980[f]		1981[p]	
	(kilograms)	(%)	(kilograms)	(%)
Electroplated ware	135 300	3.5	171 909	4.2
Sterling ware	282 482	7.3	179 747	4.3
Jewellery	183 293	4.7	205 283	5.0
Photographic materials	1 549 731	40.0	1 650 195	39.9
Dental and medical supplies	68 801	1.8	60 279	1.5
Mirrors	20 902	0.5	19 129	0.5
Brazing alloys and solders	264 628	6.8	301 673	7.3
Electrical and electronic products:				
Batteries	185 874	4.8	158 877	3.8
Contacts and conductors	864 552	22.3	972 637	23.5
Bearings	20 186	0.5	7 745	0.2
Catalysts	94 399	2.4	166 715	4.0
Coins, medallions and commemorative objects	145 969	3.8	103 637	2.5
Miscellaneous[2]	62 300	1.6	136 044	3.3
Total net industrial consumption	3 878 417	100.0	4 133 870	100.0
Coinage	2 239		5 567	
Total consumption	3 880 656		4 139 437	

Sources: United States Bureau of Mines, **Mineral Industry Surveys,** "Gold and Silver in December 1981".
[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.

The boards of directors of Silver Dollar Mining Co., Sunshine Consolidated and Silver Syndicate in late July approved a merger offer by Sunshine Mining Company. All of the companies are partners, along with Hecla, in the Sunshine silver mine at Kellogg, Idaho. The merger should make for a more efficient operation as it eliminates many of the problems related to extralateral rights and allows for an improved development approach.

Production began in August at the Troy mine controlled by ASARCO Incorporated in western Montana. Cost of the project was approximately $83 million. Annual production should be about 130 000 kg, making it the largest silver producer in the United States. Reserves are estimated at 50 million t averaging 57.8 g/t silver and 0.74 per cent copper.

In November, Johnson Matthey Investments Inc. began construction of a precious metal refinery near Salt Lake City, Utah, to treat precious metal ores and concentrates from small operations in the midwest. The refinery, expected to be completed in 1982, will have an annual refining capacity of 31 000 kg of gold and 124 000 kg of silver. Although the decision to build the refinery was not based on the impending closure of Bunker Hill, it is expected that it will compete for some of the business formerly handled by Bunker Hill.

In Australia, M.I.M. Holdings Limited and Seltrust Mining Corp. Pty. Ltd. opened the Teutonic Bore copper-zinc-silver mine near Kalgoorlie, Western Australia. Capital cost of the project was $50 million and capacity is 800 tpd. The reserves are estimated at 2.5 million t averaging 150 g/t silver, 3.5 per cent copper, 9.5 per cent zinc and minor lead.

In Chile, Compania Minera San Jose, Inc., a subsidiary of St. Joe Minerals Corporation of New York, commenced production at its 80 per cent controlled El Indio gold-silver-copper mine located about 500 km northeast of Santiago. Designed capacity of the plant is 1 250 tpy. Reserves are estimated to be 3.1 million t averaging 12.0 g/t gold, 144.0 g/t silver and 3.52 per cent copper. The property also contains 49 200 t of high-grade, direct-shipping gold ore.

TABLE 7. NON-COMMUNIST WORLD CONSUMPTION OF SILVER, 1980 AND 1981

	1980 (kilograms)[1]	1981P (kilograms)[1]
Industrial uses		
United States	3 878 604	4 124 321
Japan	1 919 085	1 804 002
Italy	699 828	886 449
West Germany	905 111	746 483
United Kingdom	637 621	653 173
France	628 290	640 732
India	590 966	590 966
Belgium	488 325	503 876
Canada	270 600	279 931
Mexico	96 420	105 752
Other countries	768 256	964 208
Total industrial uses	10 883 106	11 299 893
Coinage		
Austria	133 745	93 311
Canada	6 221	6 221
United States	3 110	3 110
Mexico	189 731	-
Other countries	93 311	83 979
Total coinage	426 118	186 621
Total consumption	11 309 224	11 486 514

Source: Handy & Harman, **The Silver Market, 1981.**
[1] One kilogram equals 32.1507 troy ounces.
P Preliminary; - Nil.

SILVER STOCKS AND COMMODITY EXCHANGES

In August 1981, the U.S. Congress approved the sale, over a three-year period, of 105.2 million oz of silver from the United States strategic silver stockpile which at that time contained 139.5 million oz. Up to 46.5 million oz is authorized for sale in fiscal year 1982 (beginning on October 1, 1981), 46.5 million oz in fiscal year 1983 and 12.2 million oz in fiscal year 1984. The 1982 and 1983 amounts are each equivalent to about 13 per cent of world annual silver mine production.

There are two main reasons for the U.S. decision to sell the majority of its strategic stockpile; the United States along with Canada and Mexico, is a major world producer of silver and in the event of a supply crisis, silver should be readily available from domestic primary and secondary sources and from Canada and Mexico; and returns from these sales can be used to purchase other strategic commodities such as cobalt.

In late September the General Services Administration (GSA) announced that sales would be made on a weekly basis, the first sale to take place on October 14, 1981. Each week a maximum of 1.25 million oz will be offered for sale. Canada expressed its concern to the United States government that large silver sales in such a short time frame could lower the price and adversely affect silver producers. Mexico and Peru also expressed concern. By law, sales by the GSA must be made in a manner not to disrupt normal market workings. Also, sales initially were to be restricted to domestic use only.

In 1981 the GSA held nine auctions in which 11.25 million oz were offered for sale but only 2 million oz were sold at an average price of $US 9.06 per oz. No bids were accepted at the last five auctions and on December 16, the GSA announced that it was suspending silver auctions because of legislation approved by Congress which requires a study be made of the disposal program and a report submitted by July 1982.

On March 16, 1981, the Chicago Board of Trade started trading in 1,000 oz silver futures contracts after receiving approval from the Commodity Futures Trading Commission. Prior to this approval silver futures trading was in 5,000 oz lots. The new contract was introduced in expectation that smaller investors would be attracted to the market. Position limits for silver speculators remain unchanged, a maximum of 3 million ounces per person in any combination of 1,000 oz and 5,000 oz contracts.

USES

There was no marked change in the pattern of silver usage in 1981 from previous years. The major uses of silver are the photographic industry, electric and electronic industries, sterling ware, electroplate ware, brazing alloys and solders. Recently silver has emerged as an important metal in the speculative field as a hedge against inflation and in hoarding. Action by speculators will continue to be a major factor in determining silver prices and in the amount of silver removed from or made available to the market. Silver is used in a myriad of applications and research is going on continuously for the development of new applications.

PRICES

The silver price trend was sharply downward in 1981 (Table 7). For the first seven months of 1981 the monthly average silver price declined from $US 14.75 per ounce in January to $8.63 in July. The price improved in August and September to a monthly average of $10.04, but then declined in the last three months of the year. The monthly average for December was $8.43 per oz, the low monthly average for the year.

High interest rates affected precious metals market by discouraging consumption and inventory holding by industrial users and investment or speculative purchases. The U.S. silver sales, now suspended, also undoubtedly had some negative affect on prices but it is difficult to assess the actual effect.

The average silver price (Handy & Harman of New York) for 1981 was $US 10.52 per oz compared with $20.63 in 1980 and $11.09 in 1979. The high silver price for 1981 was $US 16.45 on January 6, the low was $7.95 on December 29, and the closing price was $8.25. The London spot silver price closely followed the U.S. pattern. The average spot price for the year 1981 was 515.30 pence per oz ($US 10.52 per oz).

In 1981 the Canadian silver price followed its U.S. counterpart, the main difference being the currency exchange differential. The average Canadian silver price for 1981 was $405.55 per kg ($12.61 per oz).

TABLE 8. ANNUAL AVERAGE SILVER PRICES: CANADA, UNITED STATES AND UNITED KINGDOM, 1971-81

	Canada	United States Handy & Harman, New York	United Kingdom London Spot
	($Cdn)	($US)	(pence)[2]
	(per troy ounce)		
1971	1.571	1.546	63.086
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

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] 1971-81 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.

OUTLOOK

Canada's output of silver in 1982 is expected to be about the same or slightly higher than that in 1981. In the short term Canada's silver output is expected to remain near its present level. There are no major developments on the horizon that could add significantly to output.

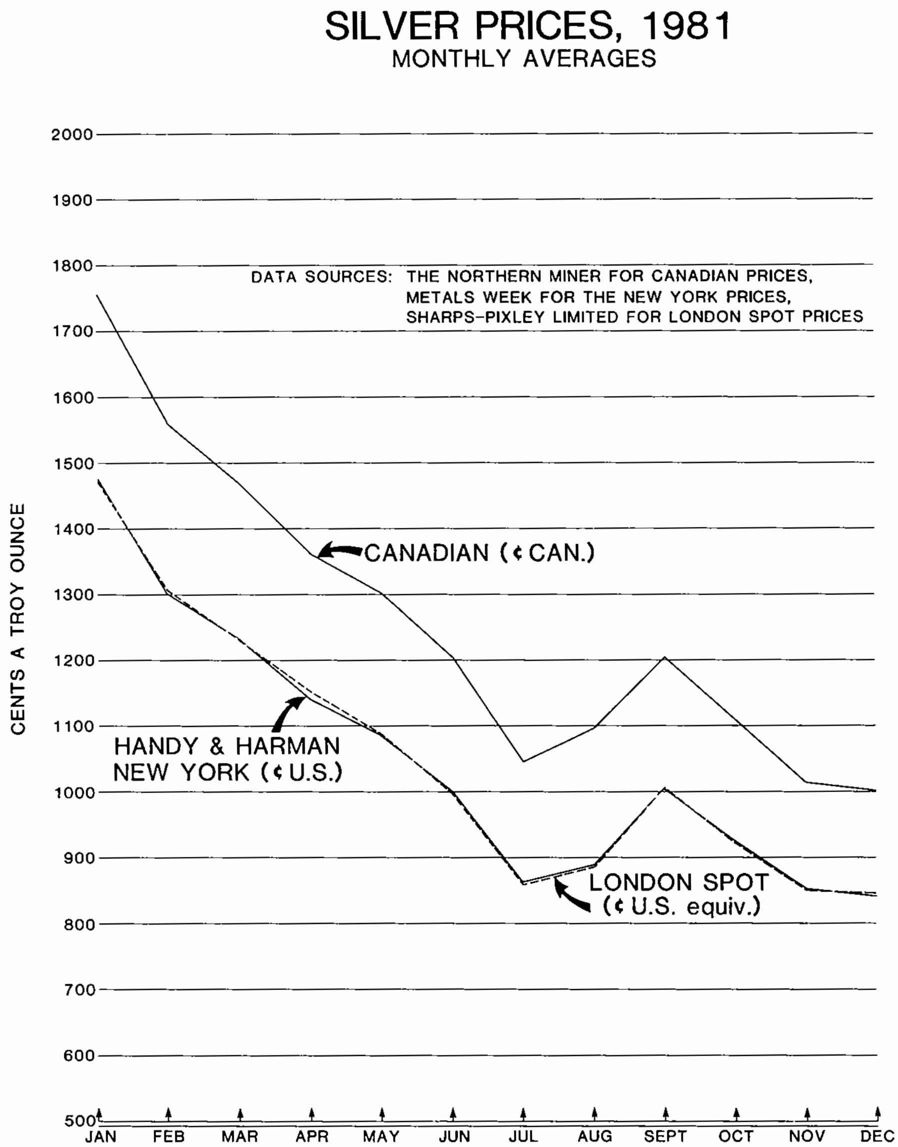
SILVER PRICES, 1981
MONTHLY AVERAGES
DATA SOURCES: THE NORTHERN MINER FOR CANADIAN PRICES, METALS WEEK FOR THE NEW YORK PRICES, SHARPS-PIXLEY LIMITED FOR LONDON SPOT PRICES
CENTS A TROY OUNCE
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
CANADIAN (¢ CAN.)
HANDY & HARMAN
NEW YORK (¢ U.S.)
LONDON SPOT
(¢ U.S. equiv.)
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEPT
OCT
NOV
DEC

Figure 3

Current developments under way or planned throughout the world should increase world production of silver by about 750 t for a total non-communist world output of about 10 000 t. World silver production after 1983 is expected to increase slightly. There are no major developments that could substantially increase output in the medium term.

Over the years there has been a shortfall between primary production and refined silver consumption which was made up from above-ground sources. In 1980 and 1981, silver was in a surplus position because of reduced consumption and an increase in refined silver production, especially from the large amount of silver scrap generated by higher prices beginning in 1980. Much of the surplus was absorbed by investors and speculators, who are expected to continue to be a significant force in the silver market. Silver from secondary sources is expected to remain near present levels or decline slightly. Future demand should be strong despite recent weakness because of the many superior characteristics of silver. Electronic technology currently being developed in the photographic industry may cut into silver usage but it is too soon to assess its impact.

Price projections are difficult to make but the extreme speculative activity in the silver market experienced in early 1980 is not expected to reoccur. Unfavourable political events, especially in the latter part of 1981, did not unduly affect precious metal prices as had been the case previously.

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	17.8	30	12.5
36200-1	Articles consisting wholly or in part of sterling or other silverware, nop; manufactures of silver, nop	15.7	19.6	45	13

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

	1981	1982	1983	1984	1985	1986	1987
			(%)				
36100-1	17.8	16.7	15.7	14.6	13.5	12.4	11.3
36200-1	19.6	18.2	16.8	15.3	13.9	12.4	11.0

UNITED STATES (MFN)

Item No.		
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

		1981	1982	1983 (%)	1984	1985	1986	1987
420.60	Silver compounds	4.7	4.5	4.4	4.2	4.0	3.9	3.7
605.46	Platinum-plated silver, unwrought or semi-manufactured	13.9	12.8	11.8	10.7	9.6	8.6	7.5
605.47	Gold-plated silver, unwrought or semi-manufactured	21.3	19.4	17.5	15.6	13.8	11.9	10.0
605.48	Other unwrought or semi-manufactured silver	9.4	8.8	8.3	7.7	7.1	6.6	6.0
605.65	Rolled silver, unworked or semi-manufactured	9.4	8.8	8.3	7.7	7.1	6.6	6.0

EUROPEAN ECONOMIC COMMUNITY (MFN)

Item No.		1980	Base Rate (%)	Concession Rate
28.49	Colloidal silver, amalgams, salts and other compounds of silver			
A.	Colloidal silver	7.3	8.0	5.3
B.	Amalgams of silver	7.3	8.0	5.3
C.	Salts and other compounds, inorganic or organic of silver	8.7	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	2.0	2.0	1.8
C.	Tubes, pipes and hollow bars	3.4	3.5	2.9
D.	Foil of a thickness, excluding any backing, not exceeding 0.15 mm	6.1	6.5	5.0
E.	Powder, purls, spangles, cuttings and other forms	4.7	5.0	3.8
71.06	Rolled silver, unworked, or semi-manufactured			
A.	Unworked	4.7	5.0	3.8
B.	Semi-manufactured	6.0	6.5	4.6

EUROPEAN ECONOMIC COMMUNITY (MFN) (cont'd)

Item No.		1980	Base Rate	Concession Rate
			(%)	
71.08	Rolled gold on silver, unworked or semi-manufactured	3.4	3.5	2.9
71.10	Rolled platinum or other platinum group metals on silver, unworked or semi-manufactured	3.4	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	4.3	4.5	3.5
B.	Of rolled silver	8.2	9.0	5.8
71.13	Articles of silversmiths wares and parts thereof, of silver, other than above			
A.	Of silver	6.4	7.5	3.0
B.	Of rolled silver	4.7	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	5.6	6.0	4.4

Sources: The Customs Tariff and Commodities Index, January 1981, Revenue Canada, Tariff Schedules of the United States Annotated 1981, USITC Publication 1111; U.S. Federal Register Vol. 44, No. 241; Official Journal of the European Communities, L315, Vol. 23.
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. Eight plants producing natural sodium sulphate operated in Canada in 1981. Byproduct sodium sulphate is recovered at one rayon plant and at three paper mills in Ontario.

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 third successive year. Shipments of natural sodium sulphate from Canadian producers increased by 15.0 per cent to 553 000 t in 1981 but were still much below the record level of 638 000 t achieved in 1974. The unit value of shipments increased from $58.33 in 1980 to $72.79 per t in 1981. On a net basis Canada exports about half of its production.

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 ($Na_2SO_4 \cdot 10H_2O$). 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. One deposit in Alberta contains 2.7 million t of Na_2SO_4. Exploitation currently takes place on the following lakes (with reserves, in millions of t, in brackets): Whitehorse Lake (6.5), Horsehoe 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 (3.0). These reserves calculations were made in 1978 and 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, 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.

TABLE 1. CANADA, SODIUM SULPHATE PRODUCTION AND TRADE, 1980 AND 1981

	1980		1981P	
	(tonnes)	($)	(tonnes)	($)
Production				
Shipments				
Saskatchewan	..	27,772,000	..	36,951,000
Alberta	..	2,696,000	..	3,303,000
Total	481 000	30,468,000	553 000	40,254,000
Imports				
Total salt cake and Glauber's salt				
United Kingdom	19 536	724,000	11 118	427,000
United States	675	123,000	1 363	329,000
Total	20 211	847,000	12 481	756,000
Exports				
Crude sodium sulphate				
United States	236 700	18,285,000	274 635	23,428,000
Egyptian Arab Republic	-	-	4 091	940,000
Other countries	9 130	1,626,000	5 557	978,000
Total	245 830	19,911,000	284 283	25,346,000

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

TABLE 2. CANADA, NATURAL SODIUM SULPHATE PLANTS, 1981

	Plant Location	Source Lake	Annual Capacity
			(tonnes)
Alberta			
Alberta Sulphate Limited	Metiskow	Horseshoe	75 000
Saskatchewan			
Francana Minerals Ltd.	Grant	Snakehole	63 000
Francana Minerals Ltd.	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[1]	Frederick	45 000
Saskatchewan Minerals	Fox Valley	Ingebrigt	135 000
Sybouts Sodium Sulphate Co., Ltd.	Gladmar	East Coteau	45 400
Total			695 600

Source: Company reports.

[1] Closed at end of June 1977 and re-opened in April 1980.

TABLE 3. CANADA, SODIUM SULPHATE PRODUCTION, TRADE AND CONSUMPTION 1970, 1975, 1976-81

	Production[1]	Imports[2]	Exports	Consumption
	(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
1981P	553 000	12 481	284 283	..

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

[1] Producers' shipments of crude sodium sulphate. [2] Includes Glauber's salt and crude salt cake.
P Preliminary; .. Not available.

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 eight 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, 1979 AND 1980

	1979	1980
	(tonnes)	
Pulp and paper	203 097	175 127
Soaps	41 218	38 814
Glass and glass wool	9 859	10 045
Other products[1]	885	8 059
Total	255 059	232 045

Source: Energy, Mines and Resources Canada.

[1] Colours, pigments, feed supplements and other minor uses.

Byproduct recovery. Courtaulds (Canada) Inc. produces approximately 21 000 t of detergent-grade sodium sulphate as a byproduct of viscose rayon production at its Cornwall, Ontario plant. Ontario Paper Company Limited at Thorold, Ontario produced 68 000 t of salt cake in 1981, (69 000 t in 1980) 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 tpy in 1981). Production capacity is double the consumption, but the extra amount cannot be commercialized because of the lack of drying facilities.

TABLE 5. CANADA, RAILWAY TRAIN LOADINGS OF SODIUM SULPHATE, 1980 AND 1981

	1980	1981P
	(tonnes)	
Eastern Canada[1]	39 979	35 207
Western Canada	453 156	499 735
Canada	493 135	534 942

Source: Statistics Canada.

[1] Eastern Canada refers to provinces east of the Ontario-Manitoba border.
P Preliminary.

PRICES

Canadian prices of sodium sulphate were \$55.00 and \$74.00 per t respectively for salt cake and detergent grade at the beginning of the year. These prices increased to \$62.00 and to \$82.00 on February 1 and to \$70.00 and \$90.00 on October 1, 1981.

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 make-up. 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.

Minor amounts of sodium sulphate are 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 28 cents) is used for a tonne of coal.

OUTLOOK

Outlook for Canadian production and sales of sodium sulphate in 1982 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. At least one Canadian company plans to increase capacity.

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.

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 but economically unwarranted. This usage is no longer considered an important new outlet for the consumption of sodium sulphate.

U.S. commodity experts, however, still forecast no 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	14.4	25.0	9.5

MFN reductions under GATT (effective January 1 of year given)

	1981	1982	1983	1984	1985	1986	1987
21000-1	14.4	14.1	13.8	13.4	13.1	12.8	12.5

UNITED STATES Custom Tariffs (MFN)

Item No.		1981	1982	1983	1984	1985	1986	1987
421.42	Crude sodium sulphate	Remains free						
421.44	Anhydrous (per long ton)	38¢	37¢	36¢	36¢	35¢	34¢	33¢
421.46	Crystallized	3%	2.9%	2.8%	2.7%	2.7%	2.6%	2.5%

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

Stone

D.H. STONEHOUSE

SUMMARY

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. Broken, irregular, screened and sized pieces constitute the crushed stone category. Material in this category 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 principle 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 contributed to the erosion of this industry and have made market penetration by concrete products possible.

CANADIAN SCENE

Production of stone of all types in Canada in 1981 decreased about 8 per cent to 94 million tonnes (t), while the unit value of production increased by over 10 per cent. Stone is produced in direct response to the demands of the construction industry, which utilizes 95 per cent of output principally as crushed stone. Less than one 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. There are, however, periodic surges of interest in Canadian stone for building uses, particularly Canadian black granites. 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 2 per cent is consumed in pulverized form as filler and extender materials.

Crushed stone statistics are included in the review on Aggregates along with data in 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 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.

TABLE 1. CANADA, TOTAL SHIPMENTS OF BUILDING AND CHEMICAL PROCESS STONE, 1979-81

	1979		1980		1981e	
	(tonnes)	($)	(tonnes)	($)	(tonnes)	($)
By province						
Quebec	880	10,721	768	11,623	698	12,034
Ontario	2 278	11,491	1 775	9,695	1 613	10,035
British Columbia	1 838	5,645	2 018	7,074	1 834	7,323
New Brunswick	258	2,251	232	2,532	211	2,621
Nova Scotia	245	2,136	205	1,864	187	1,929
Manitoba	111	1,146	37	251	34	260
Alberta	105	679	170	904	154	935
Canada	5 715	34,069	5 205	33,943	4 731	35,137
By use						
Building stone						
Rough	256	3,094	268	3,873	..	..
Monumental and ornamental stone	30	2,410	18	1,899	..	..
Other (flagstone, curbstone, paving blocks, etc.)	35	1,703	40	1,585	..	..
Chemical and metallurgical						
Cement plants, foreign	1 256	2,136	1 293	2,147	..	..
Lining, open-hearth furnaces	31	85	32	110	..	..
Flux in iron and steel furnaces	1 133	3,801	1 068	3,377	..	..
Flux in nonferrous smelters	266	1,920	157	1,277	..	..
Glass factories	230	2,098	237	2,661	..	..
Lime kilns, foreign	168	435	306	1,102	..	..
Pulp and paper mills	291	2,072	330	2,942	..	..
Sugar refineries	83	412	101	394	..	..
Other chemical uses	341	2,670	110	1,112	..	..
Pulverized stone						
Whiting (substitute)	28	1,197	32	1,513	..	..
Asphalt filler	34	291	53	403	..	..
Dusting, coal mines	6	100	6	159	..	..
Agricultural purposes and fertilizer plants	994	7,402	1 106	8,677	..	..
Other uses	533	2,243	48	712	..	..
Total	5 715	34,069	5 205	33,943	..	..

Source: Energy, Mines and Resources Canada.
e Estimated; .. Not available.

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. Large proven reserves in the Glencoe region of Inverness County have been assessed with the object of establishing a portland cement facility on site or at the Strait of Canso to supply an offshore market. A buoyant and continuing market for cement and clinker would be necessary to support such an undertaking.

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]. 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. Granite for use as a crushed stone is produced near Fredericton and near Moncton.

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 Stukely and Philipsburg areas.

Granite. Normally about 60 per cent of Canada's granite production comes from Quebec from long-established operations in two general regions - one north of the St. Lawrence and Ottawa Rivers, including the Lac Saint-Jean area, and one south of the St. Lawrence River. Precambrian rocks contain granites of various colours, compositions and textures. During 1981 a new building stone operation was being developed in the Lac St. Jean region to supply granite slabs in a wide range of colours for building exteriors in both the domestic and export market.

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[8].

TABLE 2. CANADA, SHIPMENTS OF LIMESTONE AS BUILDING AND CHEMICAL PROCESS STONE, 1979 and 1980

	1979		1980	
	(000 t)	($000)	(000 t)	($000)
By province				
Nova Scotia	245	2,119	205	1,864
New Brunswick	257	2,209	231	2,532
Quebec	727	5,532	617	5,586
Ontario	2 271	11,139	1 770	9,362
Manitoba	99	491	37	114
Alberta	105	668	169	861
British Columbia	1 838	5,635	2 018	7,064
Canada	5 542	27,793	5 047	27,383
By use				
Building stone				
Rough	220	1,309	225	1,161
Monumental and ornamental	--	50	1	77
Other (flagstone, curbstone, paving blocks, etc.)	8	245	6	253
Chemical and metallurgical				
Cement plants, foreign	1 256	2,136	1 293	2,147
Lining, open-hearth furnaces	31	85	32	90
Flux, iron and steel furnaces	1 133	3,801	1 068	3,377
Flux, nonferrous smelters	266	1,918	157	1,274
Glass factories	230	2,098	237	2,661
Lime kilns, foreign	168	435	306	1,102
Pulp and paper mills	282	1,974	321	2,840
Sugar refineries	83	412	101	394
Other chemical uses	341	2,670	110	1,112
Pulverized stone				
Whiting substitute	28	1,197	32	1,514
Asphalt filler	34	291	53	403
Dusting, coal mines	6	101	6	159
Agricultural purposes and fertilizer plants	926	6,886	1 053	8,188
Other uses	530	2,185	46	631
Total	5 542	27,793	5 047	27,383

Source: Energy, Mines and Resources Canada.
-- Amount too small to be expressed.

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.

TABLE 3. CANADA, SHIPMENTS OF MARBLE AS BUILDING AND CHEMICAL PROCESS STONE, 1979 and 1980

	1979		1980	
	(000 t)	($000)	(000 t)	($000)
By province				
Quebec	79	673	65	676
Canada	79	673	65	676
By use				
Chemical process stone				
Flux in nonferrous smelters	--	2	--	3
Pulp and paper mills	9	98	9	103
Pulverized stone				
Agricultural purposes and fertilizer plants	68	515	53	489
Other uses	2	58	3	81
Total	79	673	65	676

Source: Energy, Mines and Resources Canada.
-- Amount too small to be expressed.

TABLE 4. CANADA, SHIPMENTS OF GRANITE AS BUILDING STONE, 1979 and 1980

	1979		1980	
	(000 t)	($000)	(000 t)	($000)
By province				
Nova Scotia	--	17	-	-
New Brunswick	1	42	-	-
Quebec	50	3,746	64	4,537
Ontario	1	98	1	108
Manitoba	12	655	1	137
British Columbia	..	10	..	10
Canada	64	4,568	66	4,792
By use				
Building stone				
Rough	16	1,061	25	2,005
Monumental and ornamental	30	2,356	17	1,822
Other (flagstone, curbstone, paving blocks, etc.)	18	1,151	24	965
Total	64	4,568	66	4,792

Source: Energy, Mines and Resources Canada.
-- Amount too small to be expressed; - Nil; .. Not available.

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].

At the beginning of 1981, the operations of William R. Barnes Co. Limited at Tatlock and Perth, producing high grade calcium carbonate products, were purchased by Steep Rock Iron Mines Limited. Steep Rock continued to supply quality filler material through 1981 and is planning an expansion program for 1982-83.

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]. 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.

Sandstone. Sandstone quarried near Toronto, Ottawa and Kingston has been used widely in Ontario as building stone[13]. 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.

The Ontario Ministry of Natural Resources has identified six major sites in eastern Ontario in which high-grade silica deposits occur. The Ministry study was undertaken to stimulate exploration that could develop silica resources to serve the Canadian consuming industries, which now use about 1.5 million tpy of silica.

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[2,14].

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 centres for use in the metallurgical, chemical, agricultural and construction industries. Limestone from Steep Rock and from Lily Bay is used by cement manufacturers in Winnipeg, and limestone from Faulkner is now being used by the lime plant at Spearhill. Marl from a deposit 100 km north of Edmonton has been used as raw material in cement manufacture.

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[15]. 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]. A large amount is exported to the northwestern United States for cement and lime manufacture. Four companies mined limestone on Texada Island, with the entire output being moved by barge to Vancouver and the State of Washington. 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

TABLE 5. CANADA, SHIPMENTS OF SANDSTONE AS BUILDING STONE, 1979 and 1980

	1979		1980	
	(000 t)	($000)	(000 t)	($000)
By province				
Quebec	24	770	22	825
Ontario	6	254	4	224
Alberta	--	11	1	43
Canada	30	1,035	27	1,092
By use				
Building stone				
Rough	21	724	18	707
Monumental and ornamental	--	4	-	-
Other (flagstone, curbstone, paving blocks, etc.)	9	307	9	385
Total	30	1,035	27	1,092

Source: Energy, Mines and Reso .rces Canada.
-- Amount too small to be expressed; - Nil.

stone for construction and for filler use[16]. 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.

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 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,

TABLE 6. CANADA, SHIPMENTS OF BUILDING AND CHEMICAL PROCESS STONE BY TYPES, 1975, 1979-81

	1975		1979		1980		1981e	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
Granite	42	1,875	64	4,568	66	4,792	60	4,961
Limestone	4 457	16,429	5 542	27,793	5 047	27,383	4 587	28,346
Marble	114	647	79	673	65	676	59	700
Sandstone	38	952	30	1,035	27	1,092	25	1,130
Total	4 651	19,903	5 715	34,069	5 205	33,943	4 731	35,137

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

TABLE 7. CANADA, STONE EXPORTS AND IMPORTS, 1979-81

	1979		1980		1981P	
	(tonnes)	($)	(tonnes)	($)	(tonnes)	($)
Exports						
Building stone, rough	6 377	769,000	5 019	723,000	11 182	1,222,000
Stone crude, nes	296 121	1,817,000	67 051	1,250,000	116 782	1,693,000
Natural stone, basic products	..	6,909,000	..	7,928,000	..	10,359,000
Total		9,495,000		9,901,000		13,274,000
Imports						
Building stone, rough	10 803	1,032,000	9 329	985,000	11 086	1,012,000
Stone crude, nes	6 802	545,000	20 163	1,054,000	7 233	952,000
Granite, rough	22 662	2,306,000	21 890	1,946,000	34 278	4,802,000
Marble, rough	8 694	1,622,000	6 656	2,290,000	7 485	3,053,000
Shaped or dressed granite	..	1,549,000	..	2,509,000	..	3,880,000
Shaped or dressed marble	..	1,602,000	..	1,858,000	..	2,119,000
Natural stone basic products	..	1,788,000	..	2,980,000	..	3,590,000
Total		10,444,000		13,622,000		19,408,000

Source: Statistics Canada.
P Preliminary; nes Not elsewhere specified; .. Not available.

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.

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.

Limestone from deposits in coastal areas of British Columbia is mined, crushed, loaded on barges of up to 20 000 t capacity, and transported as much as 600 km to consuming centres along the west coast in both Canada and the United States.

TABLE 8. CANADA, VALUE OF CONSTRUCTION[1] BY PROVINCE, 1980-82

	1980			1981			1982		
	Building Construction	Engineering Construction	Total	Building Construction	Engineering Construction	Total	Building Construction	Engineering Construction	Total
					($000)				
Newfoundland	443,916	406,244	850,160	443,529	507,551	951,080	423,573	690,893	1,114,466
Nova Scotia	631,654	551,663	1,183,317	760,986	739,683	1,500,669	756,979	1,143,079	1,900,058
New Brunswick	539,095	418,957	958,052	557,600	450,986	1,008,586	643,761	524,621	1,168,382
Prince Edward Island	98,322	77,677	175,999	84,931	66,585	151,516	100,200	67,522	167,722
Quebec	4,949,915	4,402,459	9,352,374	5,812,142	4,865,982	10,678,124	5,961,929	5,144,329	11,106,258
Ontario	8,347,796	4,089,665	12,437,461	9,329,979	5,237,744	14,567,723	9,688,874	6,398,642	16,087,516
Manitoba	882,855	514,989	1,397,844	883,939	697,113	1,581,052	876,595	733,599	1,610,194
Saskatchewan	1,237,980	1,040,434	2,278,414	1,226,220	1,530,801	2,757,021	1,258,552	1,671,868	2,930,420
Alberta	5,033,629	6,659,848	11,693,477	6,252,396	7,566,664	13,819,060	7,074,819	9,577,830	16,652,649
British Columbia, Yukon and Northwest Territories	4,374,953	3,624,755	7,999,708	5,919,000	4,023,461	9,942,461	5,854,103	4,965,945	10,820,048
Canada	26,540,115	21,786,691	48,326,806	31,270,722	25,686,570	56,957,292	32,639,385	30,918,328	63,557,713

Source: Statistics Canada.

[1] Actual expenditures 1980, preliminary actual 1981, intentions 1982.

Comparatively small amounts of granite and sandstone are used as building and monument stone. Engineering construction projects, utilizing all sizes from riprap to sand, are the principal consumer. High-silica sands can be the source of silica for glass and ceramics manufacture and for moulding sands. Canada currently imports nearly 80 per cent of its silica for these uses.

OUTLOOK

Crushed stone will continue to compete with sand and gravel for major markets where the latter are scarce. Through vertical integration, large operations based on construction materials can, by mergers and acquisitions, obtain captive markets for their products in operating construction firms. Construction firms can also integrate backwards into the resource field.

The possibility of substitutes for aggregates is not likely to occur soon in Canada, although in countries where such resources are scarce other materials such as compressed garbage are being used. The use of lime or cement to stabilize soils could reduce the amount of aggregate fill required on some highway or railway projects.

Traditional markets for building stone have been lost to competitive building materials such as steel and concrete. Modern design and construction methods favour the flexibility offered by use of steel and precast or cast-in-place concrete. For aesthetic qualities not available in other materials, rough or polished stone is used in many modern structures. Monument stone continues to be in demand.

The present structure of the building stone industry in Canada is unlikely to change in the near future. 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.

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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	4.8	35	free
30520-1	Granite, sawn	free	7.0	35	free
30525-1	Paving blocks of stone	free	7.0	35	free
30530-1	Flagstone and building stone other than marble or granite, sawn on not more than two sides	free	7.0	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	7.0	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	11.4	15	7.5

CANADA (cont'd)

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
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	16.4	15.4	40	10.0
30705-1	Manufacturers of marble, nop	16.4	15.4	40	10.0
30710-1	Granite, nop	16.6	15.7	40	10.0
30715-1	Manufacturers of granite, nop	16.6	15.7	40	10.0
30800-1	Manufacturers of stone, nop	16.9	16.3	35	10.5
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

Item No.	1981	1982	1983	1984	1985	1986	1987
				%			
MFN Reductions under GATT (effective January 1 of year given)							
30515-1	4.8	4.6	4.5	4.4	4.3	4.1	4.0
30520-1	7.0	6.8	6.5	6.3	6.0	5.8	5.5
30525-1	7.0	6.8	6.5	6.3	6.0	5.8	5.5
30530-1	7.0	6.8	6.5	6.3	6.0	5.8	5.5
30605-1	7.0	6.8	6.5	6.3	6.0	5.8	5.5
30610-1	11.4	10.8	10.3	9.7	9.1	8.6	8.0
30700-1	15.4	14.3	13.3	12.2	11.1	10.1	9.0
30705-1	15.4	14.3	13.3	12.2	11.1	10.1	9.0
30710-1	15.7	14.8	13.9	12.9	12.0	11.1	10.2
30715-1	15.7	14.8	13.9	12.9	12.0	11.1	10.2
30800-1	16.3	15.6	15.0	14.4	13.8	13.1	12.5

UNITED STATES (MFN)

Item No.		
513.61	Granite, not manufactured, and not suitable for use as monumental, paving or building stone	free
514.11	Limestone, crude, not suitable for use as monumental, paving or building stone	free
514.91	Quartzite, whether or not manufactured	free
515.41	Stone, other, not manufactured and not suitable for use as monumental, paving or building stone	free

UNITED STATES (MFN) (cont'd)

		1981	1982	1983	1984	1985	1986	1987
					(%)			
513.21	Marble chips and crushed	3.8	3.1	2.5	1.9	1.3	0.6	free
515.11	Roofing slate	11.0	10.3	9.6	8.8	8.1	7.3	6.6

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

Sulphur

B.W. BOYD

In 1981, Canada's production of sulphur in all forms ranked third in the world, behind the United States and the U.S.S.R. and ahead of Poland. In terms of exports, Canada was first and accounted for 45 per cent of world trade. Canada ranks fourth in the western world in terms of consumption of sulphur-all-forms.

Canadian sulphur is obtained from three sources: elemental sulphur, derived from sour natural gas, petroleum, and tar sands; sulphur recovered from smelter gases in the form of sulphuric acid; and sulphur contained in pyrite concentrates, used in sulphuric acid manufacture. Sulphur recovered from sour natural gas in Alberta is presently the most important source in Canada.

In 1981, 45 sour gas plants were in operation in Alberta, and 3 in British Columbia, with a combined annual capacity of 10.4 million t of sulphur. Over the year the sour gas plant in Saskatchewan did not produce sulphur, and a plant in Alberta closed. Several new plants had been opened in Alberta in 1980, which retarded the decline in sulphur production in that province.

Production of sulphur at natural gas plants in Alberta was lower in 1981 continuing the trend of declining production since 1973. Production at the oil sands plants was also slightly lower in 1981 than in 1980 so that demands on the stockpiles were greater than ever. Remelt capacity at the stockpiles increased over the year to well over 300 000 t per month and close to 2.3 million t were withdrawn in 1981 to bridge the gap between production and shipments.

On June 26, 1981 Canada Development Corporation (CDC) purchased a 74.8 per cent interest in Aquitaine Company of Canada Ltd. and by year-end had also acquired the Canadian assets of Texasgulf Inc. The oil and gas operations were combined in a new company, Canterra Energy Ltd. which is now one of the largest producers of sulphur in Canada and the proprietor of more stockpiled sulphur than any other company in the world. The sulphur will be sold by Canterra Energy Ltd. with offices in Calgary and Pittsburgh, and offshore sales will be handled by Cansulex Limited.

A depressed metals market and production cutbacks reduced sulphuric acid and liquid sulphur dioxide production at Canadian smelters by about 20 per cent compared with a year earlier.

In 1981, Texasgulf Canada Ltd. (name changed to Kidd Creek Mines Ltd. in November), completed the construction of a copper smelter at the Timmins mine and increased sulphuric acid capacity at the combined zinc, copper smelter to 410 000 tpy from 190 000 tpy.

In January, Inco Metals Company arranged to purchase the C-I-L Inc. sulphuric acid and sulphur dioxide plants at Copper Cliff, Ontario. Transfer of the properties took place in March but marketing continued to be handled by C-I-L.

Canadian Electrolytic Zinc Limited (CEZ) is having a 190 000 tpy acid plant built at Valleyfield for operation in 1982. The plant will use smelter and refinery gases from the CEZ zinc plant.

The zinc pressure leach plant scheduled for completion in 1983 at Cominco Ltd.'s Trail complex will allow elemental sulphur to be recovered from the ore instead of production of sulphur dioxide.

TABLE 1. CANADA, SULPHUR SHIPMENTS AND TRADE, 1980 AND 1981

	1980		1981P	
	(tonnes)	($)	(tonnes)	($)
Shipments				
Pyrite and pyrrhotite[1]				
Gross weight	31 846	..	11 000	..
Sulphur content	14 328	344,770	5 000	124,000
Sulphur in smelter gases[2]	894 732	28,912,895	904 000	32,032,000
Elemental sulphur[3]	7 655 723	444,095,310	8 320 000	695,900,000
Total sulphur content	8 564 783	473,352,975	9 229 000	727,056,000
Imports				
Sulphur, crude or refined				
United States	1 755	463,000	4 615	835,000
West Germany	12	11,000	-	-
Total	1 767	474,000	4 615	835,000
Sulphuric acid, including oleum				
West Germany	-	-	35 750	1,317,000
United States	18 048	931,000	28 805	1,565,000
Norway	-	-	12 695	497,000
United Kingdom	-	-	5 245	388,000
Total	18 048	931,000	82 495	3,767,000
Exports				
Sulphur in ores (pyrite)				
United States	..	386,000	..	109,000
Total	..	386,000	..	109,000
Sulphuric acid, including oleum				
United States	323 763	7,523,000	336 369	7,072,000
Peru	-	-	1 143	85,000
Other countries	12	26,000	12	31,000
Total	323 775	7,549,000	337 524	7,191,000
Sulphur, crude or refined, nes				
United States	1 434 600	53,008,000	1 513 067	100,588,000
Brazil	654 122	58,865,000	632 171	81,160,000
Australia	667 453	53,199,000	591 397	70,191,000
Morocco	260 874	27,759,000	518 658	65,988,000
India	188 601	17,593,000	497 039	62,854,000
South Africa	709 983	67,190,000	486 595	59,692,000
Tunisia	409 595	42,330,000	403 267	50,752,000
Taiwan	290 864	33,001,000	279 600	37,747,000
Italy	251 847	21,127,000	276 223	34,526,000
South Korea	251 355	26,534,000	236 428	29,082,000
New Zealand	233 650	17,713,000	230 938	26,694,000
People's Republic of China	343 197	30,750,000	221 163	28,087,000
Other countries	1 154 002	93,973,000	1 422 631	162,082,000
Total	6 850 143	543,042,000	7 309 177	809,449,000

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, 1981

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
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	Pine River, B.C.		1 055
Westcoast Transmission	Taylor Flats, B.C.	3	460
Western Decalta Petroleum	Turner Valley	4	24
Total daily rated capacity December 31, 1981			28 410

Sources: From Alberta Energy Resources Conservation Board publications.

TABLE 3. CANADIAN REFINERY SULPHUR CAPACITIES, 1981

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 Limited	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	Shellburn, B.C.	15
	Oakville, Ontario	50
	Sarnia, Ontario	31
Suncor Inc.	Sarnia, Ontario	10
Texaco	Nanticoke, Ontario	8
Total 1981		986

Sources: Oilweek, Chemical Economics Handbook.

( ) Not operational in 1980.

WORLD SCENE

In the first half of 1981, in spite of slack demand by phosphate fertilizer producers in western Europe and South Africa and the oncoming recession, world sulphur demand was maintained at 1980 levels, as consumer stockpiles were replenished. In addition, unusually large demands were made by the U.S.S.R. on Polish production, and the growing fertilizer industries in Morocco and Tunisia increased their consumption. Supply throughout the year was constrained by the war in Iran and Iraq and political problems in Poland. At mid-year, however, the slackening demand in Europe and South Africa brought the market into balance; stockpiling resumed at some of the United States Frasch mines in June and the volume of trading on the spot market was low. The rather precarious balance produced by slack demand and supply constraints continued for the second half of 1981 so that prices remained relatively stable over the whole year.

Citing pressure on prices from imports of Canadian sulphuric acid into the United States, Allied Corporation sold three acid plants with a combined capacity of 450 000 tpy. Two of the plants, at Buffalo and Chicago, were purchased by Pressure Vessels Inc.

As part of the arrangements which saw Canada Development Corporation purchase the Canadian properties of Aquitaine Company of Canada Ltd. (subsidiary of Société Nationale Elf Aquitaine (SNEA)) and acquire Texasgulf Inc.'s Canadian properties, SNEA of France took over control of Texasgulf Inc. in the United States. SNEA now has the Texasgulf Frasch mines in addition to the gas fields near Lacq, in France, as sources of sulphur.

In Europe, the glut in the fertilizer market caused CdF Chimie of France to close the fertilizer plant at Toulouse and cut capacity at Grand Couronne by half. In the United Kingdom, seven sulphuric acid plants were closed.

The Machow mine, Poland's last major open pit sulphur mine, was closed in 1981 due to depletion of reserves. The several Frasch mines in the same area, however, will make up for the lost capacity.

In May, Mexico's Coachapa Frasch mine went into production, raising the country's total output for the year above 1980 levels.

PRICES

In the first half of 1981 the negotiated prices for elemental sulphur shipped offshore ranged from \$125 to \$137 per t fob Vancouver while the value of the shipments based on new and old contracts averaged \$121 per t. In the second half of the year some prices went as high as \$143 per t and the average value of offshore shipments was \$125 per t. The average value for the offshore shipments fob Alberta was about \$93 per t.

Shipments of elemental sulphur to destinations in North America, averaged \$62 per t fob Alberta for the year but exhibited a steady increase from \$50 per t to over \$70 per t during the 12 months from January to December.

TABLE 4. CANADA, PRINCIPAL SULPHUR DIOXIDE AND SULPHURIC ACID PRODUCTION CAPACITIES, 1981

Operating Company	Plant Location	Raw Material	Annual Capacity: Sulphuric Acid[1]	Annual Capacity: 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	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 Nickel Mines 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
Texasgulf Inc.	Kidd Creek, Ont.	SO_2 zinc conc.	410	134
Subtotal Eastern Canada			2 825	969
Border Chemical Company	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.	515	168
Gulf Canada Limited	Rabbit Lake, Sask.	Elem. S.	45	15
Inland Chemicals Ltd.	Fort Saskatchewan, Alta.	Elem. S.	125	41
	Prince George, B.C.	Elem. S.	35	11
Sherritt Gordon Mines Limited	Fort Saskatchewan, Alta.	Elem. S.	180	59
Western Co-operative Fertilizers Limited	Calgary, Alta.	Elem. S.	180	59
	Medicine Hat, Alta.	Elem. S.	190	62
Subtotal Western Canada			2 150	743
TOTAL			4 975	1 712

Source: Energy, Mines and Resources Canada.
[1] 100% H_2SO_4.

The average value for sulphuric acid exported to the United States in 1981 was $21 per t.

TRADE AND TRANSPORTATION

Canada is the world's largest exporter of sulphur, accounting for over 45 per cent of world trade. Most offshore shipments are through the port of Vancouver, although the new sulphur facility at Prince Rupert, British Columbia, is becoming more important each year.

In 1981 Canada's elemental sulphur exports were a record 7.3 million t at a value in excess of $800 million, 84 per cent higher than a year earlier. Exports to the United States increased by 3 per cent and offshore exports by 10 per cent. In spite of the recession and surplus phosphate fertilizer capacity in western Europe, Canada was able to increase sales there. There is evidence that Canadian sulphur was substituted for shortfalls in deliveries from Poland which in turn were partially the result of a large increase in sales from Poland to the U.S.S.R. In fact, demand in the U.S.S.R. was so great that Canadian sales there rose from zero in 1980 to 160 000 t in 1981. Israel also purchased over 100 000 t in 1981 while there had been no shipments in 1980. Shipments to Australia, Brazil and most other major markets rose by about 10 per cent but the major boost was a doubling from 260 000 to over 500 000 t in shipments to Morocco.

On the other hand, lower demand for fertilizer exports reduced South African requirements for Canadian sulphur from 710 000 t to less than 600 000 t.

TRANSPORTATION

Rail shipments from Alberta gas plants to Vancouver for 25 sulphur producers are co-ordinated by Sultran Ltd. In 1980, Sultran purchased 680 rail cars for delivery in 1981 and this additional rolling stock allowed offshore exports to reach a record 5.7 million t. In March, Cominco Ltd. agreed to sell its 78.3 per cent interest in Pacific Coast Terminals Co. Ltd. to Sultran Ltd. This will give Sultran control of the Port Moody facilities near Vancouver. If the terminal were dedicated exclusively to sulphur it could handle nearly all of Canada's offshore exports.

In May, fire damage to a bridge near San Gudo, Alberta severed the rail link from Vancouver to the Windfall and Kaybob fields for nearly two months. However, the effect on total Canadian exports of sulphur was negligible.

Sulphuric acid exports to the United States increased by about 10 per cent but, to meet the demand, acid imports into Canada increased 4-fold, mainly from Europe.

TABLE 5. CANADA, SULPHUR SHIPMENTS AND TRADE, 1966, 1971, 1976–81

	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	2 453 021	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
1976	15 377	705 327	4 029 427	4 750 131	15 717	152,000	3 719 992
1977	12 060	736 009	5 207 028	5 955 097	14 065	212,000	4 291 032
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
1981P	5 000	904 000	8 320 000	9 229 000	4 615	109,000	7 309 177

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, 1981P

Country or Area	Exports	Per cent of Total
	(million tonnes)	
United States	1.51	20.7
Europe	.97	13.3
Brazil	.63	8.6
Australia	.59	8.1
India	.50	6.8
South Africa	.49	6.7
Tunisia	.40	5.5
Taiwan	.28	3.8
South Korea	.24	3.3
New Zealand	.23	3.2
Others	1.46	20.0
Total	7.31	100.0

Source: Statistics Canada.
P Preliminary.

GOVERNMENT INITIATIVES

Changes in the United States policy on acid rain have postponed the production of large quantities of byproduct sulphuric acid at thermal power plants but encouraged continued operation of sulphur-burning acid plants in the prime market area for byproduct Canadian acid.

The United States Department of Commerce published in the September 15th Federal Register preliminary findings on dumping of sulphur in the United States. The findings, based on shipments up to November 30, 1980, identified about 25 companies which sold Canadian sulphur in the United States at less than fair value. Dumping duties were assessed, based on the margins calculated by the Department.

USES

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.

OUTLOOK

In 1981, the price of sulphur on the world market rose with inflation but, in real terms, had already peaked the previous year. At this price level the Frasch producers are able to gain a "fair" return and the Alberta sour gas producers are encouraged to melt their stockpiles to meet demand. The cushion provided by the 16 million t in Canadian stocks and over 3 million t in the United States will likely inhibit wild swings in price over the short- or medium-term.

In the long-term, possible areas for additions to supply are recovery of sulphur from gas in the Overthrust Belt in the western United States and the Middle East. The more optimistic projections of supply from the Overthrust Belt are predicated on the discovery of other large reservoirs of

TABLE 7. CANADA, SULPHURIC ACID PRODUCTION, TRADE AND APPARENT CONSUMPTION, 1966, 1971, 1976-81P

	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
1976	2 842 431	39 537	349 826	2 532 142
1977	3 140 340	6 634	293 994	2 852 980
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
1981P	4 116 860	82 495	337 524	3 861 831

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

TABLE 8. CANADA, AVAILABLE DATA ON CONSUMPTION OF SULPHURIC ACID BY INDUSTRY, 1979 AND 1980

	1979	1980P
	(tonnes - 100% acid)	
Industrial chemicals[e]	2 363 000	2 463 000
Pulp and paper mills	275 249	271 383
Smelting and refining	246 100	240 400
Uranium ore processing	210 618	225 810
Miscellaneous chemical industries	44 845	78 685
Mining[e]	49 300	50 400
Manufacturers of plastics and synthetic resins	17 144	15 035
Manufacturers of soaps and cleaning compounds	23 583	14 587
Wire and wire products manufacturers	10 971	10 747
Petroleum refineries	21 998	10 608
Iron and steel mills	8 440	5 949
Manufacturers of miscellaneous electrical products	6 062	3 747
Metal stamping, pressing and coating industry	3 039	2 833
Motor vehicle parts and accessories manufacturers[e]	2 800	1 900
Manufactures of mixed fertilizers	1 198	1 200
Miscellaneous industries	19 663	30 948
Total	3 304 010	3 427 232

Source: Statistics Canada.

[1] Miscellaneous industries include synthetic textiles, other petroleum and coal, mineral wool, starch and glucose, vegetable oils, sugar refining, municipal water works and metal fabricating.
[e] Estimated; P Preliminary.

gas, and production of the gas in spite of the expected high cost for the recovery of gas from such formations. In the Middle East, strife in Iran and Iraq has already delayed new projects and curtailed shipments from existing sources.

In the long-term, demand for sulphur and sulphuric acid is expected to keep pace with growth in the world economy. The tenuous basis for additions to supply

TABLE 9. WORLD PRODUCTION OF SULPHUR IN ALL FORMS, 1980

	Elemental	Other[1]	Total
	(000 tonnes)		
United States	10 368	2 270	12 638
U.S.S.R.	4 000	5 900	9 900
Canada	7 656	908	8 564
Poland	4 985	200	5 185
Japan	1 151	1 669	2 820
Mexico	2 140	110	2 250
France	2 060	155	2 215
West Germany	1 055	770	1 825
Spain	15	1 208	1 223
Italy	69	452	521
Iraq	491	-	491
Finland	35	366	401
Sweden	20	285	305
Iran	226	-	226
Other countries	2 079	4 172	6 151
Total	36 350	18 365	54 715

Source: British Sulphur Corporation Limited, Statistical Supplement, January/February 1981.

[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.

indicate a very real likelihood for a world shortage of "cheap" sulphur when the large stockpiles in Canada and the United States are depleted. Under these conditions higher cost sources of sulphuric acid such as pyrite and gypsum, will be developed at a much faster rate in many regions of the world. These sources would offer security of supply for sulphur-deficient countries independent of outside political factors and price fluctuations. Exporters of pyrite and sulphuric acid such as Spain and Norway are already expanding production and will likely take a growing share of world trade.

For Canada, the prospect is for a continuation of high returns on the sale of elemental sulphur from natural sour gas, tar sands and oil refining. The tight supply of elemental sulphur will also contribute to growth in the markets for byproduct sulphuric acid. As a major producer of byproduct sulphuric acid, Canada may benefit in those as well.

PRICES

Canadian sulphur prices quoted in **Alberta Energy Resources Industries** monthly statistics December, 1981	
	($)
Sulphur elemental, fob plant, tonne	
North American deliveries	63.22
Offshore deliveries	82.02
Canadian sulphuric acid price quoted in **Corpus Chemical Report** February 8, 1982	
Sulphuric acid, fob plants, East, 66° Be, tanks, per tonne	93.20
United States prices in U.S. currency, quoted in **Engineering and Mining Journal**, December 1981	
	($)
Sulphur elemental	
U.S. producers, term contracts fob vessel at Gulf ports, Louisiana and Texas, per long ton	
Bright	140-147.50
Dark	140-147.50
Export prices, ex terminal Holland, per long ton	
Bright	140.00
Dark	140.00
Mexican export, fob vessel, per long ton[1]	
Bright	118.00
Dark	117.00

fob Free on board.
[1] "Engineering and Mining Journal", June, 1981.

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	10	11.3	25	7.5
92813-4	Sulphur trioxide	free	free	free	free

TARIFFS (cont'd)

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

	1981	1982	1983	1984	1985	1986	1987
				(%)			
92808-1	11.3	9.4	7.5	5.6	3.8	1.9	free

UNITED STATES

Item No.								
418.90	Pyrites				free			
415.45	Sulphur, elemental				free			
416.35	Sulphuric acid				free			
		1981	1982	1983	1984	1985	1986	1987
					(%)			
422.94	Sulphur dioxide	5.6	5.3	5.1	4.9	4.7	4.4	4.2

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

Tin

G.E. WITTUR

International tin markets in 1981 were characterized by post World War Two record production despite the lowest consumption since the early 1960s. Prices weakened during the first half, continuing a trend that began late in 1980, but then rose strongly during the second half as a result of a determined market support campaign by unknown interests. Consequently, inventories rose to unusually high levels as excess production in 1981 was added to the more modest surpluses accumulated in 1979 and 1980.

CANADA

Canada produces relatively little tin but ranks about eighth as a consumer among non-communist countries. Production of tin in concentrates and tin-lead alloy declined slightly in 1981 (Table 1). Tin concentrates are exported for smelting as production is far too small to justify a domestic smelter.

Canadian industrial requirements of tin are met mainly by imports, which fell significantly in 1981 (Table 1). Most of this tin originates in southeast Asia but is purchased through metal merchants and transshipped through New York.

Imports are supplemented by the secondary recovery of tin-bearing solders at a few plants in Canada, and of potassium stannate at one detinning plant. Statistics on secondary tin recovery are not available but annual recoveries are only a few hundred t of tin.

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 few hundred t annually of a lead-tin alloy containing 8 per cent tin at its Trail smelter and produces small quantities of special high purity tin from purchased commercial-grade metal. Some placer gold deposits in the Yukon also contain tin and tungsten and at least one company recovers small amounts of these metals.

Tin mineralization is known in various parts of Canada, and the higher prices in recent years have encouraged increased exploration efforts. The most promising discovery so far is the Shell Canada Resources Limited East Kemptville property near Yarmouth, Nova Scotia. This deposit, discovered in 1979, contains 38 million t averaging 0.19 per cent tin. A feasibility study completed about year-end indicated that capital expenditures of more than $100 million would be required for an open-pit mining and milling operation of 6 000 tpd. Tin recovery from such lode ore tends to be quite low but an operation of this size could produce in the order of 2 500 t of tin annually in concentrates.

Other tin exploration efforts have focussed on this area of Nova Scotia, as well as on southwestern New Brunswick, southern and central Yukon and a few localities in British Columbia.

Discoveries continue to be made by Billiton Canada Ltd. and other companies in the Mount Pleasant area of New Brunswick, where the most promising mineralization occurs in breccia zones. In the Victoria Lake area, 18 km southeast of Mount Pleasant, M.E.X. Explorations Ltd. found an occurrence of tin-bearing greisen that is reported to resemble Shell's East Kemptville deposit.

Two main tin areas in western Canada attracted the attention of major companies in 1981: the Seagull Lake area on the Yukon - British Columbia border 145 km west of Watson Lake, and the Mayo area of central

TABLE 1. CANADA, TIN PRODUCTION, IMPORTS AND CONSUMPTION, 1980 AND 1981

	1980		1981P	
	(tonnes)	($)	(tonnes)	($)
Production				
Tin content of tin concentrates and lead-tin alloys	243	5,090,000	248	4,875,000
Imports				
Blocks, pigs, bars				
United States	3 153	61,848,000	2 006	35,540,000
Bolivia	617	12,165,000	917	15,853,000
Brazil	279	5,552,000	427	7,655,000
Singapore	165	3,234,000	365	6,461,000
Netherlands	175	3,425,000	50	790,000
Malaysia	35	692,000	30	502,000
Other countries	103	2,106,000	16	293,000
Total	4 527	89,022,000	3 811	67,094,000
Tinplate				
United States	1 689	1,434,000	3 573	3,480,000
United Kingdom	244	501,000	93	196,000
Netherlands	1	2,000	-	-
Total	1 934	1,937,000	3 666	3,676,000
Tin, fabricated materials, nes				
United States	437	1,205,000	670	2,338,000
United Kingdom	49	176,000	13	66,000
West Germany	2	7,000	4	13,000
Other countries	5	11,000	3	13,000
Total	493	1,399,000	690	2,430,000
Exports				
Tin in ores and concentrates				
United States	548	854,000	383	1,184,000
Mexico	156	1,423,000	67	516,000
Spain	-	-	50	451,000
United Kingdom	165	1,784,000	13	300,000
Total	869	4,061,000	513	2,451,000
Tinplate scrap				
United States	2 522	162,000	3 376	339,000
West Germany	-	-	1 003	37,000
Philippines	-	-	91	26,000
Netherlands	26	31,000	343	25,000
Other countries	952	47,000	902	21,000
Total	3 500	240,000	5 715	448,000
Consumption				
Tinplate and tinning	2 562	..	..	..
Solder	1 624	..	..	..
Babbit	187	..	..	..
Bronze	39	..	..	..
Other uses (including collapsible containers, foil, etc.)	95	..	..	..
Total	4 507	..	..	..

Sources: Energy, Mines and Resources Canada; Statistics Canada.
P Preliminary; .. Not Available; - Nil.

Yukon. In the latter, the Cortin Joint Venture of Billiton Canada Ltd., Canadian Nickel Company Limited and Inverness Petroleum Ltd. (Campbell Resources Inc.) drilled a 1 400 m zone containing narrow cassiterite-bearing veins on the EPD claims. The best intersection from the 1981 drilling averaged 1.89 per cent Sn and 19.6 g/t Ag over 1.55 m. Of the several tin occurrences investigated in the Seagull Lake area, only the mineralized skarn on the JC property of the DC syndicate (Dome Mines and Cominco) appears to be sizeable. Values from drilling averaged 0.1 to 0.3 per cent Sn.

Reported tin consumption in Canada peaked at nearly 5300 t in 1977 but, in parallel with trends in most other industrial countries, it has since declined rather significantly (Table 2). Tinplate production accounts for about half the total while the manufacture of solders (lead-tin alloys) is the second largest use (Table 1). Canada's two tinplate makers are Stelco Inc. and Dofasco Inc., both in Hamilton, Ontario. Canadian solder producers include The Canada Metal Company, Limited (50 per cent owned by Cominco Ltd.), Cramco Alloy Sales Limited, Kester Solder Company of Canada Limited, Toronto Refiners and Smelters Limited, and Metals & Alloys Company Limited.

TABLE 2. CANADA, TIN PRODUCTION, EXPORTS, IMPORTS AND CONSUMPTION, 1970, 1975-80

	Production[1]	Exports[2]	Imports[3]	Consumption[4]
	(tonnes)			
1970	120	268	5 111	4 565
1975	319	1 052	4 487	4 315
1976	274	777	4 224	4 849
1977	328	876	5 028	5 286
1978	360	943	4 809	4 922
1979	337	712	4 689	4 675
1980	243	869	4 527	4 507
1981P	248	513	3 811	..

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; .. Not available.

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. However, the International Tin Agreement (ITA) was subjected to unprecedented strains in 1981.

The Fifth ITA, which was scheduled to expire on June 30, 1981, was extended by one year to allow more time for negotiations toward a Sixth Agreement. Previous agreements had each been successfully negotiated in a single session but the Sixth ITA required four three-week sessions in Geneva, two in 1980 and two more in 1981 (in March and June respectively), and few countries were completely satisfied with the final negotiated text.

The leading issue during the negotiations was the quest by some consumer members, especially the United States, for greater reliance in stabilizing operations on buffer stock purchases and sales, and less on the use of export controls to moderate surpluses. Another issue was the formula for financing the buffer stock through member contributions and borrowings. Producing members under the Fifth ITA are required to contribute cash or tin to the buffer stock to the equivalent of 20 000 t. Consumers may voluntarily contribute up to the same amount, and borrowing can supplement members' contributions. Export controls can be considered once 5000 t of tin has been accumulated in the buffer stock. For the Sixth ITA, negotiators finally agreed on a buffer stock of up to 50 000 t - 30 000 t to be financed by mandatory cash contributions shared by producing and consuming members and 20 000 t by borrowing, with member government guarantees if necessary. Export controls may be introduced with a two-thirds majority when the buffer stock accumulates at least 35 000 t of tin, and with a simple majority at 40 000 t. Provision exists for an automatic easing of export controls according to subsequent price performance.

Provision existed under the Fourth and Fifth ITAs for voluntary buffer stock contributions from consumers, and Canada agreed to contribute up to $4.5 million as its share under the Fifth ITA, which is refundable at the end of the Agreement.

Prospective members of the Sixth ITA, scheduled to enter into force on July 1, 1982, have until April 30, 1982 to sign the Agreement and June 30 to ratify it. However, the United States announced in October that it would not join the Sixth ITA (it was a member for the first time under the Fifth ITA). At the end of 1981, while strong support was assured from tin producing countries, sufficient support of consumers to ensure entry into force did not appear certain. If consumers accounting for less than 80 per cent of consumption sign the Agreement, buffer stock limits will be scaled down. If support is less than 65 per cent required for provisional entry into force, supporters have the option of either implementing the Agreement or renegotiating it.

The second serious strain of the Fifth ITA was created by a large scale tin buying campaign that began in July. At annual Tin Council sessions in April and July consumers, in light of growing tin surpluses, had resisted producers' requests to raise the buffer stock support price range. While a 6.85 per cent increase was agreed to at the October Council session in Kuala Lumpur, the support operations continued. Principals behind the campaign, which continued past year-end, were not identified but were widely believed to be associated with some tin producing interests in Malaysia.

WORLD DEVELOPMENTS

Non-communist world production of tin in concentrates rose in 1981, while production of primary metal declined slightly (Tables 3 and 4). Reported primary tin consumption (Table 5) fell for the fourth successive year to the lowest level since 1963. Consumption declined in most industrial countries (the United Kingdom, which recovered from a lengthy steel industry strike in 1980, being one exception) but continued to rise in many developing countries. The U.S.S.R. and the People's Republic of China are also large tin consumers, estimated by the United States Bureau of Mines at 34 000 t and 22 000 t, respectively. China is an exporter of tin (about 5 000 t in 1981) but non-reporting communist countries as a whole (mainly the U.S.S.R. and the Democratic Republic of Germany) were net importers of over 19 000 t from the west in 1981. Taking this trade into account, there was a statistical surplus in world production over consumption of 21 900 t in 1981, on a metal-to-metal basis, compared with surpluses of 10 400 t in 1980 and 6 000 t in 1979.

TABLE 3. ESTIMATED WORLD[1] PRODUCTION OF TIN-IN-CONCENTRATES, 1970, 1980 AND 1981

	1970	1980r	1981P
		(tonnes)	
Malaysia	73 794	61 404	59 855
Indonesia	19 092	32 527	35 914
Thailand	21 779	33 685	32 185
Bolivia	30 100	27 271	27 697
Australia	8 828	11 588	12 100
Brazil	3 610	6 756	7 140
United Kingdom	1 722	3 027	3 857
Zaire	6 458	3 159	3 200
Nigeria	7 959	2 527	2 469
South Africa	1 986	2 434	2 362
Total, including countries not listed	184 900	200 300	202 800

Source: International Tin Council.

[1] Excludes countries with centrally planned economies, except Czechoslovakia, Poland and Hungary. The People's Republic of China and U.S.S.R. are large tin producers.
P Preliminary; r Revised.

The ITA buffer stock manager operated in the tin market during the second quarter of 1981 for the first time since early 1977 when his stocks had been sold out. Net purchases were 3865 t during the second quarter while net sales were 100 t during the third quarter and 1300 t during the fourth quarter, when 1500 t were transferred as a contribuiton from the United States. Without the latter, net sales would have been higher accordingly.

The United States General Services Administration (GSA) continued offerings of tin from the strategic stockpile, and sales in 1981 totalled 5 920 t. Sales were limited to metal for domestic consumption until December 14, when sales for export were authorized. The United States also transferred ownership of 1 500 t of tin, out of the 5 000 t authorized, to the ITA buffer stock. The goal for the U.S. strategic stockpile stood at 42 674 t in 1981, whereas the stockpile actually contained about

TABLE 4. ESTIMATED WORLD[1] PRODUCTION OF PRIMARY TIN METAL, 1970, 1980 AND 1981

	1970	1980r	1981p
	(tonnes)		
Malaysia	91 945	71 318	69 401
Thailand	22 040	34 689	33 072
Indonesia	5 190	30 465	32 244
Bolivia	300	17 533	19 937
Brazil	3 100	8 792	7 601
United Kingdom	22 035	5 829	7 220
Australia	5 211	4 819	4 211
Singapore	..	4 000	4 000
United States	4 540	3 000	3 600
Spain	3 908	3 121	3 433
Nigeria	8 069	2 684	2 644
Netherlands	5 937	1 148	2 500
South Africa	1 491	2 207	2 309
Belgium	4 257	2 822	65
Total, including countries not listed	183 600	197 600	197 300

Source: International Tin Council.

[1] Excludes countries with centrally-planned economies, except Czechoslovakia, Poland and Hungary.
p Preliminary; r Revised; .. not available.

TABLE 5. ESTIMATED WORLD[1] CONSUMPTION OF PRIMARY[2] TIN, 1970, 1980 AND 1981

	1970	1980r	1981p
	(tonnes)		
EEC, total[3]	58 246	44 484	42 996
West Germany	14 062	14 272	13 693
France	10 500	10 052	8 837
United Kingdom	16 951	6 445	7 838
Italy	7 200	5 800	6 000
Netherlands	5 467	5 188	4 400
Belgium/ Luxembourg	3 000	2 601	2 110
United States	53 807	44 342	38 450
Japan	24 710	30 879	30 269
Brazil	2 139	5 012	4 888
Canada	4 640	4 766	4 655
Spain	3 040	4 250	4 400
Australia	3 837	2 845	3 400
Czechoslovakia	3 420	4 900	3 200
Romania	..	3 000	3 200
India	4 800	2 282	2 850
Total, including countries not listed	184 800	175 600	165 900

Source: International Tin Council.

[1] Excludes countries with centrally-planned economies, except Bulgaria, Czechoslovakia, Hungary, Poland, Romania and Yugoslavia. [2] May include some secondary tin in some countries. [3] Includes all 1981 members in all years, except Greece.
p Preliminary; r Revised; .. Not available.

196 000 t at year-end. A key objective of GSA tin sales is to raise money for purchases of commodities for which stockpiles are below target levels, but primary tin producing countries continued to express strong opposition to the tin sales program as surplus world supplies continued to rise.

Southeast Asia is the world's leading tin mining area, with Malaysia, Indonesia and Thailand ranking first to third, respectively, among world producers. Together, they accounted for 62.5 per cent of non-communist world production in 1981. Malaysia's production has fallen significantly during the past decade, owing to declining grades, rising costs and high taxes and royalties. Thai production also declined in 1981, allowing Indonesia to rise into second place. These trends are expected to continue in future years, as tinfields in Malaysia and Thailand become depleted while Indonesia's production potential continues to be developed. Nevertheless, important new tin mining developments are planned in Malaysia as well, and potential exists for greater production from deeper areas of the Andaman Sea off Thailand.

In Malaysia, consolidation in the tin industry continued with the merger of Malayan Tin Dredging (M) Bhd. and Malaysia Mining Corp. to form Malaysia Mining Corp. Bhd (MMC). The new company operates 38 of Malaysia's 55 tin dredges and produces some 22 000 tpy of tin in concentrate. MMC also arranged to acquire a 42 per cent interest in the the Straits tin smelter, one of the two smelters in Malaysia.

In June, three senior executives of MMC established a private trading company, Maminco Sdn Bhd, to deal in tin and other commodities, although MMC claimed to have no interest in the company. Initial capital was $M 200 million (about $C 110 million) and the firm was estimated to have purchased more than 8 000 t of tin in Malaysia in 1981. Later in 1982, MMC joined with two other state trading agencies (Petronas - petroleum and Federal Land Development Authority - palm oil) and a private trading company to form a Japanese style international trading firm, Nastra Sdn Bhd. The new agency is expected to promote trade in Malaysia's primary products.

Development of the large, deep-alluvial tin deposits at Kuala Langat continued in 1981 under a joint venture of Kumpulan Perangsang Selangor Bhd (the Selangor State investment company, 65 per cent) and MMC (35 per cent). Borings on the 40 000 acre property have indicated reserves containing over 150 000 t of tin on only one-tenth of its area. Dredge production from depths of up to 48 m is expected to begin in 1985.

In Indonesia, tin mining development is occurring mainly in the dredging sector. The hugh Bima dredge, placed into production offshore in 1979 by P.T. Riau Tin Mining, was successfully modified to overcome technical problems. Belitung I, the first dredge to be built in Indonesia, was placed into production by state-owned P.T. Tambang Timah at a site near Belitung Island. The same company is building another new dredge for the Kundar Island region.

Thailand's second tin smelter was placed into production near Bangkok by Thai Pioneer Enterprises. The privately owned $US 8 million smelter has an initial capacity of 3 000 tpy and was financed by government and foreign loans plus local investors. Although both this and the original Thai smelter (the 35 000 tpy Thailand Smelting & Refining Co. Ltd. at Phuket) are experiencing concentrate shortages, a third company, Thai Present Smelter, is said to be planning a 10 000 tpy smelter in the Phuket region.

In an effort to stem declining tin production, the Thai government reduced royalties by about 10 per cent in 1981 and stepped up efforts to prevent illegal exports of tin concentrates. A joint Thai-United Nations survey for tin offshore in the Andaman Sea has indicated promising evidence of commercial tin deposits in water depths of 45 to 60 m. The government intends to offer production concession blocks to private firms in 1982. The state-owned Mining Organization and Offshore Mining Organization are to be merged to form the Mineral Resources Development Corp. of Thailand, and some shares of the latter are to be sold to the public.

Bolivia, the world's number two tin producer until 1979, continued to experience serious problems in its tin industry in 1981. Unlike the predominantly alluvial operations in southeast Asia, most of Bolivia's production is from underground lode deposits. Declining grades, rising costs, deterioration of facilities, labour militancy and high taxes have rendered many mines unprofitable. In 1981, the military government announced a five-year plan to revitalize the mining industry. The plan is to encourage private as well as state investment and to permit private development of mineral areas previously reserved for state companies. Proposed new legislation would provide tax concessions, guarantee against nationalization, permit the export of dividends to foreign investors, allow the export of 50 per cent of mineral output rather than requiring its delivery to state-owned processing plants, and permit joint ventures between state and private firms. The government plans to allocate up to $US 657 million over five years for exploration and investment in mining and processing. The subsequent announcement of a three-year economic plan maintained state ownership of Corporacion Minera de Bolivia (Comibol), producer of over two-thirds of Bolivia's tin, but removed some of its privileges, and banned its subsidization of commodities sold to its workers. Wage increases are to be based only on increased production. Late in 1981, union rights which had been suspended in mid-1980, were restored.

The new $US 70 million low grade tin volatization plant at La Placa, near Potosi, Bolivia, was completed in 1981 by Empresa Nacional de Fundiciones (ENAF) and production tests began in November. However, serious leaks of lethal gases halted the operation, which is based on scaled-up Russian technology. Tin oxide produced at this plant is to be smelted at ENAF's new low-grade smelter completed in 1980 at Vinto.

Australia's largest tin producer, Renison Ltd., was merged with other Australian interests of its parent, Consolidated Gold Fields Australia Ltd., to form Renison Gold Fields Consolidated Pty. Full capacity operations were achieved in April from the $A 18.6 million expansion from 630 000 to 850 000 tpy of ore. A feasibility study is being undertaken for a tin fuming plant to upgrade low-grade concentrate. Renison accounted for about half of Australia's total tin production in 1981.

Aberfoyle Limited, controlled by Cominio Ltd. of Canada and Australia's second largest tin producer with about 3 000 tpy, installed flotation units at its Ardlethan and Cleveland Mines. Testing continued on a 4 tphr matte fuming pilot plant built in 1980 at Kalgoorlie, Western Australia.

Australia will end export controls on tin concentrates at the beginning of 1982, but will provide an interim three-year bounty to assist Associated Tin Smelters Pty Ltd. (ATS) in competing for concentrates. ATS plans to reduce its operations from three reverberatory furnaces to two, but it has installed a 1 tphr prototype Sirosmelt furnace to recover tin from slag. This promising process, developed by Commonwealth Scientific and Industrial Research Organization of Melbourne, allows molten tin-bearing slag from primary smelting to be treated immediately rather than being granulated and remelted.

Greenbushes Tin N.L. continued development of the the large tin-tantalum-columbium property discovered in 1980 in Western Australia. While initially a 1 million tpy mining operation was planned, the company has now decided to develop a 250 000 tpy mine. Reserves are reported to total 28.1 million t grading 0.114 per cent tin, 0.043 per cent tantalum pentoxide and 0.031 columbium pentoxide. Numerous other tin occurrences were discovered or were under exploration in 1981, and Australia could increase its tin production significantly in the next decade.

In Brazil, Brascan Limited of Canada sold 50 per cent out of its approximately 99 per cent interest in Brascan Resources Naturais (BRN) to The British Petroleum Company Limited for $50 million. BRN subsequently announced plans to spend up to $50 million on tin exploration over the next few years, mostly on exploration and development of tin in Rondonia federal territory and the northeast Amazon area of Piting Uinhas.

Tin mining in Cornwall, United Kingdom, continues to experience a modest revival. A joint venture of Hemerdon Mining & Smelting (UK) Ltd. and Amax Exploration U.K. Inc. completed pilot plant tests and a feasibility study on the Hemerdon tin-tungsten property and applied for planning permission to develop the property. Reserves are 42.3 million t grading 0.18 per cent tungsten trioxide and 0.029 per cent tin. Billiton N.V. of Holland has an option to buy Hemerdon's half interest in the property. Carnon Consolidated Tin Mines, which reopened the Wheal Jane tin mine in 1980, continued development work.

Société Minière du Rwanda expects to begin production at its new 2 000 tpy smelter early in 1982 as part of $US 12 million tin development program. In Zaïre, Les Entreprises Minières Zaïroises began a $US 50 million rehabilitation and development program to restore its tin mining operations.

In Spain, Metalurgica del Noroeste S.A. (MENSA) plans to build a 12 000 tpy smelter at its present works in Galicia to treat low-grade concentrates from domestic and foreign sources. The company is also expanding its Ayos mine in Galicia. Established smelters in Europe, on the other hand, are experiencing serious shortages of tin concentrates. The Williams Harvey & Son Ltd. Smelter at Liverpool, in liquidation since 1973, was finally closed in mid-1981. However, Metallgesellschaft AG'sV Berzelius Metallhütten-Gesellschaft mbH. smelter at Duisberg, Germany, reopened after having closed in 1980.

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 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 and Thailand.

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 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 by-products 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 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.

The Tin Review for 1978 gives a more detailed description of the many uses of tin.

PRICES AND TARIFFS

Monthly average tin prices in 1981 are listed in Table 6. Tin prices rose sharply after 1972, when the average New York composite price was $US 1.78 a pound. The monthly average New York dealers price peaked at $8.21 in March 1980, but then trended downward through 1980 and 1981, to $5.77 in

TABLE 6. MONTHLY AVERAGE TIN PRICES[1], 1981

	Canada Cdn. ¢/lb	Dealer, NY US ¢/lb	GSA US ¢/lb	London Metal Exch. US Equiv. ¢/lb	Penang (Malaysia) US Equiv. ¢/lb
January	903.76	659.71	663.25	649.59	642.78
February	867.44	633.67	634.00	618.03	617.32
March	847.25	627.73	625.00	617.99	607.12
April	825.99	617.59	616.38	605.83	595.95
May	801.66	589.36	586.25	573.82	567.79
June	804.68	576.50	579.38	570.84	568.69
July	849.70	614.35	605.63	605.47	593.44
August	932.89	672.14	657.50	656.74	651.98
September	945.56	678.95	674.00	677.07	680.95
October	954.67	690.81	681.00	685.07	701.80
November	987.41	710.94	704.25	717.95	717.03
December	950.42	709.05	711.75	723.12	709.31
Yearly Average	889.29	648.40	644.87	641.79	637.85

Sources: **Metals Week**; U.S. General Services Administation; **Northern Miner.**

[1]Most 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.

June 1981. Thereafter, prices rose steadily under the influence of a determined support operation, reaching an average of $7.11 a pound in November and $7.09 in December 1981.

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 and transport costs. 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 $M per picul (133 1/3 lb.) to $M per kg. It continued to operate six days weekly in 1981 but plans to change to five days per week in 1982.

Tin 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 5) peaked in 1973 at 214 200 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 has been slow to impact on tin supply. However, tin surpluses have emerged since 1979 and these will continue to have a depressing effect on prices for some time.

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 use in major industrial countries. Therefore, and assuming implementation of the Sixth International Tin Agreement, price trends are expected to level off unless continued production cost escalation and declining grades combine to reduce production significantly. Concerted producer actions could serve to further delay this equilibrating adjustment but are unlikely to succeed in preventing it entirely.

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	14.4	25	free
33910-1	Collapsible tubes of tin or lead coated with tin	10	15.7	30	10
34200-1	Phosphor tin	5	7	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	12.5	25	7.5
43220-1	Manufactures of tin plate	15	15.7	30	10

TARIFFS (Cont'd)

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

	1981	1982	1983	1984	1985	1986	1987
				(%)			
33507-1	14.4	14.1	13.8	13.4	13.1	12.8	12.5
33910-1	15.7	14.8	13.9	12.9	12.0	11.1	10.2
34200-1	7.0	6.8	6.5	6.3	6.0	5.8	5.5
38203-1	12.5	11.8	11.0	10.3	9.5	8.8	8.0
43220-1	15.7	14.8	13.9	12.9	12.0	11.1	10.2

UNITED STATES (MFN)

Item No.		
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

		1981	1982	1983	1984	1985	1986	1987
					(%)			
622.15	Tin plates, sheets and strips, not clad	5.1	4.7	4.2	3.8	3.3	2.9	2.4
622.17	Tin plates, sheets and strips, clad	10.2	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	2.4
622.22	Tin wire, coated or plated with metal	5.6	5.3	5.1	4.9	4.7	4.4	4.2
622.25	Tin bars, rods, angles shapes and sections	5.6	5.3	5.1	4.9	4.7	4.4	4.2
622.35	Tin powder and flakes	5.6	5.3	5.1	4.9	4.7	4.4	4.2
622.40	Tin pipes, tubes and blanks	5.1	4.7	4.2	3.8	3.3	2.9	2.4
644.15	Tin foil	14.9	13.6	12.3	10.9	9.6	8.3	7.0

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

Titanium and Titanium Dioxide

MICHEL A. BOUCHER

SUMMARY

World demand for titanium dioxide was relatively weak in 1981 as a result of high interest rates that affected both the construction and the pulp and paper industry (two major consumers of titanium dioxide). In Canada, exports remained strong, due mainly to the low value of the Canadian dollar relative to the U.S. dollar and to some European currencies.

The supply of titanium metal on world markets increased and prices softened during the second half of the year due to a general slowdown of the economy. Canadian demand for industrial applications continued strong however, and the domestic metal fabricating sector operated at capacity.

CANADA

During the year QIT-Fer et Titane Inc. (QIT) continued modernizing its Sorel, Quebec plant. The company is spending $100 million on improvements to its electric furnaces and auxiliary equipment necessary to produce Sorelslag (70-72 per cent TiO_2) and Sorelmetal, a low manganese pig iron.

Most of the Sorelslag is exported, mainly to the United States and Europe. Some 10 per cent of the slag production is sold in Canada to two producers of titanium pigments; NL Chem Canada Inc. and Tioxide Canada Inc., both of Quebec.

At year-end, Kennecott Corporation (Kennecott) of the United States acquired Gulf & Western Industries, Inc.'s one-third interest in QIT at an undisclosed price giving Kennecott 100 per cent control of QIT.

The labour contract at QIT is due to expire April 30, 1982. The company provides jobs for close to 2,000 people in Quebec.

NL Chem Canada Inc. and Tioxide Canada Inc. reported that they operated at close to capacity in 1981 although several plants owned by their respective United States and United Kingdom parent companies had to reduce production in the United States and in western Europe as a result of the economic recession.

Ti-Ltée and Toronto Coppersmithing International Limited, two titanium metal fabricators also operated at close to capacity in 1981. Both companies stated that titanium metal prices were stable and that they experienced no supply problems as had been the case from 1978-80. Ti-Ltée has expanded its operations twice during the past five years.

WORLD

Australian production of rutile in 1981 was estimated at 249 000 t compared with 294 000 t in 1980. The decrease in production was the result of temporary disruptions at the mining town of Eneabba brought about by storm damage.

Due to a poor demand for rutile during the year, the proposed joint venture between Associated Minerals Consolidated Ltd. and Consolidated Rutile Ltd. of Australia for the development of a rutile deposit on North Stradbroke Island, Australia, did not materialize.

Most producers in the United States and Japan continued to expand their titanium sponge capacity during the year. Also new titanium sponge plants are under consideration in the United States, Australia, India, Brazil, and Japan. These plants could add more than 22 000 t of capacity to the existing 104 000 t of capacity already installed in the world.

TABLE 1. CANADA, TITANIUM PRODUCTION AND TRADE, 1980 AND 1981

	1980		1981P	
	(tonnes)	($000)	(tonnes)	($000)
Production (shipments)				
Titanium dioxide, slag	..	117,060	..	120,647
Imports				
Titanium dioxide, pure				
United States	3 817	5,651	3 797	6,913
France	809	960	1 436	1,895
West Germany	304	466	971	1,348
Spain	1	1	420	679
United Kingdom	565	1,094	-	-
Other countries	639	730	362	542
Total	6 135	8,902	6 986	11,377
Titanium dioxide, extended				
United States	111	281	116	257
United Kingdom	36	57	144	230
Spain	-	-	54	103
Switzerland	1	4	-	-
Total	148	342	314	590
Titanium metal				
United States	932	26,851	463	23,594
United Kingdom	53	2,002	33	875
Netherlands	-	-	20	494
West Germany	...	13	20	491
Other countries	1	37	16	676
Total	986	28,903	552	26,130
Exports[1] to the United States				
Titanium metal, unwrought including waste and scrap	257	1,794	1 345	5,439
Titanium metal, wrought	441	4,203	554	4,617
Titanium dioxide	9 367	10,445	14 252	17,288

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; ... Number too small to be expressed.

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

TABLE 2. CANADIAN TITANIUM PRODUCTION, IMPORTS AND CONSUMPTION, 1970, 1975-81

	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
1977	1 442 280	692 330	4 478	496	4 974	..	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	..	..
1981P	2 008 117	759 191	6 986	314	7 300		..

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 1977-1981

	Ore Treated	Titanium Slag	Iron
		(tonnes)	
1970	1 892 290	766 300	539 720
1975	1 543 480	749 840	499 890
1977	1 442 280	692 330	459 250
1978	1 809 990	850 030	595 000
1979	1 004 260	477 030	339 660
1980	1 853 270	874 710	622 330
1981P	2 008 117	759 191	540 334

Source: Kennecott Corporation Annual Report, QIT-Fer et Titane Inc.
P Preliminary.

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.

More than one-half of the titanium pigment produced is consumed by the paint industry and an additional one-quarter by the paper industry. The remainder is consumed in welding electrode coatings and the manufacture of plastics, rubber, textiles, floor-coatings, ceramics, inks and welding electrode castings. In addition to having favourable properties of whiteness and opacity, titanium dioxide pigments are resistant to chemical attack, thermally stable, resistant to ultraviolet degradation and nontoxic.

Some 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.

OUTLOOK

The demand for titanium dioxide and unalloyed titanium fabricated products is expected to weaken in Canada in 1982. World demand for these products could weaken ever further than the 1981 levels because of the recession in the United States and western Europe that is expected to continue throughout 1982 and part of 1983.

In the longer term, the demand for titanium dioxide and titanium metal should increase as the recession recedes.

The future of titanium metal and its alloys looks very promising, and demand for these products should increase considerably in the long term, for four major reasons: (1) titanium has interesting engineering properties in that it is light, strong and

TABLE 4. STRUCTURE OF THE CANADIAN TITANIUM INDUSTRY

	Location of of Plant	Products	Annual Rated Capacity (tonnes)	Production in 1981	Remarks
QIT-Fer et Titane Inc.	Sorel, Que.	Sorelslag[1]	860 000	759 191	
		Sorelmetal[2]	610 000	540 334	
		Sorelflux[3]	n.a.	n.a.	
		Ilmenite ore	2 500 000	n.a.	
NL Chem Canada Inc.	Varennes, Que.	Titanium dioxide	36 000	36 000	
Tioxide Canada Inc.	Tracy, Que.	Titanium dioxide	36 000	35 000	
Kennametal Inc.	Port Coquitlam, B.C.	Titanium carbide	n.a.		
Ti-Ltée	St-Laurent, Que.	Titanium metal fabricators	n.a.		Operated at capacity.
Toronto Coppersmithing International Ltd.	Scarborough,	Titanium metal fabrications	n.a.		Strong demand for titanium products

Source: Energy, Mines and Resources Canada.
[1] 70-72% TiO_2; [2] Low manganese pig iron; [3] Screened ilmenite ore (6 to 38 mm in size).
n.a. Not available.

TABLE 5. PRODUCTION OF ILMENITE CONCENTRATE BY COUNTRIES, 1979-81

	1979	1980P	1981e
	(000 tonnes)		
Australia	1 143	1 336	1 225
Norway	810	828	825
Canada[1]	477	875	759
United States	580	498	499
U.S.S.R.e	408	..	..
Malaysia	187	160	154
Indiae	150	180	181
Finland	132	150	145
Republic of South Africa	299	343	381
Sri Lanka	35	..	..
Other countries	780	495	490
Total	5 001	4 865	4 659

Sources: U.S. Bureau of Mines, Minerals Yearbook Preprint, 1979; U.S. Bureau of Mines, Mineral Commodity Summaries, January 1982.
[1] Titanium slag containing 70-71% TiO_2.
P Preliminary; e Estimated; .. Not available.

TABLE 6. PRODUCTION OF RUTILE BY COUNTRIES, 1979-81

	1979	1980P	1981e
	(000 tonnes)		
Australia	277	294	249
United States	-	..	..
U.S.S.R.e	..	..	..
Indiae	9	7	7
Sri Lanka	14	15	15
Brazil	..	1	1
Republic of South Africa	42	48	48
Sierra Leone	..	50	61
Other countries	33	9	9
Total	375	424	390

Sources: U.S. Bureau of Mines, Minerals Yearbook Preprint, 1979; U.S. Bureau of Mines, Mineral Commodity Summaries, January 1982.
P Preliminary; e Estimated; .. Not available; - Nil.

TABLE 7. TITANIUM SPONGE PLANTS UNDER CONSIDERATION

Country	Company	Planned Capacity (tonnes/year)
United States	The D-H Titanium Co.	6 000
	Westinghouse Electric Corporation)	
	Mitsubishi Metal Corporation)	6 000
	Albany Titanium	500
Australia	The Pratt & Whitney Durcraft Corporation)	
	General Dynamics Corporation)	n.a.
	Western Mining Corporation Ltd.)	
Brazil	Titano do Brasil (Tibras)	3 000
Japan	Ishizuka	1 200

Sources: Metals Week; Mining Journal.

resistant to corrosion; (2) technological changes will soon substantially reduce the amount of energy necessary to produce titanium sponge; (3) larger plants are being built that will lower operating costs; and (4) the industry is being reorganized and integrated (sponge, ingot melting and mill product manufacturing), which should help reduce costs of mill products and consequently increase consumption.

PRICES

The price of rutile continued to decline as a result of a weak demand for rutile's three major consuming markets: pigments; titanium metal; and welding electrode coatings. At year-end rutile was selling for about $US 455 a t, compared with $US 480 in 1980.

Titanium dioxide and titanium sponge prices increased only moderately, while titanium mill products almost doubled in price.

TABLE 8. TITANIUM SPONGE PRODUCTION CAPACITY FORECAST BY COMPANY 1980-85

	1980	1981	1982	1983	1984	1985
	(tonnes)					
Japan						
Toho Titanium Co. Ltd.	12 000	12 000	12 000	n.a.	n.a.	n.a.
Osaka Titanium Corp.	12 000	13 000	18 000	n.a.	n.a.	n.a.
Japan Soda	2 000	2 000	2 000	n.a.	n.a.	n.a.
Sub-total	26 000	27 000	32 000			32 000+
United States						
Timet Division	12 700	n.a.	n.a.	n.a.	n.a.	14 500
RMI Co.	8 600	n.a.	n.a.	n.a.	n.a.	10 400
Oremet	2 700	n.a.	n.a.	n.a.	n.a.	4 100
Dow-Howmet	-	-	-	-	4 500	4 500
Sub-total	24 000					33 500+
United Kingdom						
ICI Australia Ltd.	3 000	3 000	3 000	-	-	-
Deeside Titanium Ltd.	-	-	-	4 500	4 500	4 500
Sub-total	3 000	3 000	3 000	4 500	4 500	4 500
Total non-communist	53 000					70 000+
U.S.S.R.	45 000					45 000
China	5 000					5 000
Total communist	50 000					50 000
Total world	103 000					120 000+

Source: Roskill Letter, Japan, October 1981.
- Nil; n.a. Not available.

PRICES

Prices of selected titanium commodities, in United States currency, 1980 and 1981

	1981	1980
	($)	($)
Titanium ore, fob cars Atlantic and Great Lake ports		
Rutile, 96% per t, delivered within 12 months	443.00-467.00	468.00-495.00
Ilmenite, 54%, per t, shiploads	69.00-74.00	54
Slag, 70%, per t, fob Quebec	133.00	113.00
Titanium sponge, U.S. per kg	16.87	15.48
Mill products, per kg delivered		
Billet (Ti - 6AL-4V)	33.07	11.55-15.72
Bar (Ti - 6AL-4V)	39.70	18.01-23.66
Titanium dioxide, anatase, dry milled, Canadian dollars[1]		
Bags, carlots, delivered eastern Canada, per kg	1.54	1.533
Bags, carlots, rutile regular, per kg	1.65	1.410

Source: Metals Week, December 28, 1981.
[1] Chemical Marketing Report, December 28, 1981.

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, 1981)	free	free	25	free
34735-1	Tubing of titanium or titanium alloys for use in Canadian manufactures (expires June 30, 1981)	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, 1981)	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, 1981)	7.5	7.5	25	5

CANADA (cont'd)

Item No.		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
37506-1	Ferrotitanium	free	5	5	free
92825-1	Titanium oxides	free	11.9	25	free
93207-6	Titanium whites, not including pure titanium dioxide	free	11.9	25	free

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

	1981	1982	1983	1984	1985	1986	1987
			(%)				
37506-1	5.0	4.8	4.7	4.5	4.3	4.2	4.0
92825-1	11.9	11.6	11.3	10.9	10.6	10.3	10.0
93207-6	11.9	11.6	11.3	10.9	10.6	10.3	10.0

UNITED STATES (MFN)

Item No.		1981	1982	1983	1984	1985	1986	1987
				(%)				
422.30	Titanium compounds	6.9	6.5	6.2	5.9	5.6	5.2	4.9
473.70	Titanium dioxide	7.1	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	5.0	4.8	4.6	4.4	4.1	3.9	3.7
629.12	Titanium metal, waste and scrap[1]	15.3	14.0	12.6	11.3	9.9	8.6	7.2
629.14	Titanium metal, unwrought	18.0	17.5	17.0	16.5	16.0	15.5	15.0
629.20	Titanium metal, wrought	18.0	17.5	17.0	16.5	16.0	15.5	15.0

Sources: The Customs Tariff and Commodities Index, 1980, Revenue Canada; Tariff Schedules of the United States Annotated (1980), USITC Publication 1111; U.S. Federal Register Vol. 44, No. 241.
[1] Duty on waste and scrap temporarily suspended.

Tungsten

D.G. LAW-WEST

CANADIAN DEVELOPMENTS

Production of tungsten concentrates from Canada Tungsten Mining Corporation Limited (Cantung) was down nearly 30 per cent in 1981 as a result of a prolonged strike. The strike began on November 14, 1980 and continued for six months to May 14, 1981 when a new contract was ratified. The company was able to supply its customers from stockpiled concentrates until February 4, 1981 but had to declare **force majeure** on further deliveries when these supplies were depleted. Operations returned to normal by mid-June and the **force majeure** was lifted. Concentrate production for the year was limited by the strike to only 2 490 t of contained tungsten trioxide (WO_3) compared with 3 540 t WO_3 in 1980. Tungsten production is expected to be about 4 300 t WO_3 in 1982, anticipated to be the first full year of operation of the recently expanded facilities.

In late 1981 Dimac Resource Corp. announced the start-up of a 100 tpd gravity and floatation mill at its Silence Lake property near Clearwater, British Columbia. The company has outlined some 53 000 t of scheelite ore grading about 1.47 per cent WO_3. At the currently planned milling rate of 15 000 tpy these reserves should allow more than three years of operation. However, Dimac plans to carry out additional exploration to increase reserves. The deposit will be mined, starting in early 1982, by open-pit methods. In the meantime, mill feed will be drawn from ore that is already stockpiled. Scheelite concentrate produced by the mine will be marketed by a metal merchant.

Preproduction construction at the Mount Pleasant tungsten-molybdenum mine in New Brunswick was on schedule at year-end. Although mining of the wolframite and molybdenum ore is due to begin in February or March 1982, the ore will be stockpiled until the 2 000 tpd concentrator can be placed in operation, scheduled for the third quarter of the year. This project is a joint venture between the 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 its detailed evaluation of the Mactung scheelite deposit on the Yukon-Northwest Territories border during 1981. The reserve base has been calculated at 63 million t grading about .9 per cent WO_3, including 12.3 million t grading 1.02 per cent WO_3. However, a final production decision has not been announced, as the company has undertaken further detailed socio-economic planning studies.

INTERNATIONAL DEVELOPMENTS

Western world production of tungsten concentrate decreased by about 4 per cent in 1981 to 24 000 t contained tungsten. The lower production was primarily a result of the Cantung strike.

In the United States, Union Carbide Corporation increased production at both the Emerson and Pine Creek mines, NRO Mining Ltd. continued development work at its Rawhide mine in Nevada and Teledyne Wah Chang opened the Strawberry Mine in California. U.S. production of tungsten in concentrates increased by nearly 25 per cent to 3 500 t.

AMAX Inc. brought its ammonium paratungstate (APT) plant at Fort Madison, Iowa, into production during the third quarter of 1981. The plant is designed to process low-grade scheelite containing about 15 per cent WO_3; production capacity is 136 000 metric tonne units (mtu) of APT per year.

TABLE 1. CANADA, TUNGSTEN PRODUCTION, IMPORTS, 1980 AND 1981 AND CONSUMPTION 1979 AND 1980

	1980		1981P	
	(kilograms)	($)	(kilograms)	($)
Production[1] (WO_3)	4 007 000	..	1 736 000	..
Imports				
Tungsten in ores and concentrates				
United States	6 000	107,000	14 000	263,000
Total	6 000	107,000	14 000	263,000
Ferrotungsten[2]				
United States	2 000	56,000	6 000	147,000
Portugal	6 000	101,000	-	-
Total	8 000	157,000	6 000	147,000
Tungsten carbide powder				
United States	333 000	9,719,000		
West Germany	6 000	202,000		
Other countries	83 000	2,060,000		
Total	422 000	11,981,000	..	..
	(number)	($)	(number)	($)
Tungsten carbide rotary rock drill bits				
United States	2 803	9,847,000		
Other countries	182	972,000		
Total	2 985	10,819,000	..	..
Tungsten carbide percussion rock drill bits				
United States	63 405	1,561,000		
Ireland	51 391	1,087,000		
Other countries	291	51,000		
Total	115 087	2,699,000	..	..
Tungsten carbide tools for metal work				
United States	..	5,387,000	..	8,230,000
Other countries	..	3,565,000	..	3,005,000
Total	..	8,952,000	..	11,235,000
	1979		1980	
	(kilograms)	($)	(kilograms)	($)
Consumption (W content)				
Tungsten metal and metal powder	262 002	..	232 659	..
Other tungsten products[3]	118 227	..	57 820	..
Total	380 229	..	290 479	..

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.

Australian production of tungsten concentrate fell nearly 7 per cent to 3 300 t of contained tungsten in 1981. The drop in production was mainly the result of three small mines being placed on care and maintenance.

At year-end, the Hemerdon joint venture in the United Kingdom (owned by AMAX Hemerdon Limited (a subsidiary of AMAX Inc.) and Hemerdon Mining & Smelting (U.K.) Ltd.) was making planning applications for the development of a tungsten mine and mill complex. A recent feasibility study reported open-pit mineable reserves of 42.3 million t of ore grading 0.18 per cent WO_3 and 0.029 per cent tin. However, several environmental groups, concerned with the suggested location of the tailings pond, could delay the application procedure through prolonged public hearings.

USES

Tungsten materials can be divided into several major classes, depending upon the product form and its use. The main product classes include tungsten, 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 tq 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, 1975-81

	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	3 275 082	11 000	28 000	380 229
1980	4 007 000	6 000	7 000	290 479
1981P	1 736 000	14 000	6 000	..

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

[1] Producers' shipments of scheelite (WO_3 content); [2] W content; [3] Gross weight.
P Preliminary; - Nil; .. Not available.

TABLE 3. WORLD TUNGSTEN PRODUCTION IN ORES AND CONCENTRATES, 1979-81

	1979	1980P	1981e
	(tonnes of contained tungsten: W content)		
People's Republic of China	7 121	15 014	13 608
U.S.S.R.	8 709	8 709	8 845
Australia	3 193	3 331	3 311
Bolivia	3 114	3 359	3 175
United States	3 013	2 738	3 175
Republic of Korea	2 713	2 737	2 722
Portugal	1 378	1 557	2 495
Thailand	1 826	1 615	1 588
Canada	2 597	3 178	1 377
Austria	1 496	1 495	1 361
Brazil	1 177	1 202	1 179
Turkey	998	998	907
Burma	692	753	680
Mexico	252	270	227
Other central economy countries	2 229	2 279	2 268
Other market economy countries	6 548	4 377	4 082
World Total	47 056	53 612	51 000

Sources: United States Bureau of Mines Minerals Yearbook Preprint 1980; USBM Mineral Commodity Summaries, 1982; Energy Mines and Resources Canada.

P Preliminary; e Estimated.

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

The Thirteenth Session of the United Nations Committee on Tungsten was held in Geneva, Switzerland from December 7-11, 1981. Little progress was evident at this meeting; statements by delegates showed that the positions of most countries had remained unchanged since the Twelfth Session. In addition to agreeing to meet again in 1982, the Committee requested the UNCTAD Secretariat to prepare two studies concerning tungsten price indicators and the range of tungsten product specifications and grades required by the international market.

In early March, a third meeting of governmental representatives of tungsten producing countries was held in Chaing Mai, Thailand. Five producing countries, namely Australia, Bolivia, People's Republic of China, Portugal and Thailand were represented. Also present was the Primary Tungsten Producers Association. Canada, while invited, did not attend. The decision was based on a strong Canadian preference that where intergovernmental action on commodities appears warranted such action should be taken jointly by both producer countries and consumer countries.

The most significant outcome of the Chiang Mai meeting was the formation of a working group to prepare detailed studies concerning the establishment of an Association of Tungsten Producing Countries. A fourth meeting was scheduled for early 1982.

PRICES

Tungsten prices remained relatively stable during the first three quarters of the year, fluctuating between $US 143-145 per mtu WO_3. However, toward the end of the year the price dropped to $US 127-129 per mtu. The severe drop in prices was due mainly to a large oversupply of tungsten created when consumers madecutbacks in their tungsten requirements because of the deepening recession. Some tungsten producers responded to the situation by placing some operations on standby.

OUTLOOK

Tungsten markets are expected to remain depressed for the duration of the current recessionary period. A prolonged downturn in the market could result in some of the higher cost tungsten operations closing down permanently.

The manufacturing of tungsten carbide inserts and drill bits has been adversely affected by reduced exploration and development drilling in both the mineral and energy fields.

In the longer term, 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 thattungsten 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 tungtsen prices.

It remains to be seen whether the UNCTAD Committee on Tungsten will be successful in its goal of market stabilization and whether an Association of Tungsten Producing 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

Tungsten Prices according to **Metals Week**

	December 31, 1980	December 31, 1981
	($US)	
Tungsten ore, 65% minimum WO_3		
G.S.A. domestic, duty excluded, per short ton unit of WO_3	127.46-128.36	120.735
G.S.A. export, per short ton unit of WO_3	127.52	129.74
L.M.B. ore quoted by **London Metal Bulletin**, cif Europe, per metric ton unit of WO_3	142.00-145.00	120.00-126.00
Ferrotungsten, per pound W, fob Niagara Falls, low-molybdenum	11.90	list price suspended
Tungsten metal, per pound, fob shipping point		
Hydrogen reduced: 99.5%, depending on Fisher No. range	13.90-15.50	13.90-15.50

cif Cost, insurance and freight; fob Free on board.

TARIFFS

		British Preferential	Most Favoured Nation	General	General Preferential
			(%)		
CANADA					
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, 1982)	free	free	25	free
37506-1	Ferrotungsten	free	5	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)

	1981	1982	1983	1984	1985	1986	1987
			(%)				
37506-1	5.0	4.8	4.7	4.5	4.3	4.2	4.0

UNITED STATES (MFN)

Item No.								
601.54	Tungsten ore, per pound tungsten content			17¢				
		1981	1982	1983	1984	1985	1986	1987
			(% unless otherwise specified)					
422.40	Tungsten carbide, on tungsten content	10¢/ lb + 12.5%	5¢/ lb + 12.5%	12.5	12.0	11.5	11.0	10.5
422.42	Other tungsten compounds	11.4	11.2	11.0	10.7	10.5	10.2	10.0
606.48	Ferrotungsten and ferro-silicon tungsten, on tungsten content	21¢/ lb + 6%	8.8	8.2	7.5	6.9	6.2	5.6
629.25	Tungsten metal waste and scrap, not over 50% tungsten	6.9	6.6	6.3	5.9	5.6	5.2	4.9

TARIFFS (cont'd)

UNITED STATES (cont'd)

Item No.		1981	1982	1983	1984	1985	1986	1987
		(per cent unless otherwise specified)						
629.26	Tungsten metal waste and scrap, over 50% tungsten	4.5	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	21¢/ lb + 12.5%	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	10.5	9.8	9.0	8.3	7.5	6.8	6.0
629.30	Other unwrought tungsten metal	12.5	11.5	10.5	9.6	8.6	7.6	6.6
629.32	Unwrought tungsten alloys, not over 50% tungsten	6.4	6.1	5.9	5.6	5.3	5.0	4.7
629.33	Unwrought tungsten alloys, over 50% tungsten	12.5	11.5	10.5	9.6	8.6	7.6	6.6
629.35	Unwrought tungsten metal	11.0	10.3	9.5	8.8	8.0	7.3	6.5

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

Uranium

R.T. WHILLANS

During 1981, worldwide activity in the uranium industry moderated further in response to continued softening in the uranium market. The decline in uranium prices and the postponement of several nuclear power projects resulted in production cutbacks, deferrals or cancellations of development programs, and additional mine closures, especially in the United States. Although the short-term outlook remained bleak, longer-term projections indicate that additional increases in production capability may be necessary by the mid- to late-1990s. These longer-term opportunities encouraged continued exploration efforts in several countries.

Across Canada there was a general decrease in the level of exploration activity during the year, with the emphasis shifting from a grass-roots effort to on-property exploration and development. In Saskatchewan, still the focus of greatest interest, Cluff Mining officially started production on April 2, and in August, Key Lake Mining Corporation (KLMC) signed a surface lease agreement with the Saskatchewan government permitting orebody development to proceed. At Elliot Lake, Ontario, Denison Mines Limited doubled its mill throughput capacity. On a negative note, Eldorado Nuclear Limited announced, in December, the June 1982 closure of its Beaverlodge operation in Saskatchewan, and Esso Resources Canada Limited indicated plans to defer development of its Midwest Lake project, also in northern Saskatchewan. In British Columbia, the provincial government's moratorium on uranium exploration and mining continued despite the Royal Commission recommendation to lift the ban on exploration.

While the potential for additional production capability has increased in Canada in recent years, the rate at which this potential is being realized has now begun to slow in response to the deteriorating short-term outlook. However, Canada will be able to maintain its share of the diminished market. In the longer term, given increased assurances of global demand, Canada could very well enhance its position as a world uranium supplier.

PRODUCTION AND DEVELOPMENT

In 1981 Canada had seven primary uranium producers and one byproduct operation. The byproduct output, which was relatively small, is not included in the Canadian total because the source materials are imported from the United States and the extracted uranium is sold to U.S. companies. (See Table 1 for primary uranium output). Of Canada's total uranium shipments in 1981, some 60 per cent was attributable to the four Ontario operations, the two largest being in the Elliot Lake area, with the balance coming from the three Saskatchewan producers (Table 2).

Recovering from a six-month setback in its mill expansion project at Elliot Lake, Denison Mines Limited raised the throughput capacity of its ore processing plant from 6 800 t to 10 000 t of ore a day (tpd) in June, and by year-end to some 13 600 tpd. Previously stockpiled ore will supplement underground production which was up 20 per cent in the first half of 1981 compared to the same period in 1980. Development work continued at the Denison mine, where a new underground conveyor system was successfully put in operation. Completion of the mine expansion is expected in 1982. During 1981, some 2 788 275 t of ore averaging 0.712 kg U per t were milled, the increased ore throughput reflecting the start-up of the new processing plant. Recovery declined to 91.0 per cent from 93.3 per cent in 1980 due primarily to the lower grade of ore processed and losses incurred during commissioning of the new plant.

TABLE 1. URANIUM PRODUCTION IN CANADA, BY COMPANY, 1980 AND 1981

Company	Location	Production 1980	Production 1981
		tonnes U[1]	
Agnew Lake Mines Limited	Agnew Lake, Ont.	195	123
Cluff Mining (Amok Ltd/SMDC)	Cluff Lake, Sask.	11	1 290
Denison Mines Limited	Elliot Lake, Ont.	1 712	1 824
Eldorado Nuclear Limited	Eldorado, Sask.	423[2]	375[3]
Gulf Minerals Canada Limited[4]	Rabbit Lake, Sask.	1 967[r]	1 207
Madawaska Mines Limited	Bancroft, Ont.	235	245
Rio Algom Limited - Quirke	Elliot Lake, Ont.	1 879	1 832
- Panel		730	826
Total Canada[5]		7 152[r]	7 722

Source: Company annual reports.
[1] One metric ton of elemental uranium (tonne U) is equivalent, in terms of uranium content, to 1.2999 short tons of uranium oxide (U_3O_8). [2] Includes 6 tU from Cenex Limited property ore. [3] Includes 2 tU from Cenex property ore. [4] Joint operation with Uranerz Canada Limited. [5] Does not include output from ESI Resources Limited, byproduct uranium production (see text).
[r] Revised.

During the year, Ontario Hydro and Denison reviewed the feasibility of continuing the Can-Met/Stanrock mine rehabilitation program. Under a 1978 sales contract with Denison, Ontario Hydro had agreed to contribute $43 million toward the project but after advancing some $7 million of the total, the utility became concerned about the project's future viability. Late in the year, however, Ontario Hydro agreed that the rehabilitation program, scheduled for completion in 1985, would resume. Denison agreed to a 9 per cent reduction in its 48 465 tU[1] supply contract with Ontario Hydro and to a one-year extension of the original 1980-2011 delivery schedule.

Also at Elliot Lake, Rio Algom Limited reported uranium production increases at its 2 990 tpd Panel operation, due mainly to continued performance improvements. During the year, the mill processed some 1 003 350 t of ore averaging 0.848 kg U per t; mill recovery increased to 93.9 per cent from 88.2 per cent in 1980. Output from the 6 350 tpd Quirke mine and mill was similar to that of 1980. During 1981, the mill processed some 2 106 480 t of ore, averaging 0.890 kg U per t; mill recovery slipped to 94.7 per cent from the record high of 95.5 per cent the previous year. Deliveries to customers from both the Quirke and Panel operations totalled some 2 668 tU. The rehabilitation of the Stanleigh property, financed extensively by Ontario Hydro, continued on schedule with full production, at a rate of 4 540 tpd, expected in 1984.

[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).

TABLE 2. URANIUM OUTPUT[1] IN CANADA BY PROVINCE, 1980 AND 1981

	1980 (t)	1980 ($000)	1981P (t)	1981P ($000)
Ontario	4 394	463,454	4 664	467,925
Saskatchewan	2 345	238,584	3 082	301,658
Total	6 739	702,038	7 746	769,583

Source: Energy, Mines and Resources Canada.
[1] Shipments of uranium (U) in concentrate from ore processing plants.
P Preliminary.

TABLE 3. PRODUCTION OF URANIUM IN CONCENTRATES BY MAJOR PRODUCING COUNTRIES, 1975-81

	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
1981P	14 800	7 720	6 135	3 970	2 560	4 360	1 020	2 860	670[3]	44 100

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.

[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.
P Preliminary; - Nil; .. Not available.

On October 8, 1981 Rio Algom announced that through a restructuring of its uranium contract with Ontario Hydro a deferral in scheduled deliveries of uranium oxide from the Stanleigh operation of approximately 15 per cent during the period 1983 to 2004 would be made. Total deliveries under the contract, which extends to 2020, will remain the same at 27 695 tU.

At the salvage leaching operations of Agnew Lake Mines Limited, 90 km east of Elliot Lake, a 37 per cent drop in production was experienced during the year. The decrease was anticipated and is expected to continue, as leaching is restricted to the existing surface stockpile and broken ore underground. At year-end, ore in place, broken in the stopes and on the surface leachpile totalled an estimated 8 594 000 t containing some 2 876 tU; the solution inventory contained close to 20 tU. The company planned to continue the operation until at least the middle of 1982.

In the Bancroft area of Ontario, Madawaska Mines Limited achieved cost and grade control objectives at its 1 360 tpd operation, resulting in increased concentrate production over 1980. A total of 353 172 t of ore averaging 0.729 kg U per t was milled during 1981; uranium recovery remained at about 95 per cent. Early in the year, the company indicated that it had renegotiated prices for uranium deliveries through the remainder of 1981 and 1982 under its contract with AGIP S.p.A. of Italy; all production from Madawaska that is available for export is dedicated to AGIP.

In Saskatchewan, Eldorado Nuclear Limited reported decreased sales of mine concentrates in 1981 from its Beaverlodge operation near Uranium City. Uranium output was down some 11 per cent from 1980 despite a modest improvement in overall productivity at the Beaverlodge mine. Some 287 580 t of ore, with an average grade of 1.48 kg U per t reflecting the lower grades encountered at depth in the Fay mine, were milled during 1981. Mill recovery reached 90.5 per cent, up slightly from the 1980 rate of 88.6 per cent.

On December 3, Eldorado announced plans to close the Beaverlodge operation, effective June 30, 1982. Cited as reasons for the decision to cease production were: a steady decline in ore grades over the past five years, production costs outpacing inflation, and the drop in world uranium prices. Eldorado expects that the closing and salvage operations will continue into 1983; in the interim the company and the provincial government hope to minimize the social impact and implement an orderly shutdown.

At Saskatchewan's Rabbit Lake open-pit operation, held jointly by Gulf Minerals Canada Limited (51 per cent) and Uranerz Canada Limited (49 per cent), mining of the high-grade core of the orebody was completed; production will continue from the remaining, lower-grade envelope until Gulf commences development of its Collins Bay "B" deposit, located some 11 km north of Rabbit Lake. During 1981, 677 203 t of ore, averaging 1.88 kg U per t, were milled; recovery slipped to 92.9 per cent. Gulf submitted an environmental impact statement to the Saskatchewan government and participated in several public meetings during 1981 to outline its proposed development. Mining of the "B" deposit, necessary to maintain production capacity at the 1 500 tpd Rabbit Lake mill, could begin by 1983 although it is not expected that milling would start before 1984. Uranium extraction circuits at the mill must be modified because of the presence of base-metal oxides and arsenides in the "B" ore.

Cluff Mining, a partnership owned 80 per cent by Amok Ltd. and 20 per cent by Saskatchewan Mining Development Corporation (SMDC), began extracting the high-grade "D" orebody at Cluff Lake, Saskatchewan, in June 1980 and began concentrate production the following October. The 1 500 tU a year operation was officially opened on April 2, 1981, almost 14 years after the first radiometric anomalies in the vicinity were discovered. Phase 1, the extraction and surface stockpiling of the "D" orebody was completed by October 1981; the stockpiled "D" ore will supply the mill until 1984 or 1985. In total, some 107 600 t of ore, averaging 42.6 kg U per t were recovered during Phase I mining; mill recovery exceeded 90 per cent by July 1981 and had reached 95 per cent by year-end. The reclamation plan for backfilling the "D" pit was approved by the regulatory agencies and work commenced at the end of 1981.

Phase 2, the development of other, nearby, lower-grade orebodies, including the Claude and "N" deposits, will follow, with timing dependent on the uranium market; capital costs for Phase 2 have been reported at $100 million. In November, Cluff Mining announced that an environmental impact statement would be submitted to the provincial government for approval of the company's plan to begin extracting ore, in the summer of 1982, from a portion of the Claude orebody. The small experimental open-pit operation, expected to last 90 days, would provide improved data on the characteristics of the orebody, and bulk samples for analysis.

Having signed a surface lease agreement with the Department of Northern Saskatchewan in August (see Government Affairs), Key Lake Mining Corporation (KLMC) was able to proceed with the development of the first of its two deposits, the Gaertner orebody. 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). Although lease negotiations had delayed development of the deposit, other site preparation work continued during the year as planned, including completion of accommodations for some 800 construction workers. Stripping began late in the year and the company hopes to expose the orebody during 1982, commence mining that winter and start milling in July 1983 as originally expected. In a practice similar to that established by Gulf Minerals at Rabbit Lake, production workers at Key Lake will fly to the mine site, work an 11-hour shift for seven days, and fly out for seven days' rest. Preliminary site work for the 700 tpd capacity mill began late in 1981; production from the $500 million project could reach 4 600 tU a year. Combined reserves of KLMC's Gaertner and Deilmann deposits reportedly exceed 73 000 tU, from ore with an average grade of about 2 per cent U.

At the Midwest Lake uranium project, some 24 km west of Rabbit Lake, Saskatchewan, infill drilling on the major portions of the deposit was completed by mid-year and a preliminary environmental impact statement was filed with the Saskatchewan government. Canada Wide Mines Ltd., wholly-owned by Esso Resources Canada Limited, manages the property, jointly held by Esso Minerals Canada (50 per cent), Numac Oil & Gas Ltd. (25 per cent), Bow Valley Industries Ltd. (12.5 per cent) and two other United States investors (12.5 per cent). Development plans had indicated overburden removal, for an open-pit operation, beginning in 1982, and production, at a rate of some 1 500 tU a year, in 1986. In December, however, Esso announced that because of continued uncertainty in the international uranium market, development of the Midwest project would be deferred for at least five years. It had been reported that total capital costs of the project would exceed $500 million.

ESI Resources Limited, a wholly-owned subsidiary of Earth Sciences Incorporated of Golden, Colorado, was unable to reach full output capacity during 1981 at its Calgary byproduct uranium operation and production was suspended late in the year. Uranium was recovered from phosphoric acid produced at an adjacent plant operated by Western Co-operative Fertilizers Limited (WCFL). From the time the facility was put into service in June 1980 until the end of June 1981, ESI produced some 6 tU. Output had been expected to exceed 40 tU a year when full design capacity was achieved. Since the phosphate rock used by WCFL is imported from Idaho and the uranium recovered therefrom was contracted to two American utilities, production is not included in the Canadian total.

As of January 1, 1981, the workforce at Canada's producing uranium operations totalled some 6,100 employees. Of this total about 2,600 worked in the mines, both open pit and underground, and some 800 in the mills, with the balance described as general employees.

EXPLORATION

With the continued deterioration in the short-term uranium market, the shift away from "grass-roots" exploration that started in 1980 continued throughout 1981. In its annual uranium exploration survey, Energy, Mines and Resources Canada (EMR) reported[1] that exploration expenditures peaked at $130 and $128 million (current dollars) during 1979 and 1980, respectively, and could be as much as 20 per cent lower in 1981. Of the 113 companies or joint ventures that responded to the EMR survey in 1980, including essentially all of the major companies involved in uranium exploration, 30 operators each spent more than $1 million and together accounted for 90 per cent of the total expenditures; the number of exploration projects reported in 1980 totalled 377 as compared to 513 in 1979.

The ten most active organizations, accounting for some 56 per cent of the $128 million 1980 total, were, in alphabetical order, Amok Ltd., Asamera Inc., Canadian Occidental Petroleum Ltd., E & B Explorations Ltd., Eldorado Nuclear Limited, Gulf Minerals Canada Limited, Pan Ocean Oil Ltd., Saskatchewan Mining Development Corporation (SMDC), Uranerz Exploration and Mining Limited, and Urangesellschaft Canada Limited.

The survey also indicated that 503 300 m of uranium exploration and surface development drilling was completed during 1980, over 70 per cent of it in Saskatchewan; preliminary estimates for 1981 suggest that drilling activity will be in the order of 380 000 m, about three-quarters of the 1980 effort.

Although several companies chose not to continue uranium exploration, others have concentrated their efforts in areas of demonstrated uranium favourability. The Athabasca Basin in northern Saskatchewan was again the most important area for uranium exploration in 1981.

Major efforts were continued along the Midwest Lake - McClean Lake belt by several companies including Asamera, Esso Resources, Canadian Occidental, Inco Metals Company, Seru Nuclear (Canada) Limited and SMDC. To the east, Gulf Minerals, SMDC, Noranda Exploration Company, Limited, and E & B Explorations progressed with work to further delineate extensions of the Collins Bay - Eagle Point mineralized zone along the east rim of the Basin. In eastern Canada, continued interest was shown in the Otish Mountains area of central Quebec by Uranerz, Seru Nuclear, Esso Minerals, Pancontinental Mining (Canada) Ltd., Société québécoise d'exploration minière (SOQUEM) and James Bay Development Corporation. In Nova Scotia continued activity by Canterra Energy Ltd., Shell Canada Resources Limited, Saarberg-Interplan Canada Ltd., and Ontario Hydro, in the area of the South Mountain Batholith, was deferred because of the announcement, late in the year, of a province wide moratorium on applications for uranium exploration licences (see Government Affairs). Despite these efforts, no significant discoveries were announced during the year.

URANIUM RESOURCES

The Uranium Resource Appraisal Group (URAG) of EMR completed its seventh (1980) assessment in early-1981. Uranium resource estimates are divided by URAG into several separate categories which reflect different levels of confidence in the quantities reported. These categories are further

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[1] **Uranium in Canada: 1980 Assessment of Supply and Requirements,** Report EP 81-3, Energy, Mines and Resources Canada, September 1981.

TABLE 4. 1980 ESTIMATES OF CANADA'S MINEABLE URANIUM RESOURCES

Resource Category	Mineable at Uranium Prices		
	Up to $135/kg U[1]	Between $135 & $200/kg U	Up to $200 kg/U
	(tonnes U contained in mineable ore)		
(1) Measured	67 000	6 000	73 000
(2) Indicated	163 000	22 000	185 000
(1) + (2) = Reasonably Assured[2]	230 000	28 000	258 000
(3) Inferred	214 000	101 000	315 000
(4) Prognosticated	144 000	301 000	445 000
(3) + (4) = Estimated Additional[2]	358 000	402 000	760 000

Source: "Uranium in Canada: 1980 Assessment of Supply and Requirements"; Report EP 81-3 September 1981, Energy, Mines and Resources Canada.

[1] $135/kg U (Canadian dollars) was the average weighted price for 1980 under market-related export contracts (including spot sales) made by Canadian producers for deliveries in 1980. [2] International resource terms used by the Nuclear Energy Agency (NEA) of OECD and the International Atomic Energy Agency (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.

divided into two levels of economic exploitability related to the current market price of uranium. The 1980 assessment was carried out using a lower price range, limited by the uranium market price estimated in Canadian dollars at $135/kg U, and a higher price range, spanning the $135-$200/kg U interval. The $135/kg U price, determined in December 1980 when most of the data for the assessment was gathered, was the average weighted price for 1980 under market-related export contracts (including spot sales) made by Canadian producers for deliveries in 1980. The results[1] of URAG's 1980 uranium resource assessment, released in late 1981, are summarized in Table 4. Areas in Canada in which these resources occur are illustrated in Figure 1.

Comparison of the 1980 estimates with those published a year earlier, indicates a 5 per cent decrease in the measured category, a slight increase in the indicated category and a decrease in the inferred category of about 4 per cent. The total of the three resource categories is less than that reported in the 1979 assessment by 14 000 tU, representing a net decrease of about 2 per cent. If 1980 production and average processing recoveries are taken into account, the reduction over the period due to the reassessment amounted to only 6 400 tU, or a decrease of just over 1 per cent. Changes in the distribution of resources among individual categories resulted from the technical-economic re-evaluation of some segments of the Beaverlodge deposits, the continued evaluation of the Midwest Lake deposit, and the reassessment of the Key Lake deposits, all in northern Saskatchewan.

It is illustrative to note that the sum of the resources in the measured, indicated, and inferred categories has increased, since the first URAG assessment in 1974, by some 168 000 tU. If production of 35 400 tU over the period is included, total resource additions have exceeded 203 000 tU.

URAG also reported that resource levels in the prognosticated and speculative categories remained roughly the same; areas in Canada in which these resources occur are illustrated in Figure 2.

To provide an illustration of uranium availability in the short term, URAG made two projections of Canadian production capability as shown in Figure 3. Scenario A, a conservative projection, considered output based only on resources priced at $135/kg U or less (see Table 4) associated with operating and committed production centres. Scenario B reflected the maximum attainable output that could be supported by resources mineable at prices of $200/kg U or less in known deposits tributary to those production centres considered in Scenario A

[1] **Uranium in Canada: 1980 Assessment of Supply and Requirements,** Report EP 81-3, Energy, Mines and Resources Canada, September 1981.

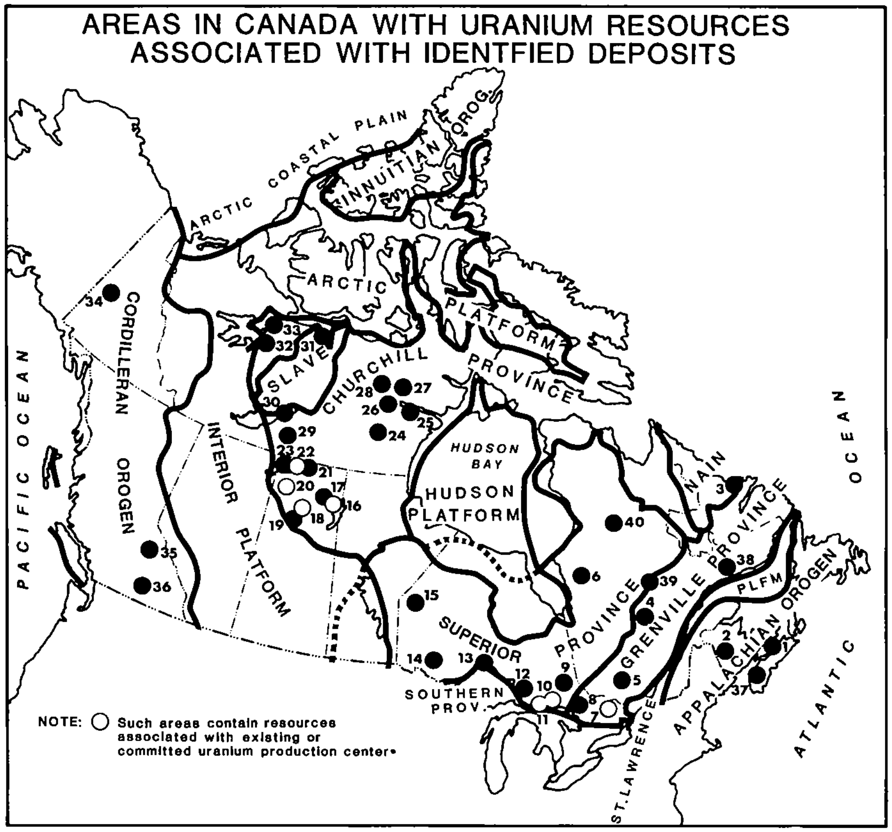

Figure 1

(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

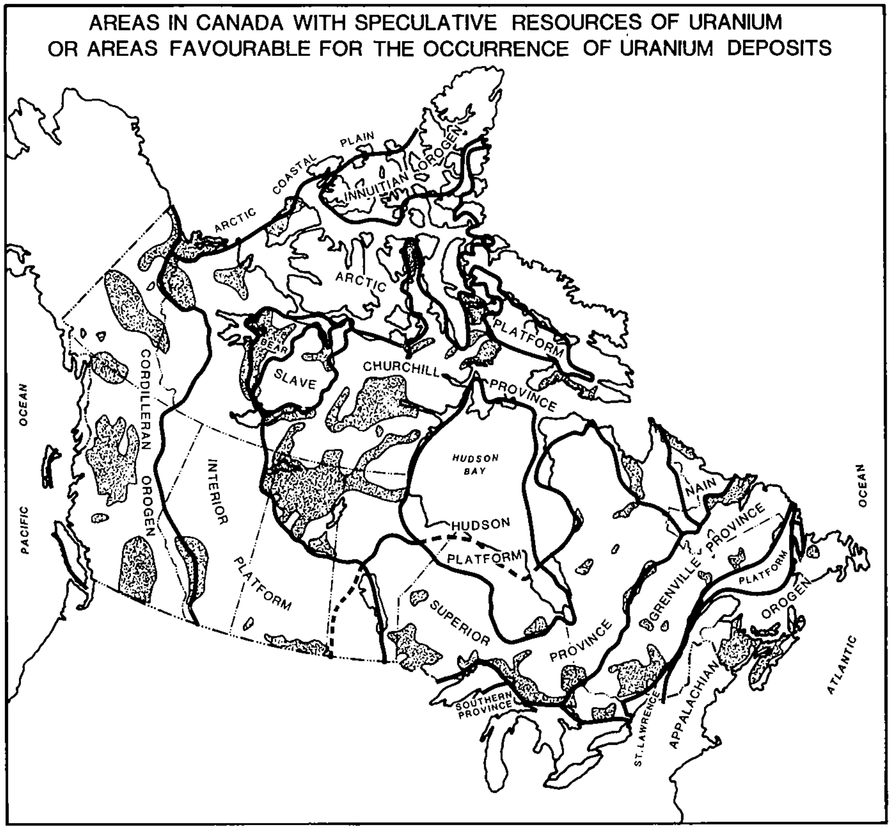

Figure 2

as well as those that are planned but as yet uncommitted. As shown in the figure, annual output is the same in each projection until 1985 and differs increasingly thereafter to 1991. Although actual achievement of production levels reflected in the above scenarios will be dependent on market developments, the similarity between the projections indicates that over the next decade the bulk of Canadian production capability can be realized from resources in the lower price category from production centres that are already committed.

GOVERNMENT AFFAIRS

On February 6, 1981, the Summary Report of the 13-month Key Lake Board of Inquiry was made public. The Board concluded that the measures proposed by Key Lake Mining Corporation (KLMC) for its $500 million project were adequate to protect environmental quality and to safeguard occupational health and safety; they also met the requirements of Canadian and Saskatchewan law, regulations and policies.

In late August, KLMC signed a 21-year surface lease agreement with the Department of Northern Saskatchewan, opening the way for orebody development. Among the terms specified in the lease are recruiting and contracting guidelines established to give priority to the permanent residents of northern Saskatchewan.

In British Columbia, the report of the Royal Commission of Inquiry into Health and Environmental Protection in Uranium Mining (the Bates' Commission) was tabled in the

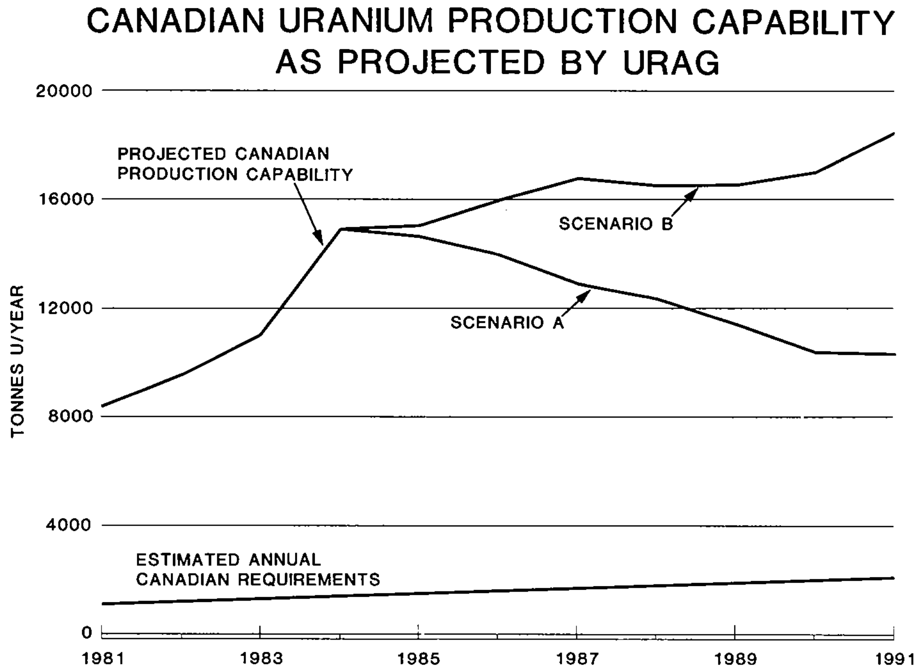

Figure 3

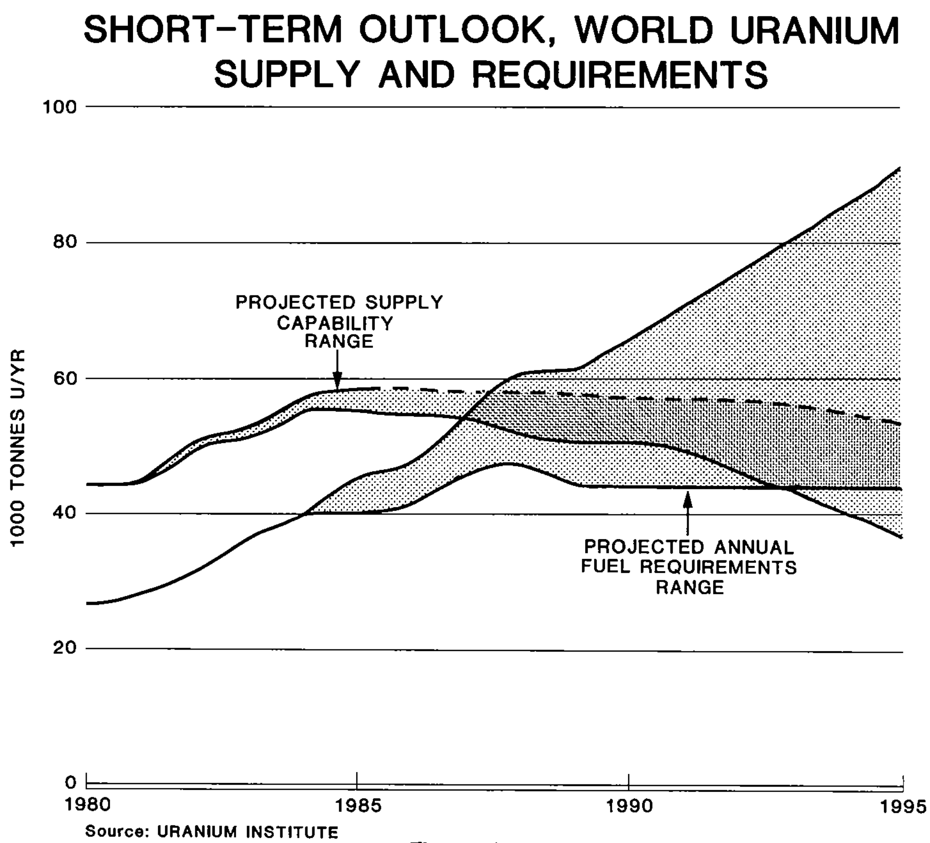

Figure 4

Legislature on March 18, 1981. It recommended that "provided that a licensing procedure for uranium exploration is instituted in British Columbia, the moratorium on uranium exploration should be lifted", because "with proper control, the possible risks attendant on this activity would be outweighed by the benefits of the knowledge gained". Despite the recommendations, the British Columbia government indicated that the moratorium on uranium mining and exploration would continue.

In March, the federal government requested parliamentary authority to transfer its general uranium stockpile of 5 570 tU in concentrates to Eldorado Nuclear Limited; the stockpile was at that time administered by Uranium Canada, Ltd. (UCAN), also a Crown company. The transfer, subsequently approved, provided Eldorado with a capital structure that would facilitate its plan to borrow in private markets in order to finance its expansion program. Eldorado will make the uranium available for sale in Canada and abroad over a period of years, as market opportunities arise. The government emphasized that the stockpile would be sold in an orderly fashion, consistent with its policy of avoiding disruptions in the market.

On May 28, 1981, it was announced that the federal government, in keeping with its oil-substitution program, would provide additional financial support to the New Brunswick Electric Power Commission (N.B. Power) in the construction and operation of the Point Lepreau Nuclear Power Station. To partly offset the cost of delays in bringing the unit into service, the federal government forgave interest already paid on the $350 million loan previously advanced to the utility, and amended the terms and conditions of the loan so that interest would not accrue or be payable until the earlier of the in-service date or October 8, 1982. To lessen the impact on the utility's revenue requirements of possible performance problems that might reduce reactor output in the early years of operation, loans at Crown Corporation rates will be made available to N.B. Power.

In July 1981, UCAN and five other companies involved in uranium production in Canada, received summonses from the Ontario Provincial Court (Criminal Division), Toronto, alleging that UCAN et al had unlawfully conspired, combined, agreed or arranged to prevent or lessen, unduly, competition in the production, manufacture, sale or supply in Canada of uranium, uranium oxide and other uranium substances, between September 1, 1970 and April 1, 1978, contrary to Section 32 (1) (c) of the Combines Investigation Act; UCAN's preliminary inquiry date was scheduled for May 17, 1982.

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, mounting public opinion prompted the provincial cabinet to place a moratorium on new uranium exploration licences. The ban, which also affects licence renewals, was to have remained in effect until the Select Committee presented its findings. 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 uranium exploration in the province. At that time there were no indications that the ban would soon be lifted.

In mid-December, the Government of Canada reached agreements with the European Atomic Energy Community (Euratom) and the Government of Sweden regarding approval of the reprocessing of irradiated uranium supplied by Canada. Each agreement incorporates a generic approach to reprocessing which will provide Canada with the non-proliferation assurances it requires for the reprocessing of Canadian nuclear material exported to Euratom and Sweden, give Euratom and Sweden the long-term predictability they need for using such material in their nuclear energy programs, and advance the evolution of an effective non-proliferation framework with the co-signing parties.

Federal consideration of the expansion of R&D efforts in the field of uranium tailings continued during 1981 in co-operation with the Governments of Ontario and Saskatchewan. The objective of these considerations is the establishment of a national research program that will examine the problem of the long-term management of uranium mine and mill wastes after the termination of mining operations. A national office, most likely within EMR's CANMET, could be established to manage the R&D program.

MARKETS AND PRICES

Uranium marketing activity was brisk during 1981 although few new sales were announced by Canadian producers. In January, Rio Algom Limited reported the conclusion of an agreement for the sale of 1 300 tU to Preussische Elektrizitäts AG (PREAG), a West German electric utility, for delivery between 1983 and 1995; the sale further offsets the abrogation by the Tennessee Valley Authority in the late 70s of its 6 540 tU contract with Rio Algom.

As part of the litigation settlements with Westinghouse Electric Corporation of Pittsburgh, certain Canadian mining companies agreed to deliver uranium to Westinghouse following mutually acceptable pricing arrangements. By the end of 1981, most of the litigants, including all of the Canadian producers involved, had settled out-of-court. All maintained that the settlements constituted no admission of wrong-doing but rather a means of ending the inconvenient and costly legal proceedings.

In 1981, new export contracts totalling some 20 700 tU were reviewed by the federal government and found to be consistent with Canadian uranium export policy, a ten-fold increase over quantities that cleared the review process in 1980. As shown in Table 5, these contracts brought to some 79 700 tU the total amount of uranium under export contracts reviewed since September 5, 1974; this total reflects scheduled deliveries under 62 contracts, 31 of which remain active. As of December 1981, forward export commitments under all active contracts, including those in place prior to September 5, 1974, were estimated at some 60 500 tU; forward domestic commitments approached 75 000 tU.

Uranium prices began to fall in late-1979 and dropped sharply in early 1980 as the short-term market outlook deteriorated. By mid-1980, prices had declined to about $US 78/kg U ($US 30/lb U_3O_8). Utility inventory sales increased in response to escalating interest rates and by January 1981, the Nuclear Exchange Corporation (NUEXCO) reported an "Exchange Value"[1] of $US 65/kg U ($US 25/lb U_3O_8). Continued uncertainty in the uranium market caused some additional production curtailment and further mine closures, particularly in the United States (see International Highlights). However, the price slide had begun to ease by mid-1981, as indicated by the NUEXCO Exchange Value which stabilized at $US 61.10/kg U ($US 23.50/lb U_3O_8) for the latter half of the year.

[1] 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.

TABLE 5. URANIUM UNDER EXPORT CONTRACTS REVIEWED[1] SINCE SEPTEMBER 5, 1974 (as of December 1981)[2]

Country	short tons[3] U_3O_8	tonnes U
Belgium	1,346	1 035
Finland	2,400	1 846
France	5,000	3 847
Italy	1,800	1 385
Japan	29,416	22 630
South Korea	6,683	5 141
Spain	5,500	4 232
Sweden	1,565	1 204
Switzerland	200	154
United Kingdom	10,000	7 693
United States	29,740	22 880
West Germany	9,963	7 664
Total	103,613	79 711

Source: Energy, Mines and Resources Canada.
[1] Reviewed and found to be consistent with Canadian uranium export policy. [2] Quantities adjusted to reflect new and amended contracts. [3] Most Canadian export contracts are written in terms of Imperial units.

In a survey conducted by the United States Department of Energy (USDOE) in July 1981 and released in the fall, it was reported that the average price paid by U.S. buyers for 1981 deliveries of domestic uranium under all contracts including settlements of "market price" agreements increased slightly during the first half of the year from $US 79.82/kg U ($US 30.70/lb U_3O_8) to $US 80.47/kg U ($US 30.95/lb U_3O_8).

In comparison, the average "market price" reportedly paid by U.S. buyers for 1981 deliveries of domestic uranium varied from $US 121.68/kg U ($US 46.80/lb U_3O_8) as of the January 1981 survey to $US 90.09/kg U ($US 34.65/lb U_3O_8) as of the July survey; these prices reflected sales of 300 tU and 1 150 tU respectively. Most "market price" contracts have floor prices which in some cases are above the current spot market price for uranium. Such procurements comprised 34 per cent of 1981 delivery commitments, up from 26 per cent in 1980.

"Contract price" arrangements, in which a base price and applicable escalation factors are determined when the contract is signed, constituted 52 per cent of 1981 delivery commitments. Such arrangements are expected to represent less than half of the total deliveries in 1982; this relative percentage is expected to continue to decline thereafter.

In Canada, market prices for 1981 deliveries of uranium were marginally higher than those reflected in the USDOE survey and significantly higher than the NUEXCO Exchange Value. Calculations made in December, as part of the continuing URAG exercise, indicated a price of $C 110/kg U as the average weighted price for 1981 under market-related export contracts (including spot sales) made by Canadian producers for deliveries in 1981. If converted to U.S. dollars at year-end exchange rates, this price would be equivalent to about $US 95/kg U ($US 37/lb U_3O_8). The $C 110/kg U value will serve to define the lower price category for the purpose of assessing Canada's uranium resources as calculated on December 31, 1981.

REFINING

At the Port Hope, Ontario, uranium processing facilities of Eldorado Nuclear Limited, uranium concentrates are first refined to high purity uranium trioxide (UO_3)[1] prior to conversion into either uranium hexafluoride (UF_6)[2] for foreign utilities that operate light water reactors, or ceramic-grade uranium dioxide (UO_2) for CANDU-type heavy water reactors. Mine concentrates containing some 6 000 tU were processed by Eldorado during 1981, a 15 per cent increase over 1980. The improved performance resulted from the installation of new equipment and the development of new processes in recent years. Some 4 652 tU as UF_6 were produced, up almost 10 per cent from 1980, while output of natural ceramic-grade uranium dioxide jumped 39 per cent in 1981 to 1 338 tU as UO_2.

[1] Uranium trioxide is the initial refined product from which either UO_2 or UF_6 is produced.
[2] Uranium hexafluoride is the required feed material for the uranium enrichment process.

During 1981, almost $63 million was spent toward the expansion of Eldorado's processing capacity. At Blind River, Ontario, where all refining to nuclear-grade UO_3 will be consolidated, plant site approval was received in February and construction approval in July from the Atomic Energy Control Board (AECB). By year-end, some $50 million had been spent on the project and plant construction was 30 per cent complete. Start-up of the refinery, capable of producing some 18 000 tU as UO_3 annually, was scheduled for April 1983. At Port Hope, Ontario, where production capacity for UF_6 conversion will be expanded, some $13 million was spent on design, engineering and site preparation work, site approval having been granted by the AECB in July. An application to the AECB for construction approval was submitted in December; construction was expected to begin in April 1982. The new facility, capable of producing some 9 000 tU as UF_6 yearly, was expected to start-up in October 1983.

NUCLEAR POWER DEVELOPMENTS

At the end of 1981, it was estimated that 273 nuclear power reactors, with a combined generating capacity of some 155 000 electrical megawatts (MWe), were operable throughout the world. Within Canada, 10 CANDU reactors with an aggregate net output capacity of 5 248 MWe were operating at year-end and a further 14 reactors with an aggregate capacity of some 9 885 MWe were either under construction or committed (Table 7).

During 1981, almost 35 per cent of the total electrical energy generated by Ontario Hydro came from nuclear-electric units, some 34 per cent came from hydroelectric sources and about 31 per cent from coal-fired plants. An additional 12.5 million t of coal would have been required to produce the equivalent amount of electricity generated by nuclear means.

Ontario Hydro's nuclear reactors were again acclaimed among the world's best performers. To the end of 1981, seven of Hydro's eight operating CANDU reactors were in the top 10, in terms of lifetime capacity factor[3], out of some 130 commercial

[3] 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 6A. EXPORTS[1] OF RADIOACTIVE ORES AND CONCENTRATES[2] FROM CANADA, 1975-81

	United States[3]	USSR	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	209,978	-	10,319	-	1	8,035	-	2,329	230,662
1981P	152,473	3,182	17,348	-	-	-	2,862	2,022	177,888

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; - Nil.

TABLE 6B. EXPORTS[1] OF RADIOACTIVE ELEMENTS[2] AND ISOTOPES FROM CANADA, 1975-81

	US[3]	USSR[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	-	5,493	94,038	1,101	87	3,992	602,077
1980	199,001	77,235	2,104	20,406	144,013	4,847	-	6,408	27,766	1,911	137,002	4,686	625,379
1981P	382,418	20,192	3,577	40,092	213,051	339	7,506	-	248	1,577	67	2,915	671,982

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; - Nil.

TABLE 7. NUCLEAR POWER PLANTS IN CANADA, DECEMBER 1981

Reactors	Owner	Net Output (MWe)	In-Service Dates
Operating			
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
Sub-total		5 248	
Under Construction or Committed			
Point Lepreau	New Brunswick Electric Power Commission	635	1982
Gentilly 2	Hydro-Québec	638	1983[r]
Pickering 5 to 8	Ontario Hydro	2 064	1983-85[r]
Bruce 5 to 8	Ontario Hydro	3 024	1984-87[r]
Darlington 1 to 4	Ontario Hydro	3 524	1988-90
Sub-total		9 885	
Grand Total		15 133	

Source: "Uranium in Canada: 1980 Assessment of Supply and Requirements"; Energy, Mines and Resources Canada, Report EP 81-3, September 1981.
[r] Revised in-service date.

power reactors, rated at 500 MWe or greater, in service around the world. The seven include the four units at the Pickering "A" station, just east of Toronto, and units 1, 3 and 4 at the Bruce "A" station near Kincardine. Work progressed on the four new units at Pickering "B" and the four at Bruce "B"; all eight reactors are scheduled to be placed in service by 1987.

In April, Ontario Hydro announced that the in service dates of the first two units of its Darlington "A" nuclear station, near Bowmanville, would be advanced by six months and the second two units by 12 months. Following the approval in May by the AECB of the construction licence for Darlington, work was stepped up. The station is now scheduled for completion by 1990.

In November, the AECB approved the modifications to the emergency coolant system at the Douglas Point CANDU prototype, located in the Bruce Nuclear Power Development, and the reactor was returned to full power capacity. In addition to electricity generation, both the Douglas Point facility and the NPD generating station at Rolphton, Ontario, continued to serve as training and R&D centres.

At Hydro-Québec's Gentilly 2 Station (a conventional CANDU-Pressurized Heavy Water Reactor) near Bécancour, the mid-year discovery of a damaged steam generator and the subsequent repairs postponed, to the middle of 1982, the date at which the reactor could go critical; start-up of the power station was expected in early 1983. The adjacent Gentilly 1 Station (a CANDU-Boiling Light Water prototype), owned by Atomic Energy of Canada Limited (AECL), remained inoperative throughout 1981 on a care-and-maintenance basis. Under its 1966 contract with AECL, Hydro Québec had the option of buying the facility. However, following discussions with AECL during 1981 toward the transfer of ownership, Hydro-Québec reported that it had decided not to acquire the plant.

At the Point Lepreau Nuclear Generating Station, some 40 km southwest of St. John, New Brunswick, plant construction was essentially completed by year-end and start-up of the project was well advanced. Expectations were that the reactor would be in service in mid-1982.

At the end of 1981, the New Brunswick Electric Power Commission had initiated agreements for the export of 335 MWe of the capacity output of Point Lepreau. Specific agreements, subject to approval by the National Energy Board of Canada, were with the Massachusetts Municipal Wholesale Electric Company, Boston Edison Company, and Eastern Maine Electric Cooperative Inc. for 100 MWe, 100 MWe and 5 MWe of firm power, respectively. Entitlement would commence on the first day of the calendar month following the in service date of the reactor and would expire on October 31, 1987; optional extensions are included in these agreements.

INTERNATIONAL HIGHLIGHTS

During 1981, the most significant changes in uranium production levels occurred in the United States and Australia; U.S. production fell by 2 000 tU while Australian production almost doubled.

The consequences of the deterioration in the uranium market were most evident in the United States. In 1980, there were 23 conventional uranium production centres in operation in the United States with a combined ore treatment capacity of some 49 000 tpd. Although by the end of 1981, 20 of these mine/mill complexes remained in production, plant closures and reduced operating schedules had decreased ore throughput capacity by 8 per cent to some 45 000 tpd. Of the 11 conventional mine/mill projects under construction or planned in 1981, all had been deferred indefinitely by year-end. The combined ore treatment capacity affected by project deferrals exceeded 18 000 tpd.

During 1981, output from U.S. non-conventional uranium operations (recovery from phosphoric acid and from solution mining operations) was close to the level achieved in 1980 despite some loss in production capacity through project deferrals and plant closures. At year-end, it was expected that further cutbacks would be made throughout the U.S. industry, and that production capacity would continue to decline in 1982.

In Australia, the expansion of the uranium industry continued, as progress was made toward the development of a number of significant uranium orebodies.

In February 1981, the Australian government approved the Environmental Impact Statement submitted for the Koongarra project, in the South Alligator Region, Northern Territory, acquired by Denison Australia Pty. Limited in late 1980. Negotiations were under way with the Northern Land Council, which represents the interests of the traditional aboriginal owners of the Koongarra properties, toward an agreement that will allow Denison to proceed with deposit development. The two contiguous orebodies, estimated to contain some 11 500 tU, are amenable to open-pit mining at a reported output capacity of some 960 tU per year.

On November 20, 1981, the Ranger uranium project was officially opened, some 12 years after the initial discovery of the deposit. Mining of the No. 1 orebody began in August 1981 and production of the first concentrate was reported in September; full output capacity of some 2 500 tU per year was reached in November. By the end of 1981, Energy Resources of Australia (ERA), the consortium formed to acquire the Australian government's 50 per cent interest in the Ranger project as well as the interests of the original joint partners, had contract commitments of some 35 000 tU, representing nearly 95 per cent of the production capacity over the first 15 years of the operation. Announced resources of the No. 1 and No. 3 orebodies were some 45 000 tU and 61 000 tU, respectively; the mine/mill complex is designed to allow a doubling of throughput capacity.

Other major uranium projects awaiting government approval at year-end included the Jabiluka project in the Northern Territory and the Roxby Downs (Olympic Dam) project, located in South Australia.

Pancontinental Mining (65 per cent) and Getty Oil Development Company, Ltd. (35 per cent), the joint-venture partners in the Jabiluka project, propose an underground mining operation at an initial capacity of 2 500 tU per year from resources in excess of 170 000 tU. Output could be expanded to 5 000 tU per year if market conditions warranted. Capital development costs at Jabiluka will exceed $A 600 million; start-up is expected in the late 1980s.

At the Roxby Downs (Olympic Dam) project, joint-venture partners, Western Mining Corporation Holdings Ltd. (51 per cent) and BP Australia Ltd. (49 per cent), anticipated government approval to proceed by mid-1982. Exploration and feasibility studies will continue at the deposit which reportedly contains in excess of 400 000 tU, 15 million t copper plus significant tonnages of gold and rare earths; production is unlikely before the 1990s.

OUTLOOK

Recent studies of the future of the nuclear industry indicate that the projections of the International Nuclear Fuel Cycle Evaluation (INFCE) released in early-1980 were overly optimistic, and that several more years of surplus uranium supply capability are likely. While providing little incentive for industry in the short-term, these more recent analyses nonetheless continue to predict that nuclear power will play an increasingly important role in the world's energy supply, and suggest that exploration efforts should be sustained in order to meet the world's long-term nuclear fuel requirements.

During 1981 the Uranium Institute released a study which examined in some detail the outlook for the uranium industry to 1995[1]. Projections of supply capability, based on then-current knowledge of uranium resources, were derived to show an upper limit, representing an estimation of maximum production capability, and a lower limit, representing the attainable output level of only those production facilities operating, or under construction, in 1980. Similarly, projections of annual fuel requirements were derived to show an upper limit, reflecting uranium demand estimates for high nuclear growth capacity, and a lower limit, reflecting demand expectations from nuclear power facilities that, in 1980, were operating or firmly committed for operation. Figure 4, which illustrates these supply and requirement projections, reveals an apparent surplus of uranium supply capability at least through the mid-1980s. It seems clear that market opportunities in the short-term will be limited. As significant price increases do not seem imminent, production will be measurably less than the industry's current total capability.

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[1] **The Uranium Equation: The Balance of Supply and Demand, 1980 to 1995,** Uranium Institute, 1981.

Beyond 1990, uranium supply capabilities could fall short of requirements if uranium exploration momentum is lost and new sources of supply are not developed. Indeed, should there be a prolonged period of low prices, future supply capabilities could be exacerbated through the permanent loss of current supply potential. For example, operations that may be forced to shut down for economic reasons in 1982 may be too costly to rehabilitate in the future, and resources left in the ground in the process of extracting higher-grade material in 1982 may never be recoverable because they may become too costly to exploit. Although such developments would contribute to a balancing of supply and demand in the short term they could increase the need for new sources of supply in the long-term.

Nuclear energy is already playing a significant role in a number of countries. In its annual report, the International Atomic Energy Agency (IAEA) indicated that, at the beginning of 1981, some 253 nuclear power reactors were in operation in 22 member states and that these power reactors supplied about 8 per cent of the world's electrial needs. In some countries, nuclear power plants are the major source of electricity. On a world basis, the IAEA predicts that, by 1985, 17 per cent of all electricity will be nuclear.

Canada's uranium industry is firmly established among the world's leading producers and should have no difficulty in meeting domestic requirements while responding to longer-term export opportunities. Given the probability of significant new uranium discoveries in Canada and the possibility that worldwide uranium requirements could exceed estimated production capability during the 1990s, the Canadian uranium industry can be expected to further expand its output capability. Continued development of the industry ultimately depends upon the manifestation of greater assurances of global demand.

Zinc

M.J. GAUVIN

The stagnation and then weakening of world economies was not favourable to markets for zinc during 1981. Possibly the most adverse economic factor, from the viewpoint of zinc, has been the level of interest rates. High interest rates are reported as being the prime cause of major declines in housing activity, spending on plant and equipment and demand for automobiles. Accordingly, zinc prices have weakened in an extremely competitive market.

CANADA

Mining

Canadian zinc mine production recovered from the low production level of 1980 caused by strikes and production problems at some of the major producers.

The Buchans mine in Newfoundland, operated by ASARCO Incorporated, continued with exploration and development of new ore zones below and at the extremity of existing mine workings. The new GaysRiver mine of Esso Resources Canada Limited in Nova Scotia encountered major production problems and experienced substantial operating losses because of ore irregularities and heavy inflows of water. Production ceased in August and the plant has been mothballed for a year while attempts are made to develop better grade ore and prevent underground flooding.

In New Brunswick, Brunswick Mining and Smelting Corporation Limited completed the expansion of its No. 12 mine near Bathurst early in the year. In April mine production increased from 9 070 tpd of ore to 10 000 tpd of ore. The new production level increases annual capacity by 10 000 t of lead and 30 000 t of zinc in concentrates. Zinc output in 1981 was close to double that in 1980, when production was interrupted by a four-month strike. Brunswick Mining ranks as one of the world's largest producers of zinc and lead concentrates. Anaconda Canada Exploration Ltd. has been doing metallurgical test work and studying the feasibility of reopening its Caribou zinc-lead-copper mine near Bathurst.

Les Mines Gallen Limitée, owned 51 per cent by Noranda Mines Limited and 49 per cent by Macdonald Mines, Ltd., has brought into production its zinc-copper-gold-silver property near Noranda, Quebec. The property, the former West MacDonald mine, is being mined as an open-pit with a designed capacity of 19 000 tpy of zinc in concentrates. The ore is trucked to Noranda's Horne Division concentrator for treatment. First shipments of ore to the Horne plant were made in November. Also in Quebec, the Louvicourt mine of Louvem Mining Company Inc. ceased production because of depletion of ore reserves. For the same reason, Selco Inc. closed its mine at South Bay, Ontario. Noranda's "F" zone mine in the Sturgeon Lake area of Ontario started production in 1981 with an annual capacity of 1 000 t of lead and 12 000 t of zinc in concentrates. The ore is treated at the Mattabi concentrator. Kidd Creek Mines Ltd. completed the development of its No. 2 mine. This new mine raised the operation's annual ore production capacity to 4 500 000 t from 3 260 000 t. Concentrator capacity has recently been increased to 12 250 tpd. Kidd Creek is the new name for Texasgulf Inc.'s Canadian operations which were acquired in 1981 by Canada Development Corporation (CDC) in exchange for CDC's former 35 per cent interest in the parent company.

Hudson Bay Mining and Smelting Co., Limited has three new copper-zinc mines - the Rod, Spruce Point and Trout Lake mines - under development in the Flin Flon area of Manitoba. The Trout Lake mine is a

TABLE 1. CANADA, ZINC PRODUCTION AND TRADE, 1980 AND 1981 AND CONSUMPTION 1979-80

	1980		1981P	
	(tonnes)	($000)	(tonnes)	($000)
Production				
All forms[1]				
Ontario	251 537	244,277	246 613	295,936
New Brunswick	135 583	131,669	232 051	278,462
Northwest Territories	177 685	172,556	224 206	269,047
Yukon	90 938	88,313	86 486	103,783
British Columbia	67 481	65,534	62 219	74,662
Quebec	65 599	63,706	54 329	64,614
Newfoundland	44 073	42,801	40 504	48,604
Manitoba	43 055	41,812	39 367	47,240
Saskatchewan	5 276	5,123	6 330	7,596
Nova Scotia	2 470	2,399	2 944	3,533
Total	883 697	858,190	995 049	1,193,477
Mine output[2]	1 058 714		1 095 958	
Refined[3]	591 565		618 650	
Exports				
Zinc blocks, pigs and slabs				
United States	278 226	259,577	304 443	336,082
United Kingdom	50 479	41,969	31 741	31,211
India	14 605	11,650	10 774	9,722
Venezuela	19 974	15,882	10 039	9,299
Brazil	15 392	16,571	9 121	7,426
Italy	6 192	4,991	7 149	6,689
Singapore	8 058	6,347	6 699	6,026
West Germany	4 269	3,425	6 069	5,784
Nigeria	5 765	4,530	6 707	5,707
Belgium-Luxembourg	9 492	7,520	6 404	5,452
Thailand	5 682	4,642	5 280	5,165
Other countries	53 816	42,550	49 106	43,403
Total	471 949 √	419,654	453 532	471,966
Zinc contained in ores and concentrates				
Belgium-Luxembourg	113 098	46,308	191 418	102,712
Japan	124 258	33,988	118 470	51,702
France	6 620	2,796	33 397	19,185
United States	62 318	21,322	35 896	17,996
United Kingdom	10 029	5,013	25 635	14,716
West Germany	46 583	17,862	28 004	13,257
Algeria	3 634	2,313	16 746	11,735
Italy	16 731	6,745	22 026	10,664
Netherlands	22 797	10,902	19 292	9,470
Other countries	28 109	11,657	25 335	13,210
Total	434 177	158,906	516 219	264,647
Zinc alloy scrap, dross and ash[4]				
United States	13 186	5,435	18 889	8,774
Belgium-Luxembourg	2 395	1,469	3 521	2,024
United Kingdom	2 893	944	2 173	641
West Germany	2 073	200	3 287	494
Taiwan	542	224	681	236
Other countries	1 106	374	413	107
Total	22 195	8,646	28 964	12,276

TABLE 1. (cont'd.)

	1980		1981P	
	(tonnes)	($000)	(tonnes)	($000)
Zinc dust and granules				
United States	3 390	3,280	5 393	7,424
United Arab Emirates	-	-	107	193
Venezuela	32	45	60	116
Other countries	219	201	97	109
Total	3 641	3,526	5 657	7,842
Zinc fabricated material, nes				
United States	3 250	4,582	2 238	5,000
Venezuela	-	-	150	146
New Zealand	17	17	72	59
Israel	-	-	7	57
West Germany	24	95	19	56
Other countries	431	441	135	222
Total	3 722	5,135	2 621	5,540
Imports				
In ores, concentrates and scrap	59 542	26,167	71 295	36,858
Dust and granules	234	319	380	578
Slabs, blocks, pigs and anodes	724	711	8 094	9,741
Bars, rods, plates, strip and sheet	390	702	526	1,059
Slugs, discs and shells	167	118	272	181
Zinc oxide	1 526	1,283	1 303	1,765
Zinc sulphate	1 322	608	1 659	710
Zinc fabricated materials, nes	897	2,440	931	2,489
Total	64 802	32,348	84 460	53,381

	1979			1980		
	Primary	Secondary	Total	Primary	Secondary	Total
	(tonnes)					
Consumption[5]						
Zinc used for, or in the manufacture of:						
Copper alloys (brass, bronze, etc.)	11 587)			7 494)		
Galvanizing: electro	1 340)	255	87 603	1 138)	365	73 372
hot dip	74 421)			64 375)		
Zinc die-cast alloy	16 540	X	X	12 738	X	X
Other products (including rolled and ribbon zinc, zinc oxide)	23 692	X	X	24 668	X	X
Total	127 580	3 737	131 317	110 413	6 205	116 618
Consumer stocks, year-end	13 139	912	14 041	20 967	1 151	22 118

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; nes Not elsewhere specified; X Confidential.

TABLE 2. CANADA, ZINC MINE OUTPUT, 1980 AND 1981

	1980	1981
	(tonnes)	
Newfoundland	47 061	43 717
Nova Scotia	4 807	4 528
New Brunswick	171 595	273 015
Quebec	78 752	62 614
Ontario	302 977	269 831
Manitoba-Saskatchewan	57 416	56 750
British Columbia	71 087	82 540
Yukon Territory	98 355	99 988
Northwest Territories	226 664	203 274
Total	1 058 714	1 096 257

Source: Energy, Mines and Resources Canada.

joint venture with Gränges Exploration AB of Sweden, Outokumpu Oy of Finland and Manitoba Mineral Resources Ltd. Hudson Bay will earn a 44 per cent interest in the venture by spending approximately $28 million to develop the property. Production is scheduled to start in mid-1982 and to reach rated capacity of 1 600 tpd in 1983. Surface construction has been completed at the Rod and Spruce Point mines, with production scheduled to start in 1982 and 1983 respectively. Underground exploration is under way on the company's Tom claims in the Yukon to obtain the additional underground data required for a feasibility study.

In British Columbia, Noranda Mines Limited is continuing development work to bring into production its Goldstream property at an estimated cost of $60 million. This copper-zinc property is located in the Goldstream Valley about 90 km north of Revelstoke. It is expected to be in production late in 1982 processing 1 350 tpd, five days a week, and producing 5 000 t of zinc in concentrates a year.

Cyprus Anvil Mining Corporation and Hudson's Bay Oil and Gas Company Limited (HBOG) are conducting a major exploration program on the Cirque deposit in the Akie River District north of Williston Lake in northcentral British Columbia. During 1981, a diamond drilling program was completed, as was construction on an 80 km access road to the property. Work to date indicates a lead-zinc-silver district of potentially major proportions. During the year, Hudson's Bay Oil and Gas acquired from Standard Oil Company (Indiana) its 63 per cent interest in Cyprus Anvil and subsequently offered to purchase the remaining outstanding common shares. Cyprus Anvil is continuing its Vangorda Plateau development program in the Yukon. Modifications to its Anvil concentrator, started in 1980, have been completed

TABLE 3. CANADA, ZINC PRODUCTION, EXPORTS AND DOMESTIC SHIPMENTS, 1970, 1975-81

	Production		Exports			Producers'
	All Forms[1]	Refined[2]	In Ores and Concentrates	Refined	Total	Domestic Shipments
			(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
1976	982 057	472 316	653 737	352 072	1 005 809	133 561
1977	1 070 515	494 938	598 452	295 358	893 810	120 727
1978	1 066 902	495 243	688 186r	439 261	1 127 447r	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
1981P	995 049	618 650	516 219	453 532	969 751	131 859

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, 1979-81

	1979	1980	1981P
		(tonnes)	
1st Quarter	42 951	37 858	35 044
2nd Quarter	40 015	30 295	39 151
3rd Quarter	30 528	30 510	27 910
4th Quarter	40 250	33 880	29 754
Total	153 744	132 543	131 859

Source: Energy, Mines and Resources Canada.
P Preliminary.

at a cost of some $71 million. The modifications were necessary to handle the ores from the Vangorda and Grum deposits. The company has started a $240 million long-term development program to bring these properties into production in 1985 and 1988 respectively. The new ore will be blended with ore from the existing Faro deposit and will see the life of the Faro camp possibly extended into the next century.

Cominco Ltd. completed construction and development work at its Polaris mine on Little Cornwallis Island in the arctic. Cominco has been a pioneer in northern mine development, first with the Con mine at Yellowknife in the Northwest Territories, then the Black Angel mine in Greenland, and now the Polaris. The Polaris will be the world's most northerly mine, located only 45 km southeast of the magnetic north pole. Start-up of the mine was scheduled for the beginning of 1982, and at full design capacity, the Polaris mill will produce 130 000 tpy of zinc in concentrates and 30 000 tpy of lead in concentrates. This will make Cominco, which celebrated its 75th anniversary in 1981, the world's largest producer of lead and zinc. A barge measuring 122 m by 30.5 m constructed by Davie Shipbuilding Limited at Lauzon, Quebec, was outfitted at Trois-Rivieres by a joint venture of Comstock Quebec Ltée and Dominion Bridge-Sulzer Inc. It contained the concentrator, powerhouse, warehouses, laboratories, changehouse, repair shops and offices. Work on the barge was completed in early July and it was towed the 4 800 km to the mine by the middle of August. The barge was permanently berthed on a prepared area of the shoreline. The only other buildings exposed to the elements in this area, where the temperature is usually well below 0°C with prolonged periods of 100 km/hr winds, is the concentrate storage shed and an accommodation complex. The waters around the island are navigable for only a short period starting in August, when the mine's production must be shipped out and all major supplies brought in. In 1982, the first shipments of about half of an average year's production will be shipped out. Ore reserves at Polaris are estimated at 23 million t averaging 14.1 per cent zinc and 4.3 per cent lead.

Another northern project is rapidly reaching the production stage. Cadillac Explorations Limited of Calgary has received the financing necessary to complete the development of its mining leases on Prairie Creek in the Nahanni mining district of the Northwest Territories. A 900 tpd mill built on the property is expected to be completed in 1982. Production at the rate of 25 000 tpy of lead and 25 000 tpy of zinc in concentrates is planned. Proven ore reserves in one of 12 known mineralized zones is reported as 1.4 million t averaging 11.2 per cent lead, 12.2 per cent zinc, 0.4 per cent copper and 186 g/ton silver.

SMELTING AND REFINING

Brunswick Mining and Smelting Corporation Limited announced a joint project with Heath Steele Mines Limited to build a 100 000 tpy zinc reduction plant at Belledune, New Brunswick. Basic engineering and planning has been completed and construction is scheduled to start in May 1982, with plant start-up targeted for late 1984. The project will cost about $360 million, including interest and working capital, and will include DREE and other grants totalling $35 million. The plant will process zinc concentrates brought by rail 60 km from the Brunswick Mining Division and some 90 km from Heath Steele Mines. Once in full production the plant will create some 400 permanent jobs.

Three zinc metal refineries are increasing their capacities. Cominco Ltd. is continuing a modernization and expansion program started in 1977, the largest component being replacement of and additions to the zinc electrolytic and melting plant. The program includes construction of the world's first zinc pressure-leaching plant, expected to be fully operational early in 1982 when it will add 27 000 t to the annual capacity of the complex. The new technology incorporated in this plant separates sulphur from

TABLE 5. PRINCIPAL ZINC MINES IN CANADA, 1981 AND (1980)

Company and Location	Daily Mill Capacity (tonnes ore)	Zinc (%)	Lead (%)	Copper (%)	Silver (grams/ tonne)	Ore Produced (tonnes)	Zinc Concentrates Produced (tonnes)	Zinc Concentrates Zinc Grade (%)	Zinc Content of all Concentrates (tonnes)	Destination of Zinc Concentrate
Newfoundland										
ASARCO Incorporated	1 100	8.95	5.31	0.80	92.9	68 946	9 123	52.68	5 727	6
Buchans	(1 100)	(9.38)	(5.42)	(0.85)	(102.5)	(75 297)	(10 002)	(55.02)	(6 646)	(6)
Newfoundland Zinc Mines	1 500	7.53	-	-	-	530 517	63 421	61.53	39 023	6,8
Limited,	(1 500)	(8.19)	(-)	(-)	(-)	(518 125)	(67 536)	(61.60)	(41 602)	(3,6,8)
Daniel's Harbour										
Nova Scotia										
Esso Resources Canada Limited	1 500	-	-	-	-	-	-	-	-	-
Gays River	(1 500)	(2.04)	(1.43)	(-)	(-)	(261 942)	(7 808)	(61.66)	(4 991)	(6)
New Brunswick										
Brunswick Mining and Smelting	10 000	8.74	3.50	0.35	97.9	3 422 690	488 064	48.37	249 998	3,7,8,9,10
Corporation Limited										11,12
Bathurst	(9 050)	(8.80)	(3.56)	(0.31)	(97.4)	(1 848 036)	(262 206)	(49.53)	(139 863)	(3,6,7,8, 9,10,11,12)
Heath Steele Mines Limited	3 600	3.94	1.45	0.91	51.4	1 249 928	76 017	48.58	40 600	3,8,9,11,
Newcastle										12
	(3 600)	(4.34)	(1.45)	(0.84)	(55.2)	(1 252 406)	(86 346)	(48.33)	(44 872)	(3,6,8,9, 12)
Quebec										
Corporation Falconbridge	1 400	1.19	-	2.79	19.5	452 953	6 944	50.58	4 169	3
Copper	(1 400)	(2.19)	(-)	(2.70)	(28.8)	(475 464)	(13 820)	(52.14)	(8 559)	(3)
Lake Dufault Division										
Noranda										
Lemoine Mines Limited	300	8.47	-	3.70	69.6	85 002	10 718	52.55	6 566	12
Lemoine Mine	(300)	(10.00)	(-)	(4.71)	(88.8)	(104 326)	(14 756)	(52.41)	(9 217)	(12)
Chibougamau										
Louvem Mining Company Inc.	900	4.03	0.19	0.19	29.5	32 276	2 109	53.30	1 124	2
Val d'Or	(900)	(3.89)	(0.11)	(0.15)	(30.4)	(244 530)	(13 806)	(54.42)	(7 945)	(2,6)
Noranda Mines Limited	4 000	4.85	-	0.75	19.6	1 203 444	99 567	51.57	51 614	3
Mattagami Division	(4 000)	(4.81)	(-)	(0.77)	(21.4)	(1 328 360)	(108 683)	(52.39)	(57 503)	(3)
Mattagami										

Ontario										
Corporation Falconbridge	-	-	-	-	-	-	-	-	-	-
Copper										
Sturgeon Lake Joint Venture	(1 100)	(5.89)	(1.05)	(1.46)	(131.7)	(371 623)	(33 421)	(52.30)	(19 206)	(1,3,12)
Sturgeon Lake										
Mattabi Mines Limited and	2 700	6.50	0.57	0.56	86.4	896 197	96 562	52.49	53 462	1,2,3,12
Noranda Mines Limited,	(2 700)	(7.24)	(0.87)	(0.44)	(106.6)	(846 940)	(102 466)	(52.33)	(55 743)	(1,2,3,12)
Lyon Lake Division and										
"F" Group Mine										
Sturgeon Lake										
Noranda Mines Limited	4 550	3.16	0.10	1.83	46.6	1 329 489	67 985	52.41	39 243	1
Geco Division	(4 550)	(3.32)	(0.14)	(1.47)	(60.7)	(1 358 317)	(73 569)	(51.54)	(41 442)	(1,2)
Manitouwadge										
Selco Inc.	450	8.81	-	1.42	79.5	38 698	5 842	53.08	3 187	6
South Bay Division	(450)	(8.79)	(-)	(1.48)	(65.5)	(117 291)	(17 178)	(52.73)	(9 274)	(6)
Uchi Lake										
Kidd Creek Mines Ltd.	13 400	5.35	0.16	1.90	64.9	4 076 359	331 993	53.08	192 792	3,5,6,12
Hoyle	(12 250)	(5.78)	(0.18)	(1.83)	(86.4)	(3 899 615)	(351 615)	(52.62)	(198 204)	(3,5,6,12)
Manitoba and Saskatchewan										
Hudson Bay Mining and										
Smelting Co., Limited,										
Flin Flon	7 250	2.10	0.14	1.58	20.0	983 990	23 052	46.38	15 738	2
	(7 250)	(2.11)	(0.15)	(1.67)	(19.8)	(945 379)	(19 383)	(44.36)	(14 263)	(2)
Snow Lake	3 450	2.65	0.14	2.56	12.4	771 427	31 420	52.3	17 454	2
	(3 450)	(3.23)	(0.23)	(2.65)	(16.7)	(756 283)	(38 611)	(51.73)	(21 027)	(2)
Sherritt Gordon Mines Limited,	2 700	1.73	-	1.42	7.6	733 538	17 315	50.68	10 274	2
Fox mine	(2 700)	(1.56)	(-)	(1.40)	(6.5)	(784 011)	(16 302)	(50.50)	(9 602)	(2)
Lynn Lake										
Ruttan mine	9 050	1.25	-	1.30	7.3	1 702 809	29 011	51.11	17 019	2
Ruttan Lake	(9 050)	(1.02)	(-)	(1.36)	(6.5)	(2 311 444)	(27 163)	(51.33)	(16 577)	(2)
British Columbia										
Cominco Ltd.										
Sullivan mine	9 050	3.23	4.43	-	62.1	2 209 669	119 049	49.54	65.127	1
Kimberley	(9 050)	(2.73)	(3.85)	(-)	(44.6)	(2 132 416)	(95 449)	(49.29)	(52 103)	(1)
Dickenson Mines Limited										
Silmonac mine	100	3.49	4.18	-	430.3	26 764	1 145	50.53	829	1,6
Sandon	(100)	(3.03)	(3.21)	(-)	(295.9)	(28 233)	(1 233)	(50.60)	(738)	(6)

TABLE 5. (cont'd)

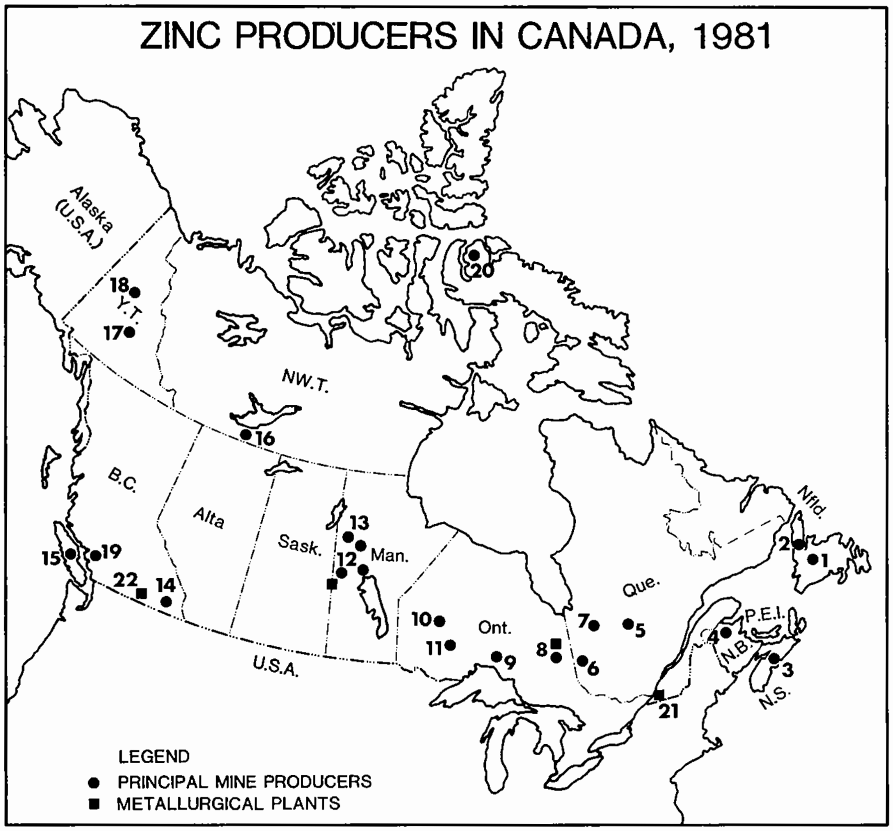
Company and Location	Daily Mill Capacity (tonnes ore)	Zinc (%)	Lead (%)	Copper (%)	Silver (grams/ tonne)	Ore Produced (tonnes)	Zinc Concentrates Produced (tonnes)	Zinc Concentrates Zinc Grade (%)	Zinc Content of all Concentrates (tonnes)	Destination of Zinc Concentrate
British Columbia (cont'd.)										
Northair Mines Ltd.	250	2.09	1.15	0.15	28.6	62 548	2 087	48.13	1 146	1
Brandywine area	(250)	(2.15)	(1.38)	(0.50)	(32.3)	(71 478)	(2 224)	(50.49)	(1 361)	(1)
Teck Corporation	100	0.82	0.35	-	353.1	35 774	433	37.53	202	1
Beaverdell mine	(100)	(0.56)	(0.23)	(-)	(290.7)	(38 550)	(359)	(27.20)	(126)	(1)
Beaverdell										
Westmin Resources Limited	900	7.37	1.22	1.13	124.1	246 150	28 695	53.43	17 245	1
Lynx and Myra Falls	(900)	(7.58)	(1.23)	(1.22)	(124.1)	(278 244)	(32 468)	(53.59)	(19 805)	(6,12)
Yukon Territory										
Cyprus Anvil Mining	9 050	4.80	2.90	-	42.0	2 751 789	201 200	49.50	107 185	7,8,12
Corporation	(9 050)	(4.68)	(3.12)	(-)	(47.0)	(2 825 150)	(209 362)	(47.12)	(108 998)	(7,8,12)
Faro										
United Keno Hill Mines	450	0.64	3.59	-	750.2	60 712	-	-	125	-
Limited	(450)	(0.79)	(3.39)	(-)	(787.2)	(79 636)	(-)	(-)	(233)	(-)
Elsa										
Northwest Territories										
Pine Point Mines Limited	10 000	4.78	2.02	-	-	3 298 655	248 964	58.45	147 261	1,2,8
Pine Point	(10 000)	(5.49)	(1.96)	(-)	(-)	(3 289 329)	(285 366)	(57.71)	(166 457)	(1,2,8)
Nanisivik Mines Ltd.	2 200	11.31	1.46	-	62.4	624 275	119 591	56.84	68 040	9
Baffin Island	(2 200)	(14.28)	(2.37)	(-)	(86.3)	(435 147)	(104 822)	(57.00)	(59 882)	(9)

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 (000 tonnes)	Per Cent Zinc	Zinc Content (000 tonnes)
New Brunswick				
Billiton Canada Ltd. and Gowganda Silver Mines Limited	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
British Columbia				
Cyprus Anvil Mining Corporation and Hudson's Bay Oil and Gas Company Limited	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
Pan Ocean Oil 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		462 510	6.47	29 906.2

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.



Principal Producers
(numbers refer to numbers on map above)

1. ASARCO Incorporated (Buchans Unit)
2. Newfoundland Zinc Mines Limited
3. Esso Resources Canada Limited (Gays River)
4. Brunswick Mining and Smelting Corporation Limited
   Heath Steele Mines Limited
5. Lemoine Mines Limited
6. Corporation Falconbridge Copper Lake Dufault Division
   Louvem Mining Company Inc.
7. Mattagami Lake Mines Limited
   Noranda Mines Limited (Orchan mine)
8. Kidd Creek Mines Ltd.
9. Noranda Mines Limited (Geco Division)
10. Selco Inc.
11. Mattabi Mines Limited
    Noranda Mines Limited (Lyon Lake)
12. Hudson Bay Mining and Smelting Co., Limited (Chisel Lake, Osborne Lake, Stall Lake, Ghost Lake, Anderson Lake, Westarm, Flin Flon, White Lake, Centennial)
13. Sherritt Gordon Mines Limited (Fox Lake mine and Ruttan mine)
14. Cominco Ltd. (Sullivan mine)
    Teck Corporation (Beaverdell mine)
    Dickenson Mines Limited (Silmonac mine)
15. Westmin Resources Limited
16. Pine Point Mines Limited
17. Cyprus Anvil Mining Corporation
18. United Keno Hill Mines Limited
19. Northair Mines Ltd.
20. Nanisivik Mines Ltd.

Metallurgical Plants

8. Kidd Creek Mines Ltd., Hoyle
12. Hudson Bay Mining and Smelting Co., Limited, Flin Flon
21. Canadian Electrolytic Zinc Limited, Valleyfield
22. Cominco Ltd., Trail

TABLE 7. CANADA, PRIMARY ZINC METAL CAPACITY, 1981

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	245 000
Canada total	648 000

Source: Energy, Mines and Resources Canada.

zinc concentrates by chemical (hydrometallurgical) rather than roasting (pyrometallurgical) methods to produce elemental sulphur instead of sulphur dioxide.

Canadian Electrolytic Zinc Limited (CEZ) will add 9 000 t to its annual capacity by 1984 and Kidd Creek Mines Ltd. will expand its current facilities at Hoyle, near Timmins, Ontario by 19 000 t in 1983. Hudson Bay Mining and Smelting Co., Limited is spending some $20 million on three projects to upgrade and modernize its zinc refinery at Flin Flon, Manitoba. Work includes building a new casting plant, installing an electric induction furnace and adding a new electrostatic precipitator unit to remove dust from waste gas streams.

Canadian zinc metal producers operated at an average of about 96 per cent of their rated capacity during 1981.

CONSUMPTION

Canadian consumption of primary zinc in 1980, as measured by consumer surveys which do not represent 100 per cent of Canadian consumption, dropped about 4.9 per cent to an estimated 105 000 t. Producers' shipments to domestic consumers were 131 859 t in 1981 compared with 132 543 t in 1980.

TABLE 8. WESTERN WORLD PRIMARY ZINC STATISTICS, 1979-82

	1979	1980	1981p	1982e
	(000 tonnes)			
Mine production (Zn content)	4 606r	4 529r	4 435	4 600
Metal production	4 706	4 471	4 523	4 500
Metal consumption	4 744r	4 486r	4 335	4 400

Source: International Lead and Zinc Study Group.

e Estimated by Energy, Mines and Resources Canada.
p Preliminary; r Revised.

WORLD DEVELOPMENTS

Mining

Non-socialist country zinc mine production in 1981 was 4.4 million t, a decrease of some 94 000 t from 1980. Increased production in Canada and Australia offset production losses in Ireland.

Employees of the Tara Mines Ltd. mine at Navan, Ireland went on strike in early July and were still on strike at year-end. The Tara mine is a major producer of concentrates for the European smelting industry, having a capacity to produce about 220 000 tpy of zinc and 40 000 tpy of lead in concentrates.

Strikes in Australia kept 1981 production at about the same level as 1980 but it is expected that mine production will increase substantially in the next two years. The Que River project of Aberfoyle Limited, 47 per cent owned by Cominco Ltd., started production in 1981 and is expected to produce at an annual rate of 12 000 t of lead and 20 000 t of zinc in concentrates. The ore is treated at the nearby concentrator of Electrolytic Zinc Company of Australasia Ltd. which increased its capacity to accommodate the Que River ore. Seltrust Mining Corp. Pty. Ltd. and M.I.M. Holdings Limited brought on-stream their new Teutonic Bore mine in Western Australia with a capacity of

25 000 t of zinc. During 1982 and 1983, total capacity in Australia resulting from new mines coming on-stream is expected to increase by some 100 000 t of zinc.

In the United States, Gulf & Western Natural Resources Group is expanding operations at the Jersey Miniere Zinc Co. mine complex in Tennessee where mine capacity will increase by 31 000 t of zinc to 55 500 t starting in 1982. St. Joe Minerals Corporation continued development work on its Pierrepont mine in New York State. This new mine, scheduled to start production in 1982, will have a capacity to produce 16 000 tpy of zinc in concentrates.

SMELTING AND REFINING

Non-socialist world zinc metal production in 1981 at 4.5 million t, was 52 000 t above that in 1980. Production dropped significantly in Japan but increased in Canada, the United States, Peru and a number of other countries.

The zinc industry is still experiencing the problems of smelter overcapacity, poor markets and a tight concentrate supply which has forced up the price of concentrates. A gradual rationalization of the smelting industry is taking place with outmoded or high cost smelters being closed, particularly in Europe and the United States. Further production cutbacks have also been made in Japan. Some major new projects previously under consideration have now been abandoned or suspended indefinitely. It is expected that most new smelters built in the future will be located in countries that are major concentrate producers.

In the United States, Gulf & Western Industries, Inc. continued the rationalization of its natural resources group, selling the Palmerton, Pa., zinc facilities of its New Jersey Zinc Company which no longer produces slab zinc but still produces zinc oxide, zinc dust, metal powders and alloys. The Bunker Hill Co. announced the closure of its Kellogg, Idaho lead-zinc-silver smelting complex for economic reasons. The plant was outmoded and could not meet environmental standards. The shutdown of the 99 000 tpy zinc and 115 000 tpy lead facility started in the middle of November. Since 1971 the United States has lost about 700 000 tpy of primary zinc capacity. St. Joe Minerals has reactivated a further 23 000 t of zinc capacity at its Monaca, Pa., smelter bringing its annual capacity up to 68 000 t. At Belleville, Michigan, the Huron Valley Steel Co started production at its new 33 000 t secondary distillation zinc plant.

Empresa Minera del Peru (Minero Peru), Peru's state mining company, completed construction of its $US 320 million zinc refinery at Cajamarquilla, east of Lima. The refinery, with an annual capacity of 100 000 t of high grade zinc, started production in February and reached full output late in the year. The refinery will also produce 176 000 tpy of sulphuric acid.

In Europe, the shortage of concentrates and high operating costs forced Société de Prayon to close its electrolytic zinc plant at Eheim. Half the capacity of 70 000 tpy had been shut down in 1980 and the entire zinc plant was closed in 1981. One small electrolytic zinc plant was closed in mid-1981 in Italy and another reduced its capacity by about 30 per cent.

Equipment breakdown at the lead-zinc smelter of Australian Mining & Smelting Limited located at Avonmouth, England stopped production for a month and forced the company to declare **force majeure** on its lead bullion shipments. The company was able to continue deliveries of slab zinc to customers from existing stocks. Preussag AG of Germany announced plans to cut the capacity of its 100 000 t Harlingerode zinc plant by 30 per cent and convert it to a secondary plant.

Japanese zinc production in 1981 was down about 9 per cent from 1980, and the industry operated at about 65 per cent of capacity during 1981. The Japanese government released 26 000 t of zinc from its stockpile during the year. The Ministry of Trade and Industry continued its agreement with the zinc smelters to support a zinc stockpile. Under this program 123 700 t of zinc were purchased from the domestic market four years ago when the market was badly depressed.

CONSUMPTION

Non-socialist world consumption in 1981 is estimated by the International Lead and Zinc Study Group at 4.33 million t, a drop of 151 000 t from 1980.

PRICES

At the beginning of 1981 the price of high grade zinc was 48.5 cents a pound in Canada and 41.25 cents US in the United States.

TABLE 9. WESTERN WORLD ZINC INDUSTRY, PRODUCTION AND CONSUMPTION, 1981

	Mine Production	Metal Production	Metal Consumption
	(000 metric tonnes)		
Europe			
Austria	18	23	27
Belgium	-	235	139
Denmark[1]	79	-	12
Finland	53	140	24
France	37	257	272
Germany F.R.	111	367	374
Greece	27	-	18
Ireland	117	-	4
Italy	42	181	215
Netherlands	-	177	49
Norway	29	80	18
Portugal	-	4	12
Spain	182	189	105
Sweden	182	-	34
Switzerland	-	-	22
United Kingdom	11	82	190
Yugoslavia	89	96	70
Total	977	1 831	1 585
Africa			
Algeria	12	31	12
Egypt	-	-	12
Morocco	8	-	4
Nigeria	-	-	18
South Africa[2]	123	81	88
Tunisia	8	-	1
Zaire	76	58	-
Zambia	40	33	1
Others	-	-	23
Total	267	203	159
Americas			
Argentina	35	27	22
Bolivia	47	-	-
Brazil	67	92	114
Canada	1 096	619	132
Colombia	1	-	12
Honduras	19	-	-
Mexico	216	130	100
Peru	497	129	14
United States	335	363	917
Venezuela	-	-	21
Others	6	-	28
Total	2 319	1 360	1 360
Asia			
Burma	4	-	-
Hong Kong	-	-	30
India	28	57	90
Indonesia	-	-	54
Iran	30	-	-
Japan	242	670	699
Korea, Rep.	59	86	68
Philippines	9	-	24
Taiwan	-	-	45
Thailand	-	-	35
Turkey	24	17	17
Others	-	-	60
Total	396	830	1 122
Oceania			
Australia	478	299	94
New Zealand	-	-	16
Total	478	299	110
Total Non-Socialist World	4 437	4 523	4 435

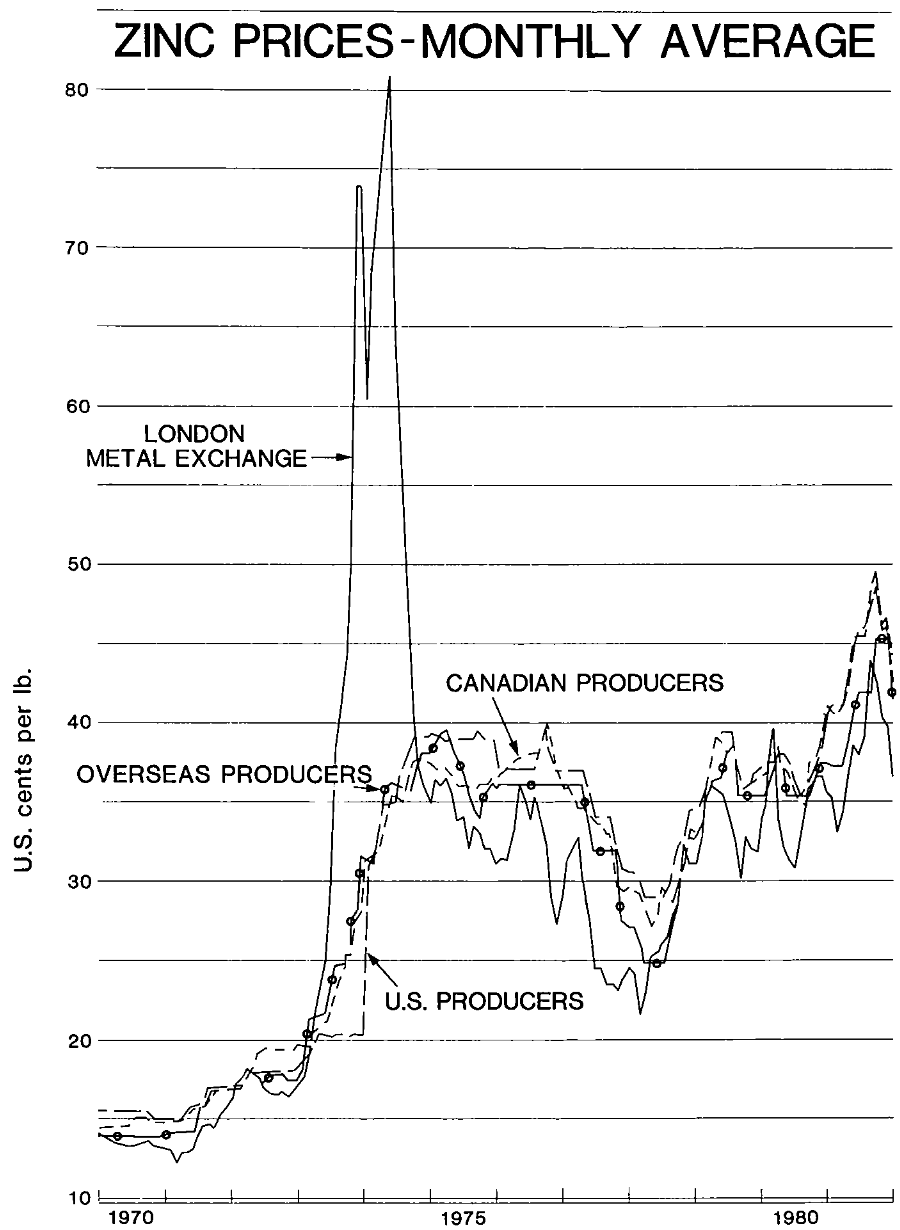
Source: International Lead and Zinc Study Group.

[1] Includes Greenland. [2] Includes Namibia.
- Nil.

The European producer price at that time was $US 825 a t. Increases during March, April and August saw the price of high grade zinc raised to 59.5 cents a pound in Canada and 49.25 cents in the United States, and the producer price for zinc metal outside North America increased to $US 1000. Toward the end of September the price trend reversed and in December most producers were quoting for high grade 52.0 cents a pound in Canada and 44.0 cents in the United States; for special high grade, prime western and continuous line zinc with controlled lead, 52.5 cents in Canada and 44.5 cents in the United States, and for continuous line zinc with aluminum added 52.75 cents in Canada and 44.75 cents in the United States. The European producer price was $US 950 a t. On the LME during 1981, the average settlement price fell slightly from £324 a t in January to £319 in February, then rose to a high of £559 on August 12. It then declined slowly to the £463 level at year-end.

GOVERNMENT INITIATIVES

The Commission of the EEC, after three years of investigation, in 1981 reached a preliminary finding that a group of European producers had conspired to fix zinc prices, control production and divide the market. The Commission is reviewing the facts to decide whether to start a formal complaint against the producers.


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

The U.S. Bureau of the Mint moved ahead with its plan to produce a copper-plated, zinc alloy penny despite strong objections and a suit filed in Federal Court by the Copper and Brass Fabricators Council. The decision to phase in a zinc penny over the next three years was prompted by a fear that rising copper prices could make the intrinsic value of the coin greater than its face value. The mint awarded its first tender for copper-plated zinc penny blanks at the end of July and has also awarded tenders for its current zinc alloy and SHG zinc requirements to be delivered to four companies making the blanks for the mint. The penny, including plating, will be 97.6 per cent zinc and 2.4 per cent copper. This program should eventually add some 40 000 tpy to U.S. zinc demand. The coins are expected to be in circulation sometime in 1982.

USES

According to the Zinc Institute, Inc. a United States-produced car for the 1981 model year used 24.24 pounds of zinc diecastings compared with 25 pounds in 1980 and 51 pounds in 1975. The decline in consumption has been attributed to downsizing of vehicles, substitution by other materials and increased use of thin-wall zinc diecasting techniques. These new techniques have retained applications and regained some earlier application losses but the amount of metal per application has fallen. However, it is expected that the use of galvanized steel and zinc-rich paint in automobiles to improve corrosion resistance will increase substantially in the next few years. This may stop or reverse the downward trend of zinc usage in automobiles.

Galvalume, an aluminum and zinc alloy-coated sheet product developed by Bethlehem Steel Corporation, was introduced in the United States market in 1976. This product has begun to penetrate steel markets that traditionally have used conventional galvanized coatings to combat corrosion. Bethlehem has now licensed six steel firms to produce Galvalume including one Canadian producer. The alloy coating is 55 per cent aluminum, 43.4 per cent zinc and 1.6 per cent silicon by weight. By volume, the alloy coating is 80 per cent aluminum. In its many markets - which include agricultural

TABLE 10. INTERNATIONAL ZINC METAL PRICES, 1981

	Average Monthly Prices			
Month	Canada	U.S.	Producers Outside North America	London Metal Exchange Prompt
	(¢/lb)	(¢/lb)	($US/tonne)	(£/tonne)
January	49.0	41.2	825.0	323.5
February	49.0	41.3	825.0	318.6
March	49.5	41.3	825.0	339.5
April	51.5	42.6	860.0	378.6
May	55.5	45.2	901.3	407.4
June	55.5	46.1	925.0	425.5
July	55.5	46.2	925.0	461.7
August	60.0	47.5	925.0	524.6
September	60.0	48.7	1000.0	517.6
October	56.0	45.9	1000.0	484.4
November	56.0	46.1	1000.0	460.9
December	53.4	42.6	957.1	444.2
1981 Average	54.2	44.6	915.4	425.0
1980 Average	44.0	37.4	798.2	327.4

Source: International Lead and Zinc Study Group Bulletin, **Northern Miner** quotes as compiled by Energy, Mines and Resources Canada.

buildings, appliances and automotive parts - Galvalume is moving toward dominating the pre-engineered building market. In addition to its anti-corrosion qualities, Galvalume's attractive spangle is an advantage in some applications. To date, the loss of zinc to Galvalume has been small, being estimated at 2 000 t in 1980. However, this could increase to 10 000 tpy or more in 1983. It has been estimated that if Galvalume were to capture half the existing galvanized sheet market, zinc usage in galvanizing, the largest market for zinc, would fall by 40 per cent.

OUTLOOK

The continuing recession presages that demand in 1982 and possibly 1983 will be less than satisfactory from a producer viewpoint. Producer restraint will be required to keep stocks within manageable quantities.

However over a longer term, mine and metal production profitability will respond to the ending of the present recession. With demand increasing at close to 2 per cent a year, mine production and metal consumption will again be in balance.

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)

Item No.		
626.04	Zinc, unwrought, alloyed	19.0%

		1981	1982	1983	1984	1985	1986	1987
		(% unless otherwise specified)						
602.20	Zinc in ores and concentrates	58¢/lb	53¢/lb	48¢/lb	44¢/lb	39¢/lb	35¢/lb	30¢/lb
626.02	Zinc, unwrought, unalloyed	1.9	1.8	1.8	1.7	1.6	1.6	1.5
626.10	Zinc, waste and scrap (suspended until June 30, 1984)	4.4	4.0	3.7	3.3	2.9	2.5	2.1

EUROPEAN ECONOMIC COMMUNITY (MFN)

		1981	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)

		1981	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	7.8 yen/kg	10 yen/kg	7 yen/kg
	Zinc, waste and scrap	2	2.5	1.9

Sources: The Customs Tariff and Commodities Index, January 1981, Revenue Canada; Tariff Schedules of the United States Annotated 1981, USITC Publication 1111; U.S. Federal Register Vol. 44, No. 241; Official Journal of the European Communities, LL 315, Vol. 23; Customs Tariff Schedules of Japan, 1981.

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

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SECTION 3: CONSUMPTION

SECTION 4: PRICES

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SECTION 6: EMPLOYMENT, SALARIES AND WAGES

SECTION 7: MINING, EXPLORATION AND DRILLING

SECTION 8: TRANSPORTATION

SECTION 9: INVESTMENT AND FINANCE

		1967	1968	1969	1970	1971
Gross national product, current dollars	($ million)	66,409	72,586	79,815	85,685	94,450
Gross national product, constant dollars (1971 = 100)	"	77,344	81,864	86,225	88,390	94,450
Value of manufacturing industry shipments	"	38,955	42,062	45,930	46,381	50,276
Value of mineral production	"	4,381	4,722	4,734	5,722	5,963
Merchandise exports	"	11,112	13,270	14,498	16,401	17,397
Merchandise imports	"	10,873	12,360[r]	14,130	13,952	15,618[r]
Balance of payments, current account	"	-499	-97	-917	+1,106	+431
Corporation profits before taxes	"	6,823	7,742	8,294	7,699	8,681
Capital investment current dollars	"	15,348	15,455	16,927	17,798	20,184
Capital investment, constant dollars (1971 = 100)	"	17,571	17,628	18,498	18,635	20,184
Population	000's	20,378	20,701	21,001	21,297	21,568
Labour force	"	7,747[r]	7,951[r]	8,194[r]	8,395	8,639
Employed	"	7,451[r]	7,593[r]	7,832[r]	7,919	8,104
Unemployed	"	296[r]	358[r]	362[r]	476	535
Unemployment rate	%	3.8[r]	4.5[r]	4.4[r]	5.7	6.2
Employment index	1961=100	122.6	122.7	127.0	127.1	127.8
Labour income	($ million)	35,303	38,444	43,065	46,706	51,528
Index industrial production[r]	1971=100	82.3	87.6	93.6	94.9	100.0
Index manufacturing production[r]	"	83.9	89.1	95.8	94.5	100.0
Index mining production[r]	"	79.9	86.2	86.9	98.7	100.0
Index gross domestic product[r]	"	82.3	86.9	92.2	94.4	100.0
Consumer price index	1971=100	86.5	90.0	94.1	97.2	100.0

P Preliminary; r Revised.

INDICATORS, 1967-81

1972	1973	1974	1975	1976	1977	1978	1979	1980	1981^{p}
105,234	123,560	147,528	165,343	191,031	208,868^{r}	230,490^{r}	261,576^{r}	291,869	331,338
100,248	107,812	111,678	113,005	119,249	121,762^{r}	126,191^{r}	129,850^{r}	130,467	134,540
56,191	66,674	82,455	88,427	98,076	109,747	129,019	152,133	165,985	188,212
6,408	8,370	11,754	13,347	15,693	18,473	20,261	26,081	31,842	33,000
19,671	24,838	31,739	32,587	37,651	43,685	52,259	64,317	74,446	81,203
18,669	23,325	31,722	34,716^{r}	37,494	42,363	50,108^{r}	62,871	69,274	79,129
-386	+108	-1,460	-4,757	-3,842	-4,301	-4,935	-4,962^{r}	-1,906	-5,346
10,799	15,417	20,062	19,663	19,985	21,090	25,360	34,884	37,172	33,856
22,218	26,618	32,882	38,216	43,636	46,597	50,360	58,355	66,193	78,512
21,242	23,551	24,927	25,694	26,727	26,527	26,546	27,894^{r}	29,055	30,987
21,802	22,043	22,364	22,697	22,993	23,258	23,476	23,671	23,936	24,189
8,897	9,276	9,639	9,974	10,206	10,498	10,882	11,207	11,522	11,830
8,344	8,761	9,125	9,284	9,479	9,648	9,972	10,369	10,655	10,933
553	515	514	690	727	850	911	838	867	898
6.2	5.5	5.3	6.9	7.1	8.1	8.4	7.5	7.5	7.6
129.9	135.9	142.8	141.1	144.1	144.3	146.5	150.7	152.4	154.9
57,570	66,501	79,846	93,299	107,922	118,998^{r}	129,846^{r}	145,212^{r}	163,785	186,628
107.6	119.0	122.8	115.5	122.2	125.3	129.8	136.6	133.9	135.3
107.7	119.1	123.4	116.2	123.1	125.5	131.9	138.1	133.7	135.9
104.4	117.8	114.0	100.9	103.1	106.1	97.8	107.1	109.6	103.3
105.2	114.1	119.3	120.4	126.4	130.1	134.4	139.3	139.8	143.3
104.8	112.7	125.0	138.5	148.9	160.8	175.2	191.2	210.6	236.9

TABLE 1. MINERAL PRODUCTION OF CANADA, 1980 AND 1981, AND AVERAGE 1977-81

	Unit of Measure	1980		1981P		Average 1977-81	
		(Quantity)	($'000)	(Quantity)	($'000)	(Quantity)	($'000)
Metals							
Antimony	t	..	7,059	..	3,138	..	7,171
Bismuth	t	149	1,015	123	854	144	1,250
Cadmium	t	1 033	7,568	1 274	6,384	1 170	7,580
Calcium	t	531	3,422	566	4,234	524	2,860
Cobalt	t	2 118	134,748	1 816	101,953	1 658	79,513
Columbium (Cb_2O_5)	t	2 463	15,302	2 740	18,739	2 540	15,285
Copper	000 t	716	1,859,637	718	1,590,841	698	1,441,724
Gold	kg	50 620	1,165,417	49 500	881,116	51 830	658,411
Indium	kg	..	..	..	..	995	..
Iron ore	000 t	49 068	1,700,915	49 844	1,917,614	51 016	1,604,619
Iron remelt	000 t	..	118,990	..	131,861	..	95,438
Lead	000 t	252	273,766	273	267,937	287	281,369
Magnesium	t	9 252	27,822	8 775	30,197	8 597	24,011
Molybdenum	t	11 889	299,323	14 134	317,207	13 542	255,641
Nickel	000 t	185	1,497,418	155	1,414,743	166	1,117,759
Platinum group	kg	12 776	159,088	18 914	223,685	12 618	113,278
Selenium	t	279	8,779	290	6,903	214	6,794
Silver	kg	1 070	828,805	1 203	487,254	1 200	450,724
Tantalum (Ta_2O_5)	t	115	21,810	110	24,663	77	12,199
Tellurium	t	15	754	20	718	29	1,332
Tin	t	243	5,090	248	4,875	303	4,835
Tungsten (WO_3)	t	4 007	..	1 736	..	2 833	..
Uranium (U)	t	6 739	702,038	7 746	769,583	7 210	610,907
Zinc	000 t	884	858,190	995	1,193,477	1 023	953,571
Total metals			9,696,956		9,397,976		7,746,270
Nonmetals							
Asbestos	000 t	1 323	618,493	1 133	589,163	1 378	582,210
Barite	000 t	..	4,380	..	4,386	..	3,242
Fluorspar	000 t	-	-	-	-	-	1,737
Gemstone	t	..	1,632	..	1,560	..	1,401
Gypsum	000 t	7 336	39,539	7 800	46,410	7 708	39,415
Magnesitic dolomite and brucite	000 t	..	10,404	..	10,590	..	8,453
Nepheline syenite	000 t	600	15,936	606	17,834	597	15,023
Peat	000 t	466	44,555	485	48,334	450	39,492
Potash (K_2O)	000 t	7 201	1,020,705	6 815	1,050,513	6 640	742,941
Pyrite, pyrrhotite	000 t	32	345	11	124	21	203
Quartz	000 t	2 252	29,184	2 321	34,661	2 285	26,296

Salt	000 t	7 423	122,775	7 283	135,103	6 816	111,226
Soapstone, talc & pyrophyllite	000 t	92	3,877	89	5,158	81	3,382
Sodium sulphate	000 t	481	30,468	553	40,254	450	27,137
Sulphur in smelter gas	000 t	895	28,913	904	32,031	776	20,254
Sulphur, elemental	000 t	7 656	444,095	8 320	695,900	6 650	296,327
Titanium dioxide	000 t	..	117,060	..	120,747	..	95,871
Total nonmetals	000 t		2,532,361		2,832,668		2,014,610
Fuels							
Coal	000 t	36 688	932,000	39 250	1,045,500	33 627	845,289
Natural gas	000 m^3	87 108 000	6,148,826	82 186 000	6,156,901	88 769 592	4,901,421
Natural gas by-products	000 m^3	19 147	1,825,148	18 988	2,398,151	18 163	1,541,142
Petroleum, crude	000 m^3	83 477	9,037,890	74 763	9,411,247	79 615	7,316,698
Total fuels			17,943,864		19,011,779		14,604,549
Structural materials							
Clay products	000 $	..	108,453	..	120,174	..	112,630
Cement	000 t	10 274	581,372	10 368	680,587	10 521	581,703
Lime	000 t	2 554	129,232	2 463	148,473	2 162	100,233
Sand and gravel	000 t	276 452	508,364	287 468	547,096	276 828	458,864
Stone	000 t	103 366	341,156	94 577	345,518	109 994	329,339
Total structural materials			1,668,577		1,841,848		1,582,768
Total, all minerals			31,841,758		33,084,291		25,948,197

Notes: [1] Production statistics for the following are not available for publication: diatomite, helium, nitrogen and yttrium. [2] Nil production for the following between 1977 and 1981: feldspar, grindstone, iron oxide, lithia and thorium. [3] Dollar values only available for publication for the following: antimony, iron remelt, barite, gemstones, magnesitic dolomite and brucite, titanium dioxide and clay products.
P Preliminary; .. Not available or not applicable; - Nil.

TABLE 2. CANADA, VALUE OF MINERAL PRODUCTION, PER CAPITA VALUE OF MINERAL PRODUCTION, AND POPULATION, 1952-81

	Metallics	Industrial Minerals	Fuels	Total	Per Capita Value of Mineral Production	Population of Canada
		($ million)			($)	(000)
1952	728	293	264	1,285	88.90	14,459
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
1978	5,698	2,986	11,577	20,261	863.05	23,476
1979	7,951	3,514	14,617	26,081	1,101.81	23,671
1980	9,697	4,201	17,944	31,842	1,330.30	23,936
1981P	9,398	4,675	19,012	33,084	1,367.73	24,189

P Preliminary.

TABLE 3. CANADA, VALUE OF MINERAL PRODUCTION BY PROVINCES, TERRITORIES AND MINERAL CLASSES, 1981P

	Metals		Industrial Minerals		Fuels		Total	
	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)
Alberta	2,145	0.0	919,090	19.7	16,650,147	87.6	17,571,382	53.1
Ontario	3,454,323	36.8	817,545	17.5	45,743	0.2	4,317,611	13.1
British Columbia	1,458,591	15.5	379,206	8.1	1,133,926	6.0	2,971,723	9.0
Saskatchewan	329,369	3.5	1,165,341	24.9	915,202	4.8	2,409,912	7.3
Quebec	1,346,295	14.3	1,037,146	22.2	-	-	2,383,441	7.2
Newfoundland	1,130,160	12.0	64,334	1.4	-	-	1,194,494	3.6
Manitoba	503,180	5.4	104,182	2.2	63,962	0.3	671,324	2.0
New Brunswick	452,832	4.8	58,657	1.3	23,080	0.1	534,569	1.6
Northwest Territories	413,432	4.4	-	-	53,739	0.3	467,171	1.4
Yukon	298,173	3.2	-	-	-	-	298,173	0.9
Nova Scotia	9,476	0.1	126,440	2.7	126,000	0.7	261,916	0.8
Price Edward Island	-	-	2,575	0.1	-	-	2,575	-
Total, Canada	9,397,976	100.0	4,674,516	100.0	19,011,799	100.0	33,084,291	100.0

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	-	92
	$000	-	-	-	38	-	10,975
Natural gas	000 m^3	-	-	-	2	-	407
	$000	-	-	-	42	-	34,768
Natural gas byproducts	000 m^3	-	-	-	-	-	-
	$000	-	-	-	-	-	-
Iron ore	000 t	26 008	-	-	-	17 970	5 267
	$000	1,058,275	-	-	-	588,009	247,213
Copper	000 t	6	-	-	13	89	228
	$000	12,350	-	-	28,359	200,477	504,738
Nickel	000 t	-	-	-	-	-	127
	$000	-	-	-	-	-	1,159,747
Zinc	000 t	41	-	3	232	54	247
	$000	48,604	-	3,533	278,462	64,614	295,936
Potash (K_2O)	000 t	-	-	-	-	-	-
	$000	-	-	-	-	-	-
Coal	000 t	-	-	2 500	520	-	-
	$000	-	-	126,000	23,000	-	-
Gold	kg	x	-	-	x	17	17
	$000	4,263	-	-	1,174	298,294	292,638
Uranium (U)	t	-	-	-	-	-	5
	$000	-	-	-	-	-	467,925
Sulphur, elemental	000 t	-	-	-	-	-	22
	$000	-	-	-	-	-	1,200
Cement	000 t	x	-	x	x	2 527	3 620
	$000	7,388	-	26,323	12,516	128,973	200,115
Asbestos	000 t	57	-	-	-	984	-
	$000	39,330	-	-	-	471,443	-
Sand and gravel	000 t	3 607	950	10 000	7 000	68 037	106 574
	$000	6,889	2,575	26,000	14,000	83,047	202,491
Silver	kg	8	-	..	192	49	324
	$000	3,107	-	..	77,702	20,936	130,784
Stone	000 t	1 100	-	2 000	3 400	44 127	32 500
	$000	3,300	-	8,500	12,750	154,143	113,000
Molybdenum	t	-	-	-	-	1	-
	$000	-	-	-	-	17,513	-
Lead	t	3	-	6	65	x	2
	$000	3,120	-	5,943	63,732	8	2,220
Platinum group	kg	-	-	-	-	-	19
	$000	-	-	-	-	-	223,214
Lime	000 t	-	-	-	x	348	1 711
	$000	-	-	-	3,497	20,589	103,500
Salt	000 t	-	-	1 053	-	-	4 963
	$000	-	-	30,057	-	-	77,121
Titanium dioxide	000 t	-	-	-	-	..	-
	$000	-	-	-	-	120,647	-
Clay products	$000	957	-	3,500	1,600	13,991	69,366
Cobalt	t	-	-	-	-	-	2
	$000	-	-	-	-	-	88,096
Total leading minerals	$000	1,187,583	2,575	229,856	516,872	2,182,684	4 225,047
Total all minerals	$000	1,194,494	2,575	261,916	534,569	2,383,441	4 317,611
Leading minerals as % of all minerals		99.4	100.0	87.8	96.7	91.6	97.9

P Preliminary; - Nil; .. Not available; x less than 1 unit amount.

BY PROVINCES AND TERRITORIES, 1981P

Manitoba	Saskat- chewan	Alberta	British Columbia	Yukon	N.W.T.	Total Canada
538	7 406	64 476	2 062	-	188	74 763
63,962	826,806	8,255,022	237,908	-	16,536	9,411,247
-	1 247	72 451	7 709	-	370	82 186
-	20,351	5,728,039	336,498	-	37,203	6,156,901
-	120	18 605	263	-	-	18 988
-	13,545	2,357,686	26,920	-	-	2,398,151
-	-	-	599	-	-	49 844
-	-	-	24,117	-	-	1,917,614
58	6	-	309	9	x	718
127,795	12,216	-	684,064	20,192	650	1,590,841
28	-	-	-	-	-	155
254,996	-	-	-	-	-	1,414,743
39	6	-	62	86	224	995
47,240	7,596	-	74,662	103,783	269,047	1,193,477
-	6 815	-	-	-	-	6 815
-	1,050,513	-	-	-	-	1,050,513
-	6 730	18 100	11 400	-	-	39 250
-	54,500	309,400	532,600	-	-	1,045,500
1	x	x	8	3	4	50
22,114	5,409	2,143	136,223	53,964	64,894	881,116
-	3	-	-	-	-	8
-	301,658	-	-	-	-	769,583
-	-	8 000	298	-	-	8 320
-	-	675,000	19,700	-	-	695,900
650	398	1 140	970	-	-	10 368
50,904	37,413	135,409	81,546	-	-	680,587
-	-	-	92	-	-	1 133
-	-	-	78,390	-	-	589,163
10 300	10 700	25 000	45 300	-	-	287 468
24,514	20,330	58,750	108,500	-	-	547,096
28	5	x	388	172	37	1 203
11,277	2,250	2	156,712	69,528	14,956	487,254
2 200	-	250	9 000	-	-	94 577
10,450	-	1,375	42,000	-	-	345,518
-	-	-	13	-	-	14
-	-	-	299,694	-	-	317,207
x	-	-	79	52	65	273
360	-	-	77,961	50,706	63,885	267,937
-	-	-	..	-	-	19
-	-	-	471	-	-	223,685
x	-	170	112	-	-	2 463
4,296	-	9,838	6,753	-	-	148,473
-	329	938	-	-	-	7 283
-	14,502	13,423	-	-	-	135,103
-	-	-	-	-	-	..
-	-	-	-	-	-	120,647
1,780	3,900	14,180	10,900	-	-	120,174
x	-	-	-	-	-	2
13,857	-	-	-	-	-	101,953
633,545	2,370,989	17,560,267	2,935,619	298,173	467,171	32,610,383
671,324	2,409,912	17,571,382	2,971,723	298,173	467,171	33,084,291
94.4	98.4	99.9	98.8	100.0	100.0	98.6

TABLE 5. CANADA, PERCENTAGE CONTRIBUTION OF LEADING MINERALS TO TOTAL VALUE OF MINERAL PRODUCTION, 1975-81

	1975	1976	1977	1978	1979	1980	1981P
Oil, crude	28.2	25.8	26.4	28.7	28.6	28.4	28.4
Natural gas	11.4	16.9	18.5	19.4	18.6	19.3	18.6
Natural gas byproducts	5.9	5.1	5.3	5.3	5.5	5.7	7.2
Iron ore	6.9	7.8	7.5	6.0	6.9	5.3	5.8
Copper	7.7	7.0	6.3	5.4	5.8	5.8	4.8
Nickel	8.3	7.3	6.6	3.1	3.2	4.7	4.3
Zinc	6.5	5.2	4.5	4.0	4.1	2.7	3.6
Coal	4.4	3.9	3.3	3.8	3.3	2.9	3.2
Potash (K_2O)	2.7	2.3	2.2	2.5	2.8	3.2	3.2
Gold	2.0	1.3	1.5	1.9	2.3	3.7	2.7
Uranium (U)	...	1.5	1.9	3.1	2.4	2.2	2.3
Cement	2.5	2.4	2.3	2.8	2.5	1.8	2.0
Asbestos	2.0	2.9	3.1	2.6	2.3	1.9	1.8
Sand and gravel	2.3	2.1	2.0	2.1	1.8	1.6	1.7
Silver	1.3	1.1	1.1	1.2	1.8	2.6	1.5
Sulphur, elemental	0.7	0.5	0.4	0.5	0.6	1.4	1.2
Molybdenum	0.5	0.6	0.8	0.9	1.3	0.9	1.0
Stone	1.5	1.5	1.6	1.6	1.3	1.1	1.0
Lead	1.2	0.8	1.1	1.3	1.6	0.9	0.8
Platinum group	0.4	0.3	0.3	0.3	0.2	0.5	0.7
Clay products	0.6	0.6	0.6	0.5	0.5	0.3	0.4
Lime	0.3	0.4	0.4	0.4	0.3	0.4	0.4
Titanium dioxide	0.4	0.5	0.4	0.4	0.3	0.4	0.4
Salt	0.5	0.5	0.5	0.5	0.4	0.4	0.4
Cobalt	0.1	0.1	0.1	0.2	0.4	0.4	0.3
Other minerals	1.7	1.6	1.3	1.5	1.2	1.5	2.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

P Preliminary; ... Too small to be expressed.

TABLE 6. CANADA, VALUE OF MINERAL PRODUCTION BY PROVINCES AND TERRITORIES, 1975-81

	1975	1976	1977	1978	1979	1980	1981P
				($ million)			
Alberta	5,750	6,934	8,576	10,087	12,899	16,379	17,571
Ontario	2,354	2,712	2,980	2,698	3,265	4,640	4,318
British Columbia	1,296	1,606	1,687	1,883	2,677	2,795	2,972
Saskatchewan	862	974	1,208	1,582	1,874	2,315	2,410
Quebec	1,232	1,493	1,675	1,796	2,165	2,467	2,383
Newfoundland	551	745	867	675	1,125	1,036	1,194
Manitoba	530	511	564	459	653	803	671
New Brunswick	232	239	289	339	480	373	535
Northwest Territories	206	225	256	310	435	425	467
Yukon	230	125	210	219	299	361	298
Nova Scotia	102	127	159	211	210	247	262
Prince Edward Island	2	2	2	2	2	2	3
Total	13,347	15,693	18,473	20,261	26,084	31,842	33,084

P Preliminary.

TABLE 7. CANADA, PERCENTAGE CONTRIBUTION OF PROVINCES AND TERRITORIES TO TOTAL VALUE OF MINERAL PRODUCTION, 1975-81

	1975	1976	1977	1978	1979	1980	1981P
Alberta	43.1	44.2	46.4	49.8	49.5	51.4	53.1
Ontario	17.6	17.3	16.1	13.3	12.5	14.6	13.1
British Columbia	9.7	10.2	9.1	9.3	10.3	8.8	9.0
Saskatchewan	6.5	6.2	6.5	7.8	7.2	7.2	7.3
Quebec	9.2	9.5	9.1	8.9	8.3	7.7	7.2
Newfoundland	4.1	4.7	4.7	3.3	4.3	3.3	3.6
Manitoba	4.0	3.3	3.1	2.3	2.5	2.5	2.0
New Brunswick	1.7	1.5	1.6	1.7	1.8	1.2	1.6
Northwest Territories	1.6	1.5	1.4	1.5	1.7	1.3	1.4
Yukon	1.7	0.8	1.1	1.1	1.1	1.1	0.9
Nova Scotia	0.8	0.8	0.9	1.0	0.8	0.8	0.8
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
Potash (K_2O equivalent)	000 t	27 642
	% of world total	
Nickel (mine production)	t	757 200
	% of world total	
Zinc (mine production)	000 t	5 745
	% of world total	
Asbestos	000 t	4 818
	% of world total	
Sulphur, elemental	000 t	36 350
	% of world total	
Titanium concentrates (Ilmenite)	000 t	4 865
	% of world total	
Uranium (U concentrates)	t	43 976
	% of world total	
Gypsum	000 t	71 150
	% of world total	
Silver	kg	10 497 870
	% of world total	
Molybdenum (Mo content)	t	107 710
	% of world total	
Platinum group metals (mine production)	kg	212 632
	% of world total	
Gold (mine production)	kg	1 256 857
	% of world total	
Copper (mine production)	t	7 846 332
	% of world total	
Lead (mine production)	t	3 620 600
	% of world total	
Aluminum (primary metal)	t	16 057 300
	% of world total	
Cadmium (smelter production)	t	18 400
	% of world total	
Iron ore	000 t	876 340
	% of world total	

P Preliminary; e Estimated.

CERTAIN IMPORTANT MINERALS, 1980[P]

Rank of Six Leading Countries					
1	2	3	4	5	6
Canada	U.S.S.R.	East Germany	West Germany	U.S.A.	France
7 303	6 750[e]	3 500[e]	2 474	2 239	1 939
26.4	24.4	12.7	9.7	8.1	7.0
Canada	U.S.S.R.	New Caledonia	Australia	Indonesia	Philippine Republic
194 900	143 000[e]	86 600	74 300	40 600	38 300
25.7	18.9	11.4	9.8	5.4	5.1
Canada	U.S.S.R.	Peru	Australia	U.S.A.	Mexico
1 059	1 000[e]	488	463	368	238
18.4	17.4	8.5	8.1	6.4	4.1
U.S.S.R.	**Canada**	South Africa	Zimbabwe	China	Italy
2 150[e]	1 323	270	251	250[e]	145
44.6	27.5	5.6	5.2	5.2	3.0
U.S.A.	**Canada**	Poland	U.S.S.R.	Mexico	France
10 368	7 656	4 985	4 000	2 140	2 060
28.5	21.0	13.7	11.0	5.9	5.7
Australia	**Canada**	Norway	U.S.A.	U.S.S.R.	South Africa
1 336	875	828	498	400[e]	343
27.5	18.0	17.0	10.2	8.2	7.1
U.S.A.	**Canada**	South Africa	Niger	Namibia	France
16 809	6 739	6 146	4 100	4 042	2 634
38.2	15.3	14.0	9.3	9.2	6.0
U.S.A.	**Canada**	France	U.S.S.R.	Spain	Iran
11 227	7 336	5 987	5 897	5 498	3 538
15.8	10.3	8.4	8.3	7.7	5.0
U.S.S.R.	Mexico	**Canada**	Peru	U.S.A.	Australia
1 550 000[e]	1 472 600	1 232 000	1 232 000	974 372	769 699
14.8	14.3	11.7	11.7	9.3	7.3
U.S.A.	Chile	**Canada**	U.S.S.R.	China	Peru
68 350	13 341	11 889	10 400[3]	2 000[e]	998
63.5	12.4	11.0	9.7	1.9	0.9
U.S.S.R.	South Africa	**Canada**	Columbia	Australia	U.S.A.
101 086[e]	96 421[e]	12 776	404	306	93
47.5	45.3	6.0	0.2	0.1	-
South Africa	U.S.S.R.	**Canada**	China	Brazil	U.S.A.
673 997	258 160[e]	50 620	46 655[e]	40 435	29 592
53.6	20.5	4.0	3.7	3.2	2.4
U.S.A.	U.S.S.R.	Chile	**Canada**	Zambia	Zaire
1 181 155	1 150 000[e]	1 067 666	716 313	595 839	459 671
15.1	14.7	13.6	9.1	7.6	5.9
U.S.S.R.	U.S.A.	Australia	**Canada**	Peru	Mexico
580 000[e]	561 800	397 500	296 641	189 100	145 500
16.0	15.5	11.0	8.1	5.2	4.0
U.S.A.	U.S.S.R.	Japan	**Canada**	West Germany	Norway
4 653 900	1 787 000[e]	1 091 500	1 068 200	731 190	651 360
29.0	11.1	6.8	6.7	4.6	4.1
U.S.S.R.	Japan	U.S.A.	Belgium	**Canada**	Germany
2 850[e]	2 173	1 578	1 527	1 303	1 197
15.5	11.8	8.6	8.3	7.1	6.5
U.S.S.R.	Brazil	Australia	China	U.S.A.	**Canada**
244 760	97 240	95 530	75 000[e]	70 730	49 068
27.9	11.1	10.9	8.6	8.1	5.6

TABLE 9. CANADA, GROSS DOMESTIC PROUDCT BY INDUSTRY IN CONSTANT 1971 PRICES, 1975-1981

	1975	1976	1977	1978	1979	1980	1981P
				($ million)			
Goods producing industries							
Agriculture	2,776.1	2,947.5	3,069.7	2,996.5	2,698.5	2,908.6	3,260.5
Forestry	655.1	705.6	741.9	794.9	795.9	816.2	788.7
Fishing and trapping	126.4	144.4	162.3	179.5	183.7	168.5	155.7
Mining[1]	3,175.1	3,243.6	3,337.3	3,015.1	3,282.9	3,401.1	3,222.8
Manufacturing	22,122.5	23,413.9	23,901.6	25,139.9	36,631.8	25,846.3	26,378.5
Construction	6,779.6	6,992.0	6,856.2	6,706.0	6,887.8	6,859.2	7,344.2
Electrical power, gas and water utilities	2,862.9	3,116.0	3,311.3	3,521.6	3,685.3	3,783.7	3,977.9
Total	38,497.7	40,581.0	41,380.3	42,353.6	44,165.9	43,783.6	45,128.3
Service producing industries							
Transportation, storage and communication	9,894.5	10,419.5	10,972.8	11,462.3	12,393.9	12,756.3	13,167.2
Trade	12,992.6	13,531.4	13,710.4	14,206.5	14,686.2	14,721.2	14,763.1
Finance, insurance and real estate	12,070.5	12,683.3	13,444.8	14,119.9	14,555.0	15,041.1	15,623.9
Community, business and personnel services	19,481.8	20,469.5	21,096.3	21,888.1	22,459.9	22,771.2	23,718.0
Public administration and defense	7,345.5	7,564.7	7,736.2	7,927.5	7,884.5	7,985.6	8,145.1
Total	61,784.9	64,668.4	66,960.5	69,604.3	71,979.5	73,275.4	75,417.3
Grand total	100,282.6	105,249.4	108,340.8	111,957.9	116,145.4	117,059.0	120,545.6

1 Cement, lime, clay and clay products industries are included under "Manufacturing".
P Preliminary.

TABLE 10. CANADA, CENSUS VALUE ADDED, TOTAL ACTIVITY, MINING AND MINERAL MANUFACTURING INDUSTRIES, 1974-80

	1974	1975	1976	1977	1978	1979	1980p
	(millions of dollars)						
Mining							
Metallic minerals							
Gold-quartz	163.6	149.9	113.7	152.0	207.6	322.8	588.8
Copper-gold-silver	1,028.6	595.4	600.7	571.3	715.9	1,434.5	1,558.6
Silver-lead-zinc	328.3	320.8	233.7	279.8	372.7	671.9	513.6
Nickel-copper	1,049.7	729.7	888.1	673.0	572.6	1,035.1	1,433.6
Iron	403.9	556.7	732.1	807.3	717.0	1,022.2	1,005.0
Uranium	93.3	157.8	195.8	300.1	501.7	525.4	559.3
Miscellaneous metal mines	50.0	53.7	74.2	118.0	138.6	179.7	243.3
Total	3,171.4	2,563.9	2,838.4	2,901.4	3,226.1	5,191.6	5,902.2
Industrial minerals							
Asbestos	239.8	230.6	373.2	474.8	401.6	456.8	473.4
Gypsum	16.5	14.9	15.8	21.0	25.9	27.5	26.9
Peat	19.8	20.6	23.7	27.4	33.7	38.8	42.7
Potash	232.7	298.5	262.1	301.4	360.2	613.5	900.4
Salt	49.8	45.9	70.7	70.9	77.9	86.4	93.7
Sand and gravel	83.5	102.3	99.0	91.3	85.8	91.5	92.0
Stone	92.9	111.0	111.0	106.1	110.2	121.7	123.4
Miscellaneous nonmetals	37.5	40.4	42.4	45.6	44.7	53.7	59.0
Total	772.4	864.1	997.8	1,138.4	1,139.9	1,489.8	1,811.5
Fuels							
Coal	261.2	483.5	474.3	508.5	566.8	658.6	621.6
Petroleum and natural gas	4,725.0	5,838.5	7,050.0	8,698.3	10,083.4	12,559.7	15,012.3
Total	4,986.2	6,322.0	7,524.3	9,206.9	10,650.2	13,218.2	15,633.9
Total mining industry	8,930.0	9,750.0	11,360.5	13,246.7	15,016.2	19,899.6	23,347.6
Mineral manufacturing							
Primary metal industries							
Iron and steel mills	1,398.7	1,364.0	1,498.8	1,677.6	1,924.9	2,424.3	2,537.9
Steel pipe & tube mills	152.3	170.3	148.8	160.3	225.1	280.4	297.6
Iron foundries	222.4	238.1	241.9	257.7	273.8	298.2	266.9
Smelting and refining	794.2	886.4	812.7	1,176.1	1,387.2	1,401.0	1,849.2
Aluminum rolling, casting and extruding	146.7	132.6	149.4	193.7	154.3	249.0	273.5
Copper and alloy rolling, casting and extruding	91.3	68.3	71.4	78.5	93.1	131.5	103.7
Metal rolling, casting and extruding, nes	106.1	88.4	113.3	110.2	136.2	198.9	203.6
Total	911.8	948.2	3,036.3	3,654.0	4,194.7	4,983.3	5,532.4

(continued on following page)

TABLE 10. (cont'd)

	1974	1975	1976	1977	1978	1979	1980P
	(millions of dollars)						
Mineral manufacturing (cont'd)							
Nonmetallic mineral products industries							
Cement manufacturers	190.4	210.3	249.1	275.0	319.9	388.8	357.3
Lime manufacturers	25.0	24.9	30.0	36.6	44.6	49.3	59.5
Concrete products manufacturers	248.5	282.1	282.1	273.5	309.3	328.7	323.9
Ready-mix concrete manufacturers	236.3	282.6	282.6	292.8	317.3	341.6	352.4
Clay products (domestic clay)	51.5	59.7	65.9	69.6	73.6	87.5	84.6
Clay products (imported clay)	41.7	41.7	39.1	39.8	43.1	44.9	51.6
Refractories manufacturers	37.2	45.8	44.4	32.5	45.3	66.6	73.6
Stone products manufacturers	12.3	14.0	16.3	19.6	22.4	28.2	33.2
Glass manufacturers	190.0	185.6	205.1	199.2	266.8	294.9	308.1
Glass products manufacturers	72.4	74.3	87.4	96.6	122.9	141.0	143.6
Abrasive manufacturers	46.0	43.9	55.1	64.1	70.6	79.4	92.1
Other nonmetallic mineral products industries	195.2	237.4	270.2	253.6	341.0	375.2	374.8
Total	1,346.6	1,502.4	1,627.3	1,652.9	1,976.8	2,226.2	2,254.8
Petroleum and coal products industries							
Petroleum refining	925.2	789.7	945.8	1,206.7	1,180.4	1,390.9	1,750.1
Manufacturers of lubricating oil and greases	26.3	32.6	32.6	36.8	36.9	38.3	26.7
Other petroleum and coal products industries	26.7	43.6	45.7	44.4	33.1	30.5	36.0
Total	978.3	866.0	1,024.2	1,287.9	1,250.4	1,459.8	1,812.8
Total mineral manufacturing	5,236.6	5,316.5	5,687.8	6,594.8	7,421.9	8,669.2	9,600.0
Total mining and mineral manufacturing	14,166.6	15,066.6	17,048.3	19,841.5	22,438.1	28,568.9	32,947.6

P Preliminary; nes Not elsewhere specified.

TABLE 11. CANADA, INDEXES OF GROSS DOMESTIC PRODUCT OF TOTAL INDUSTRIAL PRODUCTION, MINING AND MINERAL MANUFACTURING, 1967-1981 (1971=100)

	1967	1968	1969	1970	1971	1972[r]	1973[r]	1974[r]	1975[r]	1976[r]	1977[r]	1978[r]	1979[r]	1980	1981[p]
Total industrial production	82.3	87.6	93.6	94.9	100.0	107.6	119.0	122.8	115.5	122.2	125.3	129.8	136.6	133.9	135.4
Total mining	79.9	86.2	86.9	98.7	100.0	104.4	117.8	114.0	100.9	103.1	106.1	97.8	107.1	109.6	103.3
Metals															
All metals	89.9	95.5	88.4	105.4	100.0	94.3	105.7	101.8	91.2	96.7	99.5	76.5	81.3	86.3	82.0
Placer gold and gold quartz mines	134.1	121.7	118.2	105.3	100.0	90.1	80.0	68.4	67.4	69.1	68.2	65.5	59.8	53.9	54.9
Iron mines	88.8	104.8	91.9	116.1	100.0	78.7	97.4	80.4	71.4	104.6	94.7	55.6	90.2	78.4	71.8
Other metal mines	87.8	92.0	85.3	103.0	100.0	98.7	109.8	111.1	99.2	97.1	102.0	79.2	77.9	88.5	83.7
Fuels															
All fuels	67.1	73.4	80.8	92.6	100.0	114.7	130.1	124.7	112.4	107.5	108.6	111.5	124.5	120.3	112.8
Coal	70.3	68.7	68.4	87.5	100.0	105.4	115.5	116.8	137.5	128.5	125.2	167.3	177.5	193.4	207.5
Crude oil and natural gas	66.8	73.7	81.7	93.0	100.0	115.4	131.2	125.3	110.5	105.9	107.3	107.3	120.5	114.8	105.7
Nonmetals															
All nonmetals	76.8	83.7	92.8	95.0	100.0	99.7	107.8	119.7	88.9	103.6	109.4	105.0	113.2	116.0	110.7
Asbestos	78.9	82.6	89.8	95.2	100.0	101.0	102.1	102.0	63.7	85.5	85.5	67.4	71.6	66.7	56.6
Mineral manufacturing															
Primary metals	84.5	92.9	94.9	100.9	100.0	101.3	112.2	118.7	107.0	105.6	113.2	119.1	122.3	126.7	126.7
Nonmetallic mineral products	80.7	87.1	90.5	86.6	100.0	109.1	119.5	125.2	117.7	120.5	119.4	127.6	136.6	127.8	130.4
Petroleum and coal products	79.9	88.7	92.1	94.4	100.0	115.3	136.1	136.8	130.9	120.0	112.1	96.3	96.8	95.6	89.2

[p] Preliminary; [r] Revised.

TABLE 12. CANADA, INDEXES OF GROSS DOMESTIC PRODUCT BY INDUSTRIES, 1967-81 (1971=100)

	1967	1968	1969	1970	1971	1972r	1973r	1974r	1975r	1976r	1977r	1978r	1978r	1980	1981p
Real domestic product, all industries	82.3	86.9	92.2	94.4	100.0	105.9	114.1	119.3	120.4	126.4	130.1	134.4	139.3	139.8	143.4
Agriculture	78.9	85.2	90.6	89.0	100.0	88.7	96.9	89.5	103.0	109.3	113.9	111.1	100.2	105.5	114.6
Forestry	90.1	94.4	102.4	103.3	100.0	105.7	113.7	112.1	97.8	105.4	110.8	116.3	116.7	113.0	108.1
Fishing and trapping	102.0	115.6	102.6	105.4	100.0	95.7	101.6	90.2	85.8	98.0	110.1	121.6	124.3	114.7	123.3
Mining (incl. milling), quarries and oil wells	79.9	86.2	86.9	98.7	100.0	104.4	117.8	114.0	100.9	103.1	106.1	97.8	107.1	109.6	103.3
Electric power, gas and water utilities	72.6	78.2	85.4	93.3	100.0	111.1	120.3	130.1	130.5	142.0	150.9	157.5	166.3	170.4	175.9
Manufacturing	83.9	89.1	95.8	94.5	100.0	107.7	119.1	123.4	116.2	123.1	125.5	131.9	138.1	133.7	136.1
Construction	87.1	90.1	92.5	90.9	100.0	103.0	106.1	110.3	116.0	119.6	117.3	114.6	116.3	114.0	121.5
Transportation, storage and communications	77.9	82.8	89.0	94.2	100.0	108.5	117.9	125.0	126.5	134.2	141.6	147.8	157.9	161.7	166.7
Trade	83.7	87.1	91.7	93.2	100.0	109.9	119.8	129.5	132.5	138.0	139.8	144.9	149.7	149.6	150.9
Community, business and personal service	81.4	85.7	91.6	95.5	100.0	104.8	109.5	115.8	121.1	127.3	131.2	136.3	140.8	142.5	147.7
Finance, insurance and real estate	81.7	86.7	92.4	94.6	100.0	105.3	114.0	120.9	125.9	132.3	140.2	147.6	153.9	158.7	163.2
Public administration and defence	86.8	89.1	91.6	95.2	100.0	104.2	109.7	113.9	119.4	123.0	125.7	128.9	128.3	129.7	132.0

p Preliminary; r Revised.

TABLE 13. CANADA, VALUE OF EXPORTS OF CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS, BY MAIN GROUPS, 1975-81

	1975	1976	1977	1978	1979	1980	1981P
				($ million)			
Ferrous							
Crude material	721.5	984.4	1,114.9	854.5	1,469.5	1,342.9	1,540.0
Fabricated material	913.1	1,007.4	1,242.9	1,696.0	1,947.6	2,358.0	2,664.9
Total	1,634.7	1,991.8	2,357.9	2,550.6	3,417.1	3,701.1	4,205.0
Nonferrous							
Crude material	1,519.6	1,528.0	1,614.9	1,549.2	2,425.1	2,866.6	2,544.0
Fabricated material	1,843.5	2,231.3	2,578.4	3,360.9	3,807.1	6,273.8	5,615.6
Total	3,363.1	3,759.3	4,193.4	4,910.1	6,232.1	9,140.4	8,159.6
Nonmetals							
Crude material	794.9	1,103.4	1,276.1	1,369.7	1,715.3	2,305.0	2,618.7
Fabricated material	162.7	194.7	253.6	377.2	455.9	412.5	439.7
Total	957.6	1,298.1	1,529.6	1,746.8	2,171.2	2,717.5	3,058.3
Mineral fuels							
Crude material	4,637.3	4,464.0	4,428.9	4,514.9	6,128.9	7,816.8	8,022.0
Fabricated material	638.5	562.0	649.1	1,022.7	1,885.3	2,324.2	2,642.0
Total	5,275.8	5,026.0	5,078.0	5,537.6	8,014.2	10,141.0	10,664.0
Total minerals and products							
Crude material	7,673.3	8,079.8	8,434.9	8,288.2	11,738.8	14,331.4	14,724.6
Fabricated material	3,557.8	3,995.5	4,724.1	6,456.8	8,095.8	11,368.7	11,362.3
Total	11,231.1	12,075.3	13,158.9	14,745.0	19,834.7	25,700.1	26,086.9

P Preliminary.

TABLE 14. CANADA, VALUE OF IMPORTS OF CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS, BY MAIN GROUPS, 1975-81

	1975	1976	1977	1978	1979	1980	1981P
				($ million)			
Ferrous							
Crude material	179.5	129.8	106.0	223.8	322.1	354.2	373.2
Fabricated material	1,494.7	1,274.0	1,501.0	1,838.3	2,533.9	2,329.0	3,303.2
Total	1,674.2	1,403.8	1,607.0	2,062.1	2,856.0	2,683.2	3,676.4
Nonferrous							
Crude material	288.9	294.6	409.0	480.9	808.1	1,778.3	1,509.4
Fabricated material	621.8	600.4	662.1	949.1	2,122.7	2,784.6	2,433.4
Total	910.7	895.0	1,071.1	1,430.0	2,930.8	4,562.9	3,942.8
Nonmetals							
Crude material	183.0	157.9	170.6	231.0	284.5	329.3	339.3
Fabricated material	358.7	413.5	472.0	526.8	644.7	724.2	805.3
Total	541.7	571.4	642.6	757.8	929.2	1,053.5	1,144.6
Mineral fuels							
Crude material	3,886.8	3,834.1	3,876.4	4,092.8	5,364.3	7,732.3	8,696.9
Fabricated material	275.8	219.7	299.7	344.8	394.0	687.7	881.3
Total	4,162.6	4,053.8	4,176.1	4,437.6	5,758.3	8,420.0	9,578.2
Total minerals and products							
Crude material	4,538.2	4,416.4	4,562.0	5,028.6	6,779.0	10,194.1	10,918.7
Fabricated material	2,751.0	2,507.6	2,934.8	3,659.0	5,695.3	6,525.4	7,423.3
Total	7,289.2	6,924.0	7,496.8	8,687.6	12,474.3	16,719.5	18,342.0

P Preliminary.

TABLE 15. CANADA, VALUE OF EXPORTS OF CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS IN RELATION TO TOTAL EXPORT TRADE, 1971, 1976, 1981

	1971		1976		1981P	
		%		%		%
Crude material	2 968.1	17.1	8 079.8	21.5	14 724.6	18.1
Fabricated material	2 070.9	11.9	3 995.5	10.6	11 362.3	14.0
Total	5 039.0	29.0	12 075.3	32.1	26 086.9	32.1
Total exports, all products	17 396.6	100.0	37 650.7	100.0	81 203.3	100.0

P Preliminary.

TABLE 16. CANADA, VALUE OF IMPORTS OF CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS IN RELATION TO TOTAL EXPORT TRADE, 1971, 1976, 1981

	1971		1976		1981P	
		%		%		%
Crude material	1 016.0	6.5	4 416.4	11.8	10 918.7	13.8
Fabricated material	1 500.1	9.6	2 507.6	6.7	7 423.3	9.4
Total	2 516.1	16.1	6 924.0	18.5	18 342.0	23.2
Total imports, all products	15 618.1	100.0	37 494.0	100.0	79 123.4	100.0

P Preliminary.

TABLE 17. CANADA, VALUE OF EXPORTS OF CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS, BY MAIN GROUPS AND DESTINATION, 1981P

	U.S.A.	United Kingdom	E.F.T.A.[1]	E.E.C.[2]	Japan	Other countries	Total
				($ million)			
Ferrous materials and products	3,170.9	212.5	8.0	384.1	103.0	326.5	4,205.0
Nonferrous materials and products	4,647.0	819.8	429.1	798.1	832.3	633.3	8,159.6
Nonmetallic mineral materials and products	1,357.8	48.3	31.1	277.2	111.1	1,232.8	3,058.3
Mineral fuels, materials and products	9,200.8	5.2	29.6	255.4	753.7	419.3	10,664.0
Total	18,376.6	1,085.8	497.8	1,714.7	1,800.0	2,611.9	26,086.9
Percentage of total mineral exports	70.4	4.2	1.9	6.6	6.9	10.0	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 18. CANADA, VALUE OF IMPORTS OF CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS, BY MAIN GROUPS AND DESTINATION, 1981P

	U.S.A.	United Kingdom	E.F.T.A.[1]	E.E.C.[2]	Japan	Other countries	Total
				($ million)			
Ferrous materials and products	2,177.8	199.1	84.8	515.9	387.3	311.5	3,676.4
Nonferrous materials and products	2,941.4	32.4	86.9	108.9	57.9	715.4	3,942.8
Nonmetallic mineral materials and products	827.9	20.9	14.1	134.1	49.7	97.9	1,144.6
Mineral fuels, materials and products	2,518.7	430.5	96.9	43.2	0.1	6,488.7	9,578.2
Total	8,465.8	682.9	282.8	802.1	495.0	7,613.4	18,342.0
Percentage of total mineral imports	46.2	3.7	1.5	4.4	2.7	41.5	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 19. CANADA, VALUE OF EXPORTS OF CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS, BY COMMODITY AND DESTINATION, 1981P

	United States	United Kingdom	E.F.T.A.[1]	E.E.C.[2]	Japan	Other Countries	Total
				($ 000)			
Aluminum	1,132,013	7,340	4,630	12,763	229,034	199,695	1,585,475
Asbestos	138,932	30,975	21,133	112,385	43,590	264,282	611,297
Copper	332,281	159,280	77,934	202,262	304,563	111,271	1,187,591
Fuels	9,200,777	5,234	29,605	255,379	753,666	419,328	10,663,989
Iron Ore	923,751	191,903	3,677	303,022	83,483	34,189	1,540,025
Lead	80,226	25,944	4,192	41,025	26,329	16,908	194,624
Molybdenum	14,301	43,752	3,733	151,664	60,247	5,075	278,772
Nickel	530,637	201,935	275,916	102,319	31,862	85,190	1,227,859
Primary ferrous metals	341,281	5,571	39	45,012	18,692	59,002	469,597
Uranium	152,473	18,845	2,862	-	-	5,204	179,384
Zinc	375,276	46,600	3,184	180,175	51,723	105,313	762,271
All other minerals	5,154,634	348,427	70,949	308,702	196,837	1,306,443	7,385,992
Total	18,376,582	1,085,806	497,854	1,714,708	1,800,026	2,611,900	26,086,876

[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 20. CANADA, PHYSICAL VOLUME OF IMPORT TRADE FOR SELECTED COMMODITIES, 1975-81

	Units of Weight	1975	1976	1977	1978	1979	1980	1981P
Crude materials								
Metals								
Aluminum ore	tonnes	760 616	908 055	821 596	1 056 190	952 584	983 972	1 020 550
Bauxite ore	tonnes	2 420 669	1 230 052	2 764 286	2 434 435	2 149 636	3 504 368	2 702 282
Iron ore	tonnes	4 844 416	3 020 130	2 505 203	4 685 868	5 912 581	5 875 292	5 794 634
Manganese ore	tonnes	69 773	118 972	57 644	136 446	45 150	95 161	119 746
Nonmetals								
Bentonite	tonnes	242 183	274 095	358 724	353 790	638 307	471 684	311 459
Clay, ground & unground	tonnes	328 987	355 760	334 431	381 486	445 231	403 282	413 040
Fluorspar	tonnes	157 222	137 310	124 494	170 237	167 904	223 940	173 599
Limestone, crushed	tonnes	3 281 800	3 513 824	2 922 684	2 873 601	3 215 717	2 418 330	2 526 808
Phosphate rock	tonnes	3 282 257	2 241 086	2 439 021	3 043 899	3 341 039	3 816 514	3 245 446
Salt & Brine	tonnes	1 183 144	1 523 407	1 126 225	1 330 474	1 275 627	1 151 203	1 254 992
Sand & Gravel	tonnes	1 909 894	2 085 922	1 645 663	1 810 989	1 201 915	1 209 582	1 446 872
Silica sand	tonnes	1 044 160	1 337 139	1 101 186	1 242 444	1 651 890	1 200 237	1 142 880
Fuels								
Coal	tonnes	14 962 896	14 371 622	15 026 358	13 000 320	17 381 794	15 719 025	14 687 279
Petroleum, crude	metres^{3r}	47 446 092	44 027 841	38 042 718	36 754 037	35 330 535	32 710 030	30 154 730
Fabricated materials								
Metals								
Aluminum & Aluminum alloy	tonnes	79 726	115 870	118 216	119 154	168 125	128 061	139 377
Ferroalloys	tonnes	117 920	95 272	93 672	101 160	167 232	118 516	117 907
Steel:								
bars & rods	tonnes	382 990	307 057	301 502	318 336	300 069r	189 853	341 532
castings & forgings	tonnes	108 826	123 609	113 365	116 473	139 095	129 363	118 475
pipes & tubes	tonnes	196 138	169 916	203 238	317 031	285 144	322 121	364 803
sheets & strips	tonnes	582 573	466 172	552 606	704 502	1 039 054	582 233	1 717 433
structural shapes	tonnes	190 655	231 619	225 869	151 502	273 111	207 657	363 406
Nonmetals								
Cement	tonnes	428 777	329 045	263 528	256 721	248 422r	223 247	721 205
Fire bricks	tonnes	229 664	189 599	242 720	156 002	227 156	236 205	187 017
Magnesia & dolomite	tonnes	89 800	45 689	56 189	68 214	92 824	80 916	64 139
Phosphate fertilizers	tonnes	128 045	168 482	200 445	286 744	381 887	248 328	306 502
Fuels								
Coke	tonnes	1 119 013	876 943	1 267 895	1 527 342	1 366 182	1 311 698	1 436 037
Fuel oil	metres^3	1 335 056	1 137 041	1 260 034	1 277 077	871 425r	1 617 606	1 256 795

P Preliminary; r Revised.

TABLE 21. CANADA, PHYSICAL VOLUME OF EXPORT TRADE FOR SELECTED COMMODITIES, 1975-81

	Unit of Weight	1975	1976	1977	1978	1979	1980	1981P
Crude materials								
Metals								
Copper, ores & concentrates	tonnes	314 518	294 823	279 582	282 159	315 211	286 076	276 810
Iron, ores & concentrates	tonnes	36 059 820	44 684 868	45 060 391	31 929 094	48 849 270	39 020 922	41 452 044
Lead, ores & concentrates	tonnes	211 909	140 933	137 820	142 693	151 485	147 008	146 090
Zinc, ores & concentrates	tonnes	705 089	653 737	598 451	688 186	598 279	435 831	516 210
Nonmetals								
Asbestos, crude & fibers	tonnes	1 085 598	1 502 435	1 415 482	1 398 081	1 461 042r	1 217 737	1 062 189
Crude refractory materials	tonnes	536 208	820 645	747 938	1 081 684	1 023 734r	803 892	629 770
Gypsum	tonnes	3 691 676	3 798 243	4 994 323	5 178 631	5 474 764	4 960 240	5 094 873
Limestone, crushed	tonnes	1 217 564	1 287 976	1 502 492	1 710 348	2 296 295	2 214 489	1 758 299
Nepheline syenite	tonnes	356 629	418 975	443 763	420 961	471 056	448 468	476 281
Salt and Brine	tonnes	-	1 423 847	1 163 163	1 608 582	1 822 120	1 655 768	1 507 710
Sand and Gravel	tonnes	138 452	377 677	273 745	269 216	323 639	383 533	318 635
Sulphur, crude or refined	tonnes	3 284 246	3 719 992	4 291 032	4 984 545	5 154 831	6 850 143	7 309 216
Fuels								
Coal	tonnes	11 694 655	11 761 930	12 068 905	13 657 514	13 852 848r	14 310 782	16 285 102
Natural gas	thousand metres³	26 885 865	27 015 710	28 141 415	24 992 242	28 047 648	22 963 134	21 687 359
Fabricated materials								
Metals								
Aluminum, pig ingots	tonnes	512 050	510 751	655 353	863 320	551 957	784 720	725 441
Copper, refinery shapes	tonnes	320 705	322 991	294 490	247 727	191 211	335 200	262 642
Iron, pig ingots	tonnes	406 308	281 577	505 277	544 716	255 523	562 351	466 360
Lead, pig ingots	tonnes	110 882	114 421	130 819	131 950	117 992	126 538	119 815
Zinc, pig ingots	tonnes	247 474	352 071	295 358	439 260	429 352	471 949	453 526
Nonmetals								
Cement	tonnes	934 981	921 031	1 274 652	1 634 582	2 288 822	1 550 562	1 578 659
Lime, quick & hydrated	tonnes	234 034	309 355	359 540	478 551	490 863	403 166	432 845
Peat	tonnes	263 284	296 258	303 414	312 903	358 267	390 457	326 826
Fuels								
Butane gas, liquified	metres³	2 356 672	2 712 650	2 432 188	2 208 682	2 926 459	2 563 406	3 137 545
Coke	tonnes	257 657	321 636	355 919	352 358r	354 016r	470 496	391 027
Fuel Oil	metres³	3 781 202	2 092 266	1 456 991	4 232 409	4 654 162	4 273 510	3 846 907
Gasoline	metres³	775 240	439 222	388 080	972 282	913 271	706 539	600 969
Propane gas, liquified	metres³	3 512 927	4 048 280	5 019 524	3 543 782	4 858 175	3 879 915	3 867 950

P Preliminary; - Not available; r Revised.

TABLE 22. CANADA, APPARENT CONSUMPTION[1] OF SOME MINERALS, AND RELATION TO PRODUCTION[2], 1979-81

		1979r			1980			1981p		
	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	33 646	1 492 719	2.3	106 472	1 323 053	8.0	71 000	1 133 000	6.3
Cement	t	10 928 566	12 968 966	84.3	9 884 463	11 211 778	88.2	9 781 000	10 368 000	94.3
Gypsum	t	3 585 864	8 908 166	40.3	2 530 695	7 336 218	34.5	2 849 000	7 800 000	36.5
Iron ore		16 680 597	59 617 286	30.0	15 922 485	49 068 115	32.4	14 187 000	49 844 000	28.5
Lime	t	1 409 942	1 859 325	75.8	1 678 379	2 040 644	82.2	2 053 000	2 463 000	83.4
Quartz silica	t	3 549 330	2 368 497	149.9	3 003 599	2 251 831	133.4	2 988 000	2 321 000	128.7
Salt	t	6 334 628	6 881 121	92.1	6 918 289	7 422 854	93.2	7 030 000	7 283 000	96.5

[1] "Apparent consumption" is production, plus imports, less exports. [2] "Production" refers to producers' shipments.
[p] Preliminary; [r] Revised.

TABLE 23. CANADA, REPORTED CONSUMPTION OF MINERALS AND RELATION TO PRODUCTION, 1978-80

		1978			1979			1980p		
	Unit of Measure	Consumption	Production	Consumption as % of production	Consumption	Production	Consumption as % of production	Consumption	Production	Consumption as % of production
Metals										
Aluminum	t	380 291	1 048 469	36.3	399 049	860 287	46.4	329 371	1 068 197	30.8
Antimony	kg	345 282r	..	..	463 423r	..	..	369 732	..	..
Bismuth	kg	25 664	145 104	17.7	25 117	136 733	18.4	10 271	149 366	6.9
Cadmium	kg	47 523	1 151 298	4.1	48 746	209 459	4.0	49 868	1 033 097	4.8
Chromium (chromite)	t	27 472	-	..	27 205	-	..	27 900	-	..
Cobalt	kg	144 610	1 233 777	11.7	114 606	1 639 624	7.0	105 225	2 118 154	5.0
Copper	t	228 694[1]	659 380	34.7	210 689[1]	636 383	33.1	195 124[1]	716 363	27.2
Lead	t	100 762[2]	319 809	31.5	126 464[2]	310 745	40.7	124 813[2]	251 627	49.6
Magnesium	t	3 953	8 309	47.6	4 450	9 015	49.4	5 412	9 252	58.5
Manganese ore	t	201 320	-	..	61 643	-	..	159 243	-	..
Mercury	kg	29 904	-	..	26 249	-	..	36 326	-	..
Molybdenum (Mo content)	kg	1 269	13 943	9.1	1 250	11 175	11.2	1 055	11 889	8.9
Nickel	t	11 790	128 310	9.2	8 336	126 482	6.6	9 676	184 802	5.2
Selenium	kg	14 364	122 405	11.7	15 773	217 759	7.2	10 795	279 626	3.9
Silver	kg	329 320	1 266 927	2.6	251 985	1 146 908	22.0	67 122	1 069 635	6.3
Tellurium	kg	..	31 421	..	..	42 433	..	..	15 011	..
Tin	t	4 922	360	1 367.2	4 675	338	1 383.1	4 507	243	1 854.7
Tungsten (W content)	kg	388 146	2 885 619	13.5	380 229	3 254 067	11.7	290 479	4 006 647	7.3
Zinc	t	121 375	1 066 902	11.4	131 317	1 099 926	11.9	107 879	883 697	12.2
Nonmetals										
Barite	t	58 123	99 339	58.5	79 595	73 512	108.3	142 421	94 317	151.0
Feldspar	t	4 586	-	..	4 588r	-	..	4 051	-	..
Fluorspar	t	128 280	-	..	107 004	-	..	131 262	-	..
Mica	kg	3 793r	..	..	2 208r	-	..	2 576	..	..
Nepheline syenite	t	88 806	599 121	14.8	86 788r	605 699	14.3	84 873	599 699	14.2
Phosphate rock	t	3 029 600r	-	..	3 203 400r	-	..	3 546 636	-	..
Potash (K_2O)	t	..	6 344 010	..	..	7 074 388	..	..	7 201 217	..
Sodium sulphate	t	227 766	376 563	60.5	255 050	443 279	57.5	232 045	480 666	48.3
Sulphur	t	799 709	5 752 208	13.9	976 730r	6 314 144	15.5	817 362	7 655 723	10.7
Talc, etc.	t	43 119	61 661	69.9	46 940	90 330	52.0	42 217	91 848	44.0
Fuels										
Coal	t	31 738	30 478	104.1	34 764	33 200	104.7	37 333	36 688	101.8
Natural gas	000 m^3	42 543r[3]	80 609	52.8	44 156r[3]	94 426	46.8	44 820[3]	87 108	51.5
Crude oil	m^3	105 485r[4]	76 348	138.2	113 150r[4]	86 910	130.2	109 865[4]	83 477	131.6

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] Producers domestic shipments of refined metal. [2] Includes primary and secondary refined metal. [3] Domestic sales. [4] Refinery receipts.

p Preliminary; - Nil; .. Not available or not applicable; r Revised.

TABLE 24. CANADA, DOMESTIC CONSUMPTION OF PRINCIPAL REFINED METALS IN RELATION TO REFINERY PRODUCTION[1], 1974-80

	Unit of Measure	1974	1975	1976	1977	1978	1979	1980P
Copper								
Domestic consumption[2]	tonnes	247 985	185 194	206 205	200 372	228 694	210 689	195 124
Production	tonnes	559 125	529 199	510 469	508 767	446 278	397 263	505 238
Consumption of production	%	44.4	35.0	40.4	39.4	51.2	53.0	38.6
Zinc								
Domestic consumption[3]	tonnes	117 619	98 280	98 897	105 412	121 375	131 317	107 879
Production	tonnes	437 725	426 902	472 316	494 938	495 243	580 449	591 565
Consumption of production	%	26.9	23.0	20.9	21.3	24.5	22.6	18.2
Lead								
Domestic consumption[3]	tonnes	99 734	89 192	107 654	106 962	100 762	126 464	124 813
Production	tonnes	126 460	171 517	175 720	187 457	194 054	183 769	162 463
Consumption of production	%	78.9	52.0	61.3	57.1	51.9	68.8	76.8
Aluminum								
Domestic consumption[4]	tonnes	359 790	293 280	332 206	322 393	380 291	399 049	329 371
Production	tonnes	1 006 632	878 056	628 049	973 524	1 048 469	860 287	1 068 197
Consumption of production	%	35.7	33.4	51.3	34.1	36.3	46.4	30.8

[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 25. AVERAGE ANNUAL PRICES[1] OF SELECTED MINERALS, 1975-81[2]

	Unit of Measure	1975	1976	1977	1978	1979	1980	1981
Aluminum, major U.S. producer	cents/lb	39.786	44.341	51.339	53.075	59.395	69.566	76.000
Antimony, New York dealer	$/lb	1.494	1.561	1.237	1.145	1.407	1.508	1.355
Asbestos, No. 4 cement fibre	Cdn $/st	389.333	492.000	551.000	642.000	687.000	769.000	850
Bismuth, U.S. producer	$/lb	7.715	7.500	6.010	3.378	3.011	2.637	..
Cadmium, U.S. producer	$/lb	3.355	2.662	2.962	2.450	2.760	2.843	1.927
Calcium, metal crowns	$/lb	1.315	1.335	1.482	1.680	1.868	2.502	2.831
Chrome, U.S. metal, 9% carbon	$/lb	2.570	2.640	2.900	3.080	3.375	4.017	4.450
Cobalt metal, shot/cathode/250 kg	$/lb	3.979	4.508	5.633	12.246	24.583	25.000	..
Columbium, pyrochlore	$/lb	1.560	n	n	2.550	2.550	2.550	3.250
Copper, electrolytic cathode	Cdn $/lb	0.638	0.684	0.695	0.746	1.076	1.178	1.004
Gold, London[3]	Cdn $/troy oz	163.781	123.107	157.089	220.407	359.289	716.087	551.178
Iridium, major producer	$/troy oz	475.000	316.667	300.000	300.000	258.333	505.833	600.000
Iron ore, taconite pellets	cents/ltu	45.686	51.012	55.300	57.108	63.966	69.562	80.073
Lead, producer	Cdn cents/lb	20.26	22.65	31.42	36.82	59.92	49.35	44.52
Manganese, U.S. metal, regular	cents/lb	54.000	55.333	58.000	58.000	58.333	65.267	70.000
Magnesium, U.S. primary ingot	cents/lb	82.000	89.537	97.487	100.500	105.758	116.667	130.250
Mercury, New York	$/flask (76 lb)	158.115	121.302	135.710	153.322	281.096	389.447	413.885
Molybdenum, climax concentrate	$/lb	2.493	2.999	3.730	4.644	7.762	9.768	8.493
Nickel, major producer cathode	$/lb	2.073	2.256	2.360	2.091	2.707	3.415	3.429
Osmium, major producer	$/troy oz	200.000	200.000	170.000	150.000	150.000	150.000	150.000
Palladium, major producer	$/troy oz	92.702	50.928	59.702	70.873	113.143	213.975	129.500
Platinum, major producer	$/troy oz	164.005	161.729	162.544	237.250	351.649	439.425	475.000
Potash, K_2O, coarse major producer	cents/lb	65.667	74.667	76.000	80.583	100.417	112.667	120.75
Rhodium, major producer	$/troy oz	337.50	350.000	441.667	516.667	737.500	764.583	639.583
Ruthenium, major producer	$/troy oz	60.000	60.000	60.000	60.000	45.000	45.000	45.000
Selenium, major producer commercial	$/lb	18.000	18.000	17.000	15.000	12.250	9.654	..
Silver, fob Toronto	Cdn $/troy oz	4.506	4.298	4.920	6.171	12.974	24.099	12.617
Sulphur, elemental, major producer	Cdn $/lt	22.831	17.204	15.678	17.913	25.665	30.740[5]	59.323[5]
Tantalum, Tanco	$/lb	15.000	16.000	17.750	26.479	60.014	97.604	100.83
Tellurium, major producer, slab	$/lb	9.333	10.500	17.416	20.000	20.000	19.500	..
Tin	Cdn $/lb	3.529	3.822	5.779	7.265	8.898	10.008	8.893
Titanium, ilmenite ore	$/lt	55.000	55.000	55.000	53.229	51.083	55.000	68.021
Tungsten, U.S. hydrogen red	$/lb	10.210	10.087	14.065	13.900	13.900	13.900	13.900
Uranium, U[4]	Cdn $/lb	23.60	47.20	49.90	56.70	59.00	61.20	50.00
Vanadium, pentoxide metal	$/lb	2.980	2.600	2.750	2.900	3.050	3.050	3.250
Zinc, special high grade	Cdn cents/lb	37.50	37.62	35.53	34.757	43.717	44.050	54.24

[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] Average P.M. fixings of London bullion dealers, converted to Canadian dollar. [4] From EMR publications on assessment of Canada's uranium supply and demand series EP 76-3 to EP 81-3. [5] Starting 1980, North American deliveries.

.. Not available; n Nominal.

TABLE 26. CANADA, MINERAL PRODUCTS INDUSTRIES, SELLING PRICE INDEXES, 1975-81 (1971 = 100)

	1975	1976	1977	1978	1979	1980	1981P
Iron and steel products industries							
Agricultural implements industry	155.2	165.7	177.6	188.7	206.0	224.9	259.6
Hardware, tool and cutlery manufacturers	137.9	147.3	162.6	179.1	207.3	238.4	268.7
Heating equipment manufacturers	137.3	146.9	156.5	169.8	188.0	213.2	235.6
Primary metal industries	160.8	169.9	190.5	207.7	258.8	308.3	312.6
Iron and steel mills	162.0	177.2	187.9	203.9	233.7	261.7	290.3
Steel pipe and tube mills	162.9	179.1	197.8	218.0	248.1	276.9	322.1
Iron foundries	168.4	181.0	189.6	200.1	223.3	243.2	261.8
Wire and wire products manufacturers	158.3	171.0	175.4	185.8	206.4	226.9	242.3
Nonferrous metal products industries							
Aluminum rolling, casting and extruding	145.4	155.8	173.6	191.5	234.0	271.0	292.6
Copper and alloy, rolling, casting and extruding	131.6	138.4	144.5	153.0	201.8	219.7	206.1
Jewellery and silverware manufacturers	234.1	235.2	277.8	337.6	507.3	871.3	676.1
Metal rolling, casting and extruding, nes	171.8	181.0	216.3	239.8	310.4	327.3	326.1
Nonmetallic mineral products industries							
Abrasives manufacturers	140.5	167.5	194.7	223.6	255.3	290.6	324.4
Cement manufacturers	146.3	171.1	186.7	207.5	233.2	265.7	308.0
Clay products and manufacturers from imported clay	151.0	161.7	164.7	173.7	190.1	215.2	251.9
Glass and glass products manufacturers	127.1	138.6	150.4	162.1	173.4	197.0	222.7
Lime manufacturers	181.7	204.3	228.7	252.9	292.7	338.3	395.6
Concrete products manufacturers	152.0	161.5	173.7	187.7	200.1	222.5	258.7
Clay products from domestic clay	157.1	169.6	182.8	196.4	214.3	226.9	243.0
Petroleum and coal products industries	183.7	210.2	244.5	275.4	321.3	404.6	551.8
Petroleum refineries	184.5	211.5	246.7	278.7	325.8	410.6	559.8
Mixed fertilizers	204.0	176.9	180.2	191.0	229.0	280.3	290.5

Note: Industry selling price indexes reflect wholesale price trends of products or groups of products sold by the industries listed.

P Preliminary; nes Not elsewhere specified.

TABLE 27. CANADA, PRINCIPAL STATISTICS OF THE MINING INDUSTRY[1], 1980

	Mining 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)
Metals											
Gold quartz	27	4,781	10,132	103,293	18,665	93,742	696,720	584,313	5,839	127,869	588,752
Copper-gold-silver	33	12,299	26,338	289,899	93,736	829,793	2,474,922	1,551,394	16,637	402,214	1,558,568
Silver-lead-zinc	22	5,275	10,565	122,248	42,106	442,965	1,007,896	522,825	7,349	180,430	513,573
Nickel-copper	3	11,148	21,382	220,481	23,327	641,698	2,097,139	1,432,115	14,426	314,411	1,433,649
Iron	15	8,264	17,035	216,280	174,165	657,409	1,872,690	1,041,116	13,753	374,529	1,005,060
Uranium	7	4,463	9,230	107,209	31,336	137,780	722,522	553,406	6,304	152,426	559,322
Misc. metal mines	7	1,362	2,849	32,438	11,555	53,690	307,771	242,526	1,810	44,285	243,300
Total	114	47,592	97,532	1,091,848	394,889	2,857,076	9,179,660	5,927,695	66,118	1,596,165	5,902,224
Nonmetals											
Asbestos	9	6,473	14,179	149,995	52,876	132,795	655,551	469,880	8,055	193,462	473,425
Gypsum	11	599	1,326	8,702	2,739	11,065	40,838	27,033	715	10,990	26,863
Peat	55	1,080	2,245	13,459	2,147	11,431	53,627	40,050	1,308	17,301	42,686
Potash	10	3,094	6,533	69,661	54,675	92,556	1,046,261	899,029	4,160	97,173	900,380
Salt	9	931	2,164	19,432	9,931	19,882	124,308	94,495	1,418	30,184	93,722
Sand and gravel	113	1,331	2,871	23,352	10,010	23,352	121,213	87,851	1,801	34,592	92,094
Stone	115	2,077	4,466	39,206	14,394	55,762	192,188	122,032	2,660	51,633	123,376
Misc. nonmetals	28	1,060	2,188	19,197	14,234	20,616	95,121	60,270	1,323	24,601	59,050
Total	350	16,645	35,973	343,004	161,007	367,459	2,329,107	1,800,640	21,440	459,936	1,811,596
Fuels											
Coal	26	9,428	19,328	200,951	49,068	242,043	913,302	622,191	11,416	250,338	621,630
Oil, crude and natural gas	833	6,401	13,594	143,586	101,441	335,484	15,239,177	14,802,252	27,448	673,031	15,012,232
Total	859	15,829	32,922	344,537	150,509	577,527	16,152,479	15,424,443	38,864	923,369	15,633,862
Total mining industry	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

[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 29, 31 and 33. [2] Total activity includes sales and head offices.

TABLE 28. CANADA, PRINCIPAL STATISTICS OF THE MINERAL MANUFACTURING INDUSTRIES[1], 1980

	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)
Primary metal industries											
Iron and steel mills	55	47,854	100,969	1,013,918	359,226	3,638,582	6,431,455	2,545,602	61,238	1,364,629	2,537,850
Steel pipe and tube mills	35	5,462	12,129	116,280	18,627	663,756	972,250	293,863	6,514	142,888	297,623
Iron foundries	120	7,638	15,404	122,801	23,686	223,675	512,726	261,309	9,245	157,704	266,858
Smelting and refining	32	24,512	52,010	528,680	298,046	1,211,908	3,273,169	1,763,214	36,137	824,509	1,849,225
Aluminum rolling, casting and extruding	77	4,768	10,275	81,826	16,881	762,340	1,049,304	274,450	6,627	122,918	273,491
Copper and alloy rolling casting and extruding	42	2,707	5,366	47,854	8,633	451,883	573,285	105,500	3,230	59,530	103,726
Metal rolling, casting and extruding, nes	99	4,589	9,405	69,064	13,219	390,025	605,645	200,033	5,749	95,267	203,564
Total	460	97,530	205,558	1,980,423	738,318	7,342,169	13,417,834	5,443,971	128,740	2,767,445	5,532,337
Nonmetallic mineral products industries											
Cement manufacturers	28	2,909	6,173	73,280	136,153	134,499	611,742	352,930	4,791	122,686	357,250
Lime manufacturers	15	759	1,589	15,476	38,451	17,694	114,897	58,948	1,003	21,112	59,489
Concrete products manufacturers	488	6,888	14,044	120,928	18,402	229,040	566,325	315,574	9,280	168,375	323,883
Ready-mix concrete manufacturers	500	7,196	15,011	147,953	31,638	537,335	898,347	332,067	9,348	191,703	352,414
Clay products manufacturers (domestic)	113	2,350	4,848	35,892	18,491	28,295	127,791	84,151	2,993	49,653	84,635
Clay products manufacturers (imported)	35	1,523	3,015	21,526	4,397	30,067	83,447	50,698	1,882	28,181	51,630
Refractories manufacturers	20	926	2,054	16,512	4,564	78,434	135,657	56,358	1,630	31,100	73,646
Stone products manufacturers	128	1,104	2,245	15,710	1,326	23,379	57,251	33,215	1,315	19,203	33,175
Glass manufacturers	14	6,517	13,450	112,258	44,115	147,044	484,347	311,844	8,604	158,395	308,116
Glass products manufacturers	101	2,869	5,962	46,763	6,061	120,893	260,869	137,967	3,439	59,720	143,601
Abrasive manufacturers	25	1,959	4,007	32,184	23,573	94,055	202,006	88,332	2,628	47,256	92,112
Other nonmetallic mineral products industries	104	5,799	12,091	104,772	46,915	287,447	686,493	356,352	9,173	179,685	374,825
Total	1,571	40,799	84,489	743,254	374,086	1,728,182	4,229,172	2,178,436	56,086	1,077,069	2,254,776
Petroleum and coal products industries											
Petroleum refining industry	41	7,356	16,371	187,090	155,881	12,756,411	14,255,804	1,742,049	18,743	515,911	1,750,101
Manufacture of lubricating oils & greases	21	507	1,032	8,174	1,681	138,826	158,649	20,309	771	14,579	26,668
Other petroleum & coal products industries	50	414	862	8,422	2,936	79,984	115,876	33,201	532	11,061	35,986
Total	112	8,277	18,265	203,686	160,498	12,975,221	14,530,329	1,795,559	20,046	541,551	1,812,755
Total, mineral manufacturing industries	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

[1] Industry coverage is the same as in Tables 28, 30 and 32. [2] Includes sales and head offices.
nes - Not elsewhere specified.

TABLE 29. CANADA, PRINCIPAL STATISTICS OF THE MINING INDUSTRY[1], 1974-80

	Mineral Manufacturing Activity								Total Activity[2]		
		Production and Related Workers			Costs						
	Establish-ments (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)
1974	1,438	79,928	165,999	894,538	285,767	2,004,476	11,187,764	8,897,522	118,730	1,450,330	8,929,981
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	1,232	79,902[r]	167,884	1,342,508	473,202	2,715,468	16,400,460	13,211,792	119,061[r]	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

[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 27, 31 and 33. [2] Includes sales and head offices.

[r] Revised.

TABLE 30. CANADA, PRINCIPAL STATISTICS OF THE MINERAL MANUFACTURING INDUSTRIES[1], 1974-80

		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)
1974	1,708	145,209	309,481	1,582,014	463,395	8,809,583	14,003,237	5,110,117	197,220	2,315,107	5,236,626
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

[1] Industry coverage is the same as in Tables 28, 32 and 34. [2] Includes sales and head offices.

TABLE 31. CANADA, CONSUMPTION OF FUEL AND ELECTRICITY IN THE MINING INDUSTRY[1], 1980

	Unit	Metals	Nonmetals	Fuels	Total
Coal and coke	000 t	156	12	-	168
	$000	6,239	191	-	6,430
Gasoline	000 litres	29 496	22 806	8 153	60 455
	$000	7,328	5,636	1,963	14,927
Fuel oil, kerosene, diesel oil	000 litres	1 251 607	347 200	131 779	1 730 586
	$000	176,441	60,658	22,181	259,280
Liquefied petroleum gas	000 litres	97 130	5 675	5 923	108 728
	$000	13,259	976	844	15,079
Natural gas	000 m^3	184 476	755 835	106 000	1 046 311
	$000	16,378	45,211	7,594	69,183
Other fuels[2]	$000	407	-	-	407
Total value of fuels	$000	220,052	112,672	32,582	365,306
Electricity purchased	million kwh	11 024	2 269	3 504	16 797
	$000	174,837	48,336	117,927	341,100
Total value of fuels and electricity purchased, all reporting companies	$000	394,889	161,008	150,509	706,406

[1] Cement and lime manufacturing and manufacturers of clay products (domestic clays) are included under mineral manufacturing, Tables 32 and 34. Industry coverage is the same as in Tables 27, 29, and 33. [2] Includes wood, manufactured gas, steam purchased and other miscellaneous fuels.
- Nil.
Note: Totals may not add due to rounding.

TABLE 32. CANADA, CONSUMPTION OF FUEL AND ELECTRICITY IN THE MINERAL MANUFACTURING INDUSTRIES[1], 1980

	Unit	Primary Metal Industries	Nonmetallic Mineral Products Industries	Petroleum and Coal Products Industries	Total
Coal and coke	000 t	378	435	-	813
	$000	36,700	20,791	-	57,491
Gasoline	000 litres	19 514	37 642	3 009	60 165
	$000	4,320	8,497	727	13,545
Fuel oil, kerosene, diesel oil	000 litres	1 279 315	760 427	15 236	2 054 979
	$000	153,574	97,955	2,295	253,824
Liquefied petroleum gas	000 litres	33 718	18 948	28 462	81 128
	$000	4,606	2,812	2,333	9,751
Natural gas	000 m^3	2 750 899	1 689 350	1 037 308	5 477 557
	$000	217,618	133,620	77,534	428,771
Other fuels	$000	4,608	7,806	5,422	17,836
Total value of fuels	$000	421,426	271,481	88,311	781,218
Electricity purchased	million kWh	20 535	4 633	3 705	28 873
	$000	316,884	102,765	72,186	491,834
Total value of fuels and electricity purchased, all reporting companies	$000	738,317	374,248	160,498	1,273,063

[1] Industry coverage is the same as in Tables 28, 30 and 34.
- Nil.

TABLE 33. CANADA, COST OF FUEL AND ELECTRICITY USED IN THE MINING INDUSTRY[1], 1974-80

	Unit	1974	1975	1976	1977	1978	1979	1980
Metals								
Fuel	$000	90,596	107,808	128,637	148,578	153,608	193,828	220,052
Electricity purchased	million kwh	10 282	10 259	11 326	11 713	10 739	11 459	11 024
	$000	77,669	85,063	107,318	135,014	132,100	153,905	174,837
Total cost of fuel and electricity	$000	168,265	192,871	235,955	283,591	285,708	347,733	394,889
Nonmetals[2]								
Fuel	$000	42,209	46,561	62,453	72,946	79,090	92,499	112,672
Electricity purchased	million kwh	2 015	1 763	1 959	2 457	2 082	2 244	2 269
	$000	20,065	20,049	23,401	29,510	35,141	42,982	48,336
Total cost of fuel and electricity	$000	62,274	66,610	85,854	102,456	114,231	135,481	161,008
Fuels								
Fuels	$000	5,755	11,352	12,015	15,117	19,774	23,988	32,582
Electricity purchased	million kwh	2 972	2 539	2 770	2 791	2 699	3 238	3 504
	$000	49,473	48,663	68,075	72,035	81,624	98,783	117,927
Total cost of fuel and electricity	$000	55,228	60,015	80,090	87,152	101,398	122,771	150,509
Total mining industry								
Fuel	$000	138,560	165,721	203,105	236,642	252,470	310,315	365,306
Electricity purchased	million kwh	15 267	14 560	16 055	16 961	15 520	16 941	16 797
	$000	147,207	153,775	198,794	236,559	248,865	295,670	341,100
Total cost of fuel and electricity	$000	285,767	319,496	401,899	473,201	501,335	605,985	706,406

[1] Cement and lime manufacturing and manufacture of clay products (domestic clays) are included in mineral manufacturing, Tables 32 and 34. Industry coverage is the same as in Tables 27, 29 and 31. [2] Includes structural materials.

TABLE 34. CANADA, COST OF FUEL AND ELECTRICITY USED IN THE MINERAL MANUFACTURING INDUSTRIES[1], 1974-80

	Unit	1974	1975	1976	1977	1978	1979	1980
Primary metals								
Fuel	$ 000	153,468	187,846	224,928	279,172	336,684	357,775	421,426
Electricity purchased	million kwh	17 727	16 544	16 497	15 352	17 257	18 451	20 535
	$ 000	122,567	129,750	151,011	183,574	226,313	260,317	316,884
Total cost of fuel and electricity	$ 000	276,035	317,596	375,939	462,746	562,997	618,092	738,317
Nonmetallic mineral products								
Fuel	$ 000	112,531	133,016	162,312	181,952	221,855	280,846	271,481
Electricity purchased	million kwh	4 106	3 723	4 137	4 190	4 782	5 163	4 633
	$ 000	38,671	41,258	52,113	65,553	79,606	98,296	102,765
Total cost of fuel and electricity	$ 000	151,202	174,274	214,425	247,507	301,461	379,142	374,248
Petroleum and coal products								
Fuel	$ 000	13,275	21,758	30,474	42,184	61,891	74,968	88,311
Electricity purchased	million kwh	2 715	2 904	3 010	3 205	3 505	3 555	3 705
	$ 000	22,885	28,028	34,988	46,050	55,303	63,395	72,186
Total cost of fuel and electricity	$ 000	36,160	49,786	65,462	88,233	117,194	138,363	160 498
Total mineral manufacturing industries								
Fuel	$ 000	279,274	342,620	417,714	503,308	620,430	713,589	781,218
Electricity purchased	million kWh	24 548	23 171	23 644	22 747	25 544	27 169	28 873
	$ 000	184,123	199,036	238,112	295,177	361,222	422,008	491,834
Total cost of fuel and electricity	$ 000	463,397	541,656	655,826	798,486	981,652	1,135,597	1,273,063

[1] Industry coverage is the same as in Tables 28, 30 and 32.

TABLE 35. CANADA, EMPLOYMENT, SALARIES AND WAGES IN THE MINING INDUSTRY[1], 1974-80

	Unit	1974	1975	1976	1977	1978	1979	1980
Metals								
Production and related workers	Number	50,886	50,319	49,834	49,414	39,977	41,541	47,592
Salaries and wages	$000	580,185	685,562	759,499	849,345	757,258	879,383	1,091,848
Annual average salary and wage	$	11,402	13,624	15,241	17,188	18,942	21,169	22,942
Administrative and office workers	Number	19,152	18,842	18,435	17,831	16,470	17,419	18,526
Salaries and wages	$000	282,348	320,873	352,847	377,714	358,680	428,639	504,316
Annual average salary and wage	$	14,732	17,030	19,140	21,183	21,778	24,608	27,222
Total metals								
Employees	Number	70,038	69,161	68,269	67,245	56,447	58,960	66,118
Salaries and wages	$000	862,533	1,006,435	1,112,346	1,227,059	1,115,938	1,308,022	1,596,165
Annual average salary and wage	$	12,315	14,552	16,294	18,248	19,770	22,185	24,141
Nonmetals								
Production and related workers	Number	17,767	15,397	16,447	16,812	16,133	16,633	16,645
Salaries and wages	$000	180,962	188,956	237,982	266,294	274,037	321,303	343,004
Annual average salary and wage	$	10,185	12,272	14,470	15,840	16,986	19,317	20,607
Administrative and office workers	Number	4,628	4,688	4,887	4,986	4,749	4,829	4,795
Salaries and wages	$000	57,243	69,208	82,861	89,757	95,659	106,776	116,932
Annual average salary and wage	$	12,369	14,763	16,955	18,002	20,143	22,114	24,386
Total nonmetals								
Employees	Number	22,395	20,085	21,334	21,798	20,882	21,462	21,440
Salaries and wages	$000	238,205	258,164	320,843	356,051	369,696	428,079	459,936
Annual average salary and wage	$	10,637	12,854	15,039	16,334	17,704	19,946	21,452
Fuels								
Production and related workers	Number	11,275	11,375	12,708	13,679	14,196	14,406	15,829
Salaries and wages	$000	133,392	155,491	187,704	226,869	243,713	293,087	344,537
Annual average salary and wage	$	11,831	13,670	14,771	16,585	17,168	20,345	21,766
Administrative and office workers	Number	15,022	15,094	15,383	16,342	18,423	20,417	23,035
Salaries and wages	$000	216,200	235,188	281,789	327,544	388,995	463,527	578,832
Annual average salary and wage	$	14,392	15,582	18,318	20,043	21,115	22,703	25,128
Total fuels								
Employees	Number	26,297	26,469	28,091	30,021	32,619	34,823	38,864
Salaries and wages	$000	349,592	390,679	469,493	554,413	632,708	756,614	923,369
Average annual salary and wage	$	13,294	14,760	16,713	18,468	19,397	21,727	23,759
Total mining								
Production and related workers	Number	79,928	77,091	78,989	79,905	70,306	72,580	80,066
Salaries and wages	$000	894,538	1,030,009	1,185,184	1,342,508	1,275,008	1,493,773	1,779,389
Average annual salary and wage	$	11,192	13,361	15,004	16,801	18,135	20,581	22,224
Administrative and office workers	Number	38,802	38,624	38,705	39,159	39,642	42,665	46,356
Salaries and wages	$000	555,792	625,269	717,498	795,015	843,335	998,942	1,200,081
Annual average salary and wage	$	14,324	16,189	18,538	20,302	21,274	23,414	25,888
Total mining								
Employees	Number	118,730	115,715	117,694	119,064	109,948	115,245	126,422
Salaries and wages	$000	1,450,330	1,655,278	1,902,682	2,137,523	2,118,343	2,492,715	2,979,470
Annual average salary and wage	$	12,215	14,305	16,166	17,954	19,267	21,630	23,568

[1] Does not include cement and lime manufacturing and clay products (domestic clays) manufacturing. These industries are included in Table 36 under "Nonmetallic mineral products industries". See Table 27 for detail of industries.

TABLE 36. CANADA, EMPLOYMENT, SALARIES AND WAGES IN THE MINERAL MANUFACTURING INDUSTRIES[1], 1974-80

	Unit	1974	1975	1976	1977	1978	1979	1980
Primary metal industries								
Production and related workers	Number	94,538	90,169	88,939	91,683	93,798	95,942	97,530
Salaries and wages	$000	1,052,519	1,119,159	1,241,893	1,399,390	1,544,412	1,725,904	1,980,423
Annual average salary and wage	$	11,133	12,412	13,963	15,263	16,465	17,989	20,306
Administrative and office workers	Number	27,681	30,161	28,102	27,536	28,198	30,812	28,920
Salaries and wages	$000	403,151	493,764	511,236	545,957	597,544	713,279	787 022
Annual average salary and wage	$	14,564	16,371	18,192	19,827	21,191	23,149	27 214
Total primary metal industries								
Employees	Number	122,219	120,330	117,041	119,219	121,996	126,754	126,450
Salaries and wages	$000	1,455,671	1,612,923	1,753,128	1,945,347	2,140,956	2,432,183	2,767,445
Annual average salary and wage	$	11,910	13,404	14,979	16,317	17,549	19,188	21,886
Nonmetallic mineral products industries								
Production and related workers	Number	42,884	42,149	41,272	39,321	41,297	41,813	40,799
Salaries and wages	$000	424,096	471,466	529,264	564,444	638,152	710,622	743,254
Annual average salary and wage	$	9,889	11,186	12,824	14,355	15,452	16,995	18,217
Administrative and office workers	Number	14,682	13,783	13,749	13,187	14,439	14,935	15,287
Salaries and wages	$000	180,802	197,884	218,164	229,855	264,166	297,211	333,815
Annual average salary and wage	$	12,314	14,357	15,868	17,430	18,295	19,900	21,837
Total nonmetallic mineral products								
Employees	Number	57,566	55,932	55,021	52,508	55,736	56,748	56,086
Salaries and wages	$000	604,898	669,350	747,428	794,299	902,318	1,007,833	1,077,069
Annual average salary and wage	$	10,507	11,967	13,584	15,127	16,189	17,760	19,203
Petroleum and coal products industries								
Production and related workers	Number	7,787	7,877	7,099	7,696	8,822	8,174	8,277
Salaries and wages	$000	105,398	122,268	127,594	146,566	183,218	185,290	203,686
Annual average salary and wage	$	13,535	15,522	17,974	19,044	20,768	22,668	24,609
Administrative and office workers	Number	9,648	9,387	9,590	10,153	11,531	11,019	11,769
Salaries and wages	$000	149,140	175,772	192,722	228,532	267,844	285,148	337,865
Annual average salary and wage	$	15,458	18,725	20,096	22,509	23,228	25,887	28,708
Total petroleum and coal products								
Employees	Number	17,435	17,264	16,689	17,849	20,353	19,193	20,046
Salaries and wages	$000	254,539	298,040	320,316	375,098	451,062	470,438	541,551
Annual average salary and wage	$	14,599	17,264	19,193	21,015	22,162	24,511	27,015
Total mineral manufacturing								
Production and related workers	Number	145,209	140,195	137,310	138,700	143,917	145,929	146,606
Salaries and wages	$000	1,582,014	1,712,892	1,898,751	2,110,400	2,365,782	2,621,816	2,927,363
Annual average salary and wage	$	10,895	12,218	13,828	15,216	16,439	17,966	19,968
Administrative and office workers	Number	52,011	53,331	51,441	50,876	54,168	56,766	55,976
Salaries and wages	$000	733,093	867,421	922,122	1,004,344	1,129,554	1,295,638	1,458,702
Annual average salary and wage	$	14,095	16,269	17,926	19,741	20,853	22,824	26,059
Total mineral manufacturing industries								
Employees	Number	197,220	193,526	188,751	189,576	198,085	202,695	202,582
Salaries and wages	$000	2,315,107	2,580,313	2,820,872	3,114,744	3,494,336	3,910,454	4,386,065
Annual average salary and wage	$	11,739	13,333	14,945	16,430	17,641	19,292	21,651

Note: See footnote, Table 35. See Table 28 for detail of industries covered.

TABLE 37. CANADA, NUMBER OF WAGE EARNERS EMPLOYED IN THE MINING INDUSTRY, (SURFACE, UNDERGROUND AND MILL), 1974-80

	1974	1975	1976	1977	1978	1979	1980
Metals							
Surface	16,229	16,230	16,143	16,115	12,901	12,664	14,347
Underground	21,045	20,555	20,043	19,482	15,682	15,906	19,308
Mill	13,612	13,534	13,648	13,817	11,394	12,971	13,937
Total	50,886	50,319	49,834	49,414	39,977	41,541	47,592
Nonmetals							
Surface	7,743	7,180	7,264	7,166	6,660	6,877	6,510
Underground	2,210	1,870	2,180	2,245	2,275	2,370	2,550
Mill	7,814	6,347	7,003	7,401	7,198	7,386	7,585
Total	17,767	15,397	16,447	16,812	16,133	16,633	16,645
Fuels							
Surface	8,443	8,789	9,705	10,510	11,045	11,535	12,929
Underground	2,832	2,586	3,003	3,169	3,151	2,871	2,900
Total	11,275	11,375	12,708	13,679	14,196	14,406	15,829
Total mining industry							
Surface	32,415	32,200	33,112	33,791	30,606	31,076	33,786
Underground	26,087	25,010	25,226	24,896	21,108	21,147	24,758
Mill	21,426	19,881	20,651	21,218	18,592	20,357	21,522
Total	79,928	77,091	78,989	79,905	70,306	72,580	80,066

TABLE 38. CANADA, MINE AND MILL WORKERS BY SEX, 1980

	Mine Workers				Mill Workers		Total	
	Underground		Surface					
	Male	Female	Male	Female	Male	Female	Male	Female
Metallic Minerals								
Gold-quartz	2,910	-	1,002	34	809	26	4,721	60
Copper-gold-silver	4,139	6	3,932	106	3,914	202	11,985	314
Silver-lead-zinc	2,213	6	1,565	78	1,344	69	5,122	153
Nickel-copper	7,225	4	2,920	45	938	16	11,083	65
Iron Ore	294	3	2,720	64	4,979	204	7,993	271
Uranium	2,271	6	1,269	31	775	111	4,315	148
Miscellaneous metal mines	231	-	555	26	505	45	1,291	71
Total	19,283	25	13,963	384	13,264	673	46,510	1,082
Industrial minerals								
Asbestos	530	-	2,051	12	3,788	92	6,369	104
Gypsum	121	-	422	3	53	-	596	3
Peat	-	-	590	13	473	4	1,063	17
Potash	1,485	13	72	2	1,497	25	3,054	40
Salt	353	-	151	-	403	24	907	24
Sand and gravel	-	-	1,217	12	100	2	1,317	14
Stone	6	-	1,757	8	299	7	2,062	15
Miscellaneous nonmetals	42	-	196	4	803	15	1,041	19
Total	2,537	13	6,456	54	7,416	169	16,409	236
Mining Total	21,820	38	20,419	438	20,680	842	62,919	1,318

TABLE 39. CANADA, LABOUR COSTS IN RELATION TO TONNES MINED, METAL MINES, 1978-80

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)		($)
1978						
Gold-quartz	4,094	65,788	16,069	5 914	1 445	11.12
Copper-gold-silver	10,433	195,806	18,768	98 307	9 423	1.99
Nickel-copper	7,924	137,570	17,361	11 306	1 427	12.17
Silver-lead-zinc	5,129	95,649	18,649	15 859	3 092	6.03
Iron ore	7,532	175,695	23,326	96 323	12 789	1.82
Uranium	3,550	61,969	17,456	6 126	1 726	10.11
Miscellaneous metals	1,315	24,781	18,845	14 221	10 814	1.74
Total	39,977	757,258	18,942	248 056	6 205	3.05
1979						
Gold-quartz	4,155	75,979	18,286	5 478	1 318	13.87
Copper-gold-silver	10,976	231,527	21,040	99 254	9 043	2.33
Nickel-copper	7,159	137,967	19,272	10 183	1 422	13.55
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
Copper-gold-silver	12,299	289,899	23,570	105 193	8 553	2.76
Nickel-copper	11,148	220,481	19,778	16 206	1 454	13.60
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

TABLE 40. CANADA, MAN-HOURS PAID, PRODUCTION AND RELATED WORKERS, TONNES OF ORE MINED AND ROCK QUARRIED, METAL MINES AND NONMETALLIC MINERAL OPERATIONS, 1974-80

	Unit	1974	1975	1976	1977	1978	1979	1980
Metal mines[1]								
Ore mined	million tonnes	278.7	264.2	296.5	299.5	248.1	274.8	290.1
Man-hours paid[2]	million	104.0	102.4	100.6	101.2	84.9	85.1	97.5
Man-hours paid per tonne mined	number	0.37	0.39	0.34	0.34	0.34	0.31	0.34
Tonnes mined per man-hour paid	tonnes	2.68	2.58	2.95	2.96	2.92	3.23	2.98
Nonmetallic mineral operations[3]								
Ore mined and rock quarried	million tonnes	174.5	155.1	162.0	200.2	200.4	192.1[r]	185.0
Man-hours paid[2]	million	27.9	23.4	26.9	27.7	26.3	27.8	26.5
Man-hours paid per tonne mined	number	0.16	0.15	0.17	0.14	0.13	0.14	0.14
Tonnes mined per man-hour paid	tonnes	6.25	6.63	6.02	7.23	7.62	6.91[r]	6.98

[1] Excludes placer mining. [2] Man-hours paid for production and related workers only. [3] Includes asbestos, potash, gypsum and stone.
[r] Revised.

TABLE 41. CANADA, AVERAGE WEEKLY WAGES AND HOURS WORKED, HOURLY-RATED EMPLOYEES IN MINING, MANUFACTURING AND CONSTRUCTION INDUSTRIES, 1975-81

	1975	1976	1977	1978	1979[r]	1980	1981[p]
Mining							
Average hours per week	40.0	40.3	40.6	40.5	41.1	40.8	40.4
Average weekly wage ($)	260.74	298.44	329.45	354.51	396.58	440.61	494.62
Metals							
Average hours per week	39.4	39.6	39.8	39.4	40.4	40.1	40.2
Average weekly wage ($)	260.33	296.21	325.75	344.94	387.14	425.08	485.03
Mineral fuels							
Average hours per week	39.7	40.6	41.3	41.0	41.8	41.8	40.8
Average weekly wage ($)	264.98	309.24	333.51	367.34	414.96	465.05	511.40
Nonmetals							
Average hours per week	40.1	40.5	40.3	40.5	40.5	40.0	40.1
Average weekly wage ($)	230.84	273.56	301.92	326.23	330.47	357.03	402.32
Manufacturing							
Average hours per week	38.6	38.7	38.7	38.8	38.8	38.5	38.5
Average weekly wage ($)	195.12	222.79	246.63	265.06	287.82	314.80	352.08
Construction							
Average hours per week	39.0	38.9	38.7	39.0	39.4	39.0	38.9
Average weekly wage ($)	293.96	330.95	378.50	400.58	433.51	470.45	592.72

Note: Wages reflect seasonally unadjusted figures.
[p] Preliminary; [r] Revised.

TABLE 42. CANADA, AVERAGE WEEKLY WAGES OF HOURLY-RATED EMPLOYEES IN THE MINING INDUSTRY, IN CURRENT AND 1971 DOLLARS, 1975-81

	1975	1976	1977	1978	1979	1980	1981P
Current dollars							
All mining	260.74	298.44	329.45	354.51	396.58	440.61	494.62
Metals	260.33	296.21	325.75	344.94	387.14	425.08	485.03
Mineral fuels	264.98	309.24	333.51	367.34	414.96	465.05	511.40
Coal	243.01	274.00	303.53	323.49	362.20	430.16	485.03
Nonmetals except fuel	230.84	273.56	301.92	326.23	330.47	357.03	402.32
1971 dollars							
All mining	188.26	200.43	204.88	202.35	207.42	209.22	208.79
Metals	187.96	198.93	202.58	196.88	202.48	201.84	204.74
Mineral fuels	191.32	207.68	207.41	209.67	217.03	220.82	215.87
Coal	175.46	184.02	188.76	184.64	189.44	204.25	204.74
Industrial minerals	166.67	183.72	187.76	186.20	172.84	169.53	169.83

Note: Wages reflect seasonally unadjusted figures.
P Preliminary.

TABLE 43. CANADA, INDUSTRIAL FATALITIES PER THOUSAND WORKERS, BY INDUSTRY GROUPS 1979-81[1]

	Fatalities (number)			Number of Workers (000)			Rate per 1,000 workers[2]		
	1979	1980	1981P	1979	1980	1981P	1979	1980	1981P
Agriculture	14	7	15	142.0	156.0	151.0	0.10	0.05	0.10
Forestry	106	76	59	70.2	68.2	65.6	1.51	1.11	0.90
Fishing	15	22	19	12.0	15.0	13.8	1.25	1.47	1.38
Mining	141	168	113	151.0	170.2	178.1	0.93	0.99	0.63
Manufacturing	163	140	138	1 873.9	1 851.2	1 884.0	0.09	0.08	0.07
Construction	178	182	172	465.0	455.4	475.3	0.38	0.40	0.36
Transportation	212	220	183	819.6	842.8	849.7	0.26	0.26	0.22
Trade	66	73	60	1 515.8	1 555.6	1 628.6	0.04	0.05	0.04
Finance	5	8	8	502.4	517.1	533.0	0.01	0.02	0.02
Service	75	86	79	2 626.4	2 766.5	2 935.0	0.03	0.03	0.03
Public administration	63	44	61	625.0	635.6	628.3	0.10	0.07	0.10
Unknown	21	15	5	..	..	..	..	..	..
Total	1,059	1,041	912	8 833.3	9 033.6	9 342.4	0.12	0.12	0.10

Note: See footnotes, Table 44.
[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 44. CANADA, INDUSTRIAL FATALITIES PER THOUSAND WORKERS, BY INDUSTRY GROUPS, 1975-81

	1975	1976	1977	1978	1979	1980	1981P
Agriculture	0.10	0.13	0.11	0.05	0.10	0.05	0.10
Forestry	1.25	1.14	0.92	1.28	1.51	1.11	0.90
Fishing[1]	3.25	3.60	2.37	1.44	1.25	1.47	1.38
Mining[2]	1.20	1.18	0.92	0.82	0.93	0.99	0.63
Manufacturing	0.13	0.11	0.10	0.10	0.09	0.08	0.07
Construction	0.48	0.42	0.37	0.38	0.38	0.40	0.36
Transportation[3]	0.28	0.28	0.22	0.25	0.26	0.26	0.22
Trade	0.05	0.04	0.05	0.04	0.04	0.05	0.04
Finance[4]	0.01	0.02	0.02	0.01	0.01	0.02	0.02
Service[5]	0.04	0.03	0.03	0.02	0.03	0.03	0.03
Public administration	0.14	0.09	0.08	0.12	0.10	0.07	0.10
Total	0.15	0.13	0.11	0.12	0.12	0.12	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 45. CANADA, INDUSTRIAL FATALITIES BY OCCUPATIONAL INJURIES AND ILLNESSES, 1979-81

	Occupational Injuries			Occupational Illnesses			Total		
	1979	1980	1981P	1979	1980	1981P	1979	1980	1981P
Agriculture	13	7	10	0	0	0	13	7	10
Forestry	89	66	49	0	1	0	89	67	49
Fishing	15	19	19	0	0	0	15	19	19
Mining	74	93	65	58	67	44	132	160	109
Manufacturing	108	88	80	28	30	36	136	118	116
Construction	139	146	148	7	10	5	146	156	153
Transportation	179	197	161	1	4	1	180	201	162
Trade	45	56	47	2	0	1	47	56	48
Finance	1	5	5	0	0	0	1	5	5
Service	50	68	60	4	1	3	54	69	63
Public administration	48	38	47	5	0	2	53	38	49
Unknown	5	12	1	1	2	0	6	14	1
Total	766	795	692	106	115	92	872	910	784

P Preliminary.

TABLE 46. CANADA, NUMBER OF STRIKES AND LOCKOUTS BY INDUSTRIES, 1979-1981

	1979			1980			1981		
	Strikes and lockouts	Workers involved	Duration in person-days	Strikes and lockouts	Workers involved	Duration in person-days	Strikes and lockouts	Workers involved	Duration in person-days
Agriculture	1	12	10	1	30	900	3	65	7,750
Forestry	11	2,632	110,940	8	3,588	337,220	14	3,292	349,400
Fishing and trapping	-	-	-	2	16,082	395,870	1	400	330
Mines	40	28,396	1,586,360	33	21,400	418,270	42	24,359	580,720
Manufacturing	511	149,656	3,129,460	404	86,247	3,137,370	423	152,207	4,638,290
Construction	48	10,839	88,290	69	57,940	1,107,060	44	5,780	43,280
Transportation and utilities	129	79,933	1,181,580	106	27,329	729,070	101	58,135	1,513,970
Trade	78	16,442	247,410	109	7,855	218,550	90	4,886	149,170
Finance, insurance and real estate	18	2,164	38,110	20	1,238	47,710	18	3,480	294,760
Service	139	64,855	760,600	218	136,193	1,883,280	221	57,248	577,400
Public administration	74	58,845	642,740	58	83,123	700,090	90	17,696	717,420
Various industries	1	48,730	48,730	-	-	-	1	6,000	6,000
All industries	1,050	462,504	7,834,230	1,028	441,025	8,975,390	1,048	338,548	8,878,490

- Nil.

TABLE 47. CANADA, NUMBER OF STRIKES AND LOCKOUTS BY MINING AND MINERAL MANUFACTURING, 1979-81

	1979			1980			1981		
	Strikes and lockouts	Workers involved	Duration in person-days	Strikes and lockouts	Workers involved	Duration in person-days	Strikes and lockouts	Workers involved	Duration in person-days
Mines	40	28,396	1,586,360	33	21,400	418,270	42	24,359	580,720
Metal	17	18,861	1,506,980	18	10,749	189,570	25	11,457	248,930
Mineral fuels	8	7,717	55,010	5	7,486	99,450	9	11,159	306,690
Nonmetals	10	1,645	22,980	7	3,039	121,750	5	1,674	16,130
Quarries	5	173	1,390	3	126	7,500	3	69	8,970
Mineral manufacturing	73	25,080	1,126,900	52	10,086	530,620	62	30,770	1,553,000
Primary metals	30	17,929	924,150	18	5,212	321,530	29	27,169	1,429,150
Nonmetallic mineral products	41	5,875	185,870	31	3,208	123,310	33	3,601	123,850
Petroleum and coal products	2	1,276	16,880	3	1,666	85,780	0	0	0

TABLE 48. CANADA, SOURCE OF ORES HOISTED OR REMOVED FROM SELECTED TYPES OF MINES; 1978-80

Mines	1978 Under-ground	1978 Open Pit	1978 Total	1979 Under-ground	1979 Open Pit	1979 Total	1980 Under-ground	1980 Open Pit	1980 Total
					(kilotonnes)				
Asbestos	1 903	26 885	28 788	2 151	29 371	31 522	1 997	26 106	28 103
Copper-gold-silver	14 108	84 199	98 307	14 620	84 634	99 254	16 180	89 013	105 193
Gold-quartz	5 350	564	5 914	5 144	334	5 478	5 193	1 153	6 346
Gypsum	728	7 665	8 393	754	7 556	8 310	1 062	6 549	7 611
Iron Ore	3 550	92 773	96 323	3 641	127 158	130 799	3 222	119 886	123 107
Nickel-copper	10 224	1 082	11 306	8 950	1 233	10 183	14 660	1 546	16 206
Silver-lead-zinc	8 853	7 006	15 859	8 692	6 386	15 078	9 822	6 397	16 219
Uranium	5 306	820	6 126	5 408	733	6 141	5 981	1 171	7 152
Miscellaneous metals	1 245	12 976	14 221	1 212	6 610	7 822	1 491	14 381	15 871
Total	51 267	233 970	285 237	50 572	264 015	314 587	59 608	266 201	325 809
Percentage	18.0	82.0	100.0	16.0	84.0	100.0	18.3	81.7	100.0

TABLE 49. CANADA, SOURCE OF MATERIAL HOISTED OR REMOVED FROM METAL MINES, 1980

	Underground		Open Pit		
	Ore	Waste	Ore	Waste	Overburden
			(kilotonnes)		
Gold-quartz	5 193	596	1 153	469	3 641
Copper-gold-silver	16 180	1 183	89 013	167 632	11 146
Nickel-copper	14 660	969	1 546	1 348	28
Silver-lead-zinc	9 822	702	6 397	23 181	1 524
Iron	3 222	119	119 886	62 121	21 947
Uranium	5 981	420	1 171	2 635	-
Miscellaneous metals	1 491	70	14 381	15 394	320
Total	56 549	4 059	233 547	440 881	38 606

- Nil.

TABLE 50. CANADA, ORE MINED AND ROCK QUARRIED IN THE MINING INDUSTRY, 1974-80

	1974	1975	1976	1977	1978	1979	1980
				(kilotonnes)			
Metals							
Gold-quartz	5 629	5 901	5 921	5 768	5 914	5 478	6 346
Copper-gold-silver	111 381	97 656	103 600	108 966	98 307	99 254	105 193
Silver-lead-zinc	14 295	16 169	14 309	16 730	15 859	15 078	16 219
Nickel-copper	25 302	23 265	21 462	20 395	11 306	10 183	16 206
Iron	107 105	101 482	133 073	127 057	96 323	130 799	123 107
Uranium	2 633	3 449	3 663	5 014	6 126	6 141	7 152
Miscellaneous metals	12 376	16 296	14 499	15 599	14 221	7 822	15 871
Total	278 721	264 218	296 527	299 528	248 056	274 755	290 095
Nonmetals							
Asbestos	34 524	22 186	31 055	31 912	28 788	31 522	28 103
Potash	21 945	21 713	20 277	24 813	24 856	25 511	26 988
Gypsum	6 917	5 578	5 978	7 216	8 393	8 310	7 611
Rock salt	4 291	3 627	5 080	4 974	5 050	5 639	5 321
Total	67 677	53 104	62 390	68 915	67 087	70 982	68 023
Structural materials							
Stone, all kinds quarried[1]	92 833	88 921	87 876	120 163	122 144	109 719	103 366
Stone used to make cement	14 948	13 654	13 350	12 614	13 051	13 982[r]	14 138
Stone used to make lime	3 391	2 980	3 442	3 534	3 178	3 028	4 751
Total	111 172	105 555	104 668	136 310	138 373	126 729[r]	122 255
Total ore mined and rock quarried	457 570	422 877	463 585	504 753	453 516	472 466[r]	480 373

[1] Excludes stone used to manufacture cement and lime.
[r] Revised.

TABLE 51. 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 smelting and refining industries; (2) Confidential, included in total.
P Preliminary; - Nil.

TABLE 52. 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 53. CANADA, DIAMOND DRILLING IN THE MINING INDUSTRY, BY MINING COMPANIES WITH OWN EQUIPMENT AND BY DRILLING CONTRACTORS, 1978-80

		1978			1979			1980		
		Exploration	Other	Total	Exploration	Other	Total	Exploration	Other	Total
			(metres)							
Metal mining										
Gold-quartz	Own equipment	12 410	2 544	14 954	13 455	-	13 455	27 775	1 000	28 775
	Contractors	154 703	39 678	194 381	170 711	14 789	185 500	154 812	4 048	158 860
	Total	167 113	42 222	209 335	184 166	14 789	198 955	182 587	5 048	187 635
Copper-gold-silver	Own equipment	97 698	292	97 990	141 220	-	141 220	101 366	-	101 366
	Contractors	161 075	18 000	179 075	133 445	10 713	144 158	245 218	40 605	285 823
	Total	258 773	18 292	277 065	274 665	10 713	285 378	346 584	40 605	387 189
Nickel-copper	Own equipment	63 910	-	63 910	109 799	-	109 799	138 103	-	138 103
	Contractors	5 747	-	5 747	42 385	-	42 385	41 318	-	41 318
	Total	69 657	-	69 657	152 184	-	152 184	179 421	-	179 421
Silver-lead-zinc and silver-cobalt	Own equipment	45 729	348 508	394 237	18 609	4 090	22 699	42 161	19 545	61 706
	Contractors	96 252	-	96 252	106 569	1 764	108 333	198 171	-	198 171
	Total	141 981	348 508	490 489	125 178	5 854	131 032	240 332	19 545	259 877
Iron mines	Own equipment	-	-	-	-	-	-	38 424	-	38 424
	Contractors	18 734	-	18 734	28 266	-	28 266	30 007	27 474	57 481
	Total	18 734	-	18 734	28 266	-	28 266	68 431	27 474	95 905
Uranium	Own equipment	17 503	-	17 503	23 509	-	23 509	-	-	-
	Contractors	40 174	914	41 088	45 255	3 269	48 524	10 884	-	10 884
	Total	57 677	914	58 591	68 764	3 269	72 033	10 884	-	10 884
Miscellaneous metal mining	Own equipment	-	-	-	4 629	-	4 629	-	-	-
	Contractors	57 872	-	57 872	45 090	-	45 090	67 156	-	67 156
	Total	57 872	-	57 872	49 719	-	49 719	67 156	-	67 156
Total metal mining	Own equipment	237 250	351 344	588 594	311 221	4 090	315 311	347 829	20 545	368 374
	Contractors	534 557	58 592	593 149	571 721	30 535	602 256	747 566	72 127	819 093
	Total	771 807	409 936	1 181 743	882 942	34 625	917 567	1 095 395	92 672	1 188 067

(continued on following page)

TABLE 53 (cont'd)

		1978			1979			1980		
		Exploration	Other (metres)	Total	Exploration	Other	Total	Exploration	Other	Total
Nonmetal mining										
Asbestos	Own equipment	-	-	-	-	-	-	-	-	-
	Contractors	48 087	-	48 087	20 238	-	20 238	28 790	-	28 790
	Total	48 087	-	48 087	20 238	-	20 238	28 790	-	28 790
Gypsum	Own equipment	-	-	-	1 779	-	1 314	1 314	-	1 314
	Contractors	5 660	-	5 660	4 177	-	4 177	4 463	-	4 463
	Total	5 660	-	5 660	5 956	-	5 956	5 777	-	5 777
Salt	Own equipment	1 722	-	1 722	2 632	-	2 632	-	-	-
	Contractors	-	-	-	-	-	-	-	-	-
	Total	1 722	-	1 722	2 632	-	2 632	-	-	-
Miscellaneous nonmetal mining	Own equipment	2 480	-	2 480	1 958	-	1 958	2 844	-	2 844
	Contractors	294	-	294	671	-	671	798	-	798
	Total	2 774	-	2 774	2 629	-	2 629	3 642	-	3 642
Total nonmetal mining	Own equipment	4 202	-	4 202	6 369	-	6 369	4 158	-	4 158
	Contractors	54 041	-	54 041	25 086	-	25 086	34 051	-	34 051
	Total	58 243	-	58 243	31 455	-	31 455	38 209	-	38 209
Total mining industry	Own equipment	241 452	351 344	592 796	317 590	4 090	321 680	351 987	20 545	372 532
	Contractors	588 598	58 592	647 190	596 807	30 535	627 342	781 617	72 127	853 744
	Total	830 050	409 936	1 239 986	914 397	34 625	949 022	1 133 604	92 672	1 226 276

- Nil.

TABLE 54. **CANADA, ORE MINED AND ROCK QUARRIED IN THE MINING INDUSTRY, 1951-80**

	Metals	Nonmetal[1]	Total
		(million tonnes)	
1951	44.2	39.7	83.9
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[r]	472.5[r]
1980	290.1	190.3	480.4

[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 50.
[r] Revised.

TABLE 55. CANADA, TOTAL DIAMOND DRILLING, METAL DEPOSITS, 1951-80

	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)		
1951	891 648	1 264 630	460 296	108 224	2 724 798
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

[1] Includes iron, titanium, uranium, molybdenum and other metal deposits.

TABLE 56. CANADA, EXPLORATION DIAMOND DRILLING, METAL DEPOSITS, 1951-80

	Mining companies with own personnel and equipment	Diamond drill contractors	Total
		(metres)	
1951	368 015	1 102 260	1 470 275
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

TABLE 57. CANADA, DIAMOND DRILLING, OTHER THAN FOR EXPLORATION, METAL DEPOSITS, 1951-1980

	Mining companies with own personnel and equipment	Diamond drill contractors	Total
	(metres)		
1951	..	..	1 254 523
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

The total footage drilled shown in Tables 56 and 57 equals the total footage drilled reported in Table 55. Nonproducing companies excluded since 1964.

.. Not available.

TABLE 58. CANADA, CRUDE MINERALS TRANSPORTED BY CANADIAN RAILWAYS, 1978-80

	1978	1979	1980
		(000 tonnes)	
Metallic minerals			
Alumina and bauxite	2 682	1 973	2 752
Copper ores and concentrates	1 963	1 696	1 546
Iron ores and concentrates	42 595	62 343	54 167
Iron pyrite	10	14	46
Lead ores and concentrates	695	941	515
Lead-zinc ores and concentrates	41	2	353
Manganese ores	8	10	7
Nickel-copper ores and concentrates	3 479	2 626	4 983
Nickel ores and concentrates	571	145	628
Tungsten ores and concentrates	2	2	2
Zinc ores an concentrates	1 882	1 704	1 442
Metallic ores and concentrates, nes	82	58	32
Total metallic minerals	54 010	71 514	66 473
Nonmetallic minerals			
Abrasives, natural	57	90	70
Asbestos	699	594	400
Barite	61	87	133
Clay	705	682	621
Gravel	139	145	13
Gypsum	4 876	4 905	4 652
Limestone, agricultural	68	74	72
Limestone, industrial	339	400	331
Limestone, nes	3 581	3 725	3 801
Nepheline syenite	397	406	340
Phosphate rock	2 294	2 634	2 912
Potash (KCl)	9 690	10 560	10 652
Refractory materials, nes	10	3	4
Salt, rock	818	906	1 015
Salt, nes	141	147	120
Sand, industrial	1 262	1 182	1 105
Sand, nes	25	20	13
Silica	23	24	33
Sodium carbonate	629	566	581
Sodium sulphate	459	540	547
Stone, building, rough	10	13	62
Stone, nes	400	420	236
Sulphur, liquid	1 384	1 517	1 750
Sulphur, nes	4 009	4 571	5 728
Nonmetallic minerals, nes	176	175	178
Total nonmetallic minerals	32 252	34 386	35 369
Mineral fuels			
Coal, anthracite	185	160	125
Coal, bituminous	20 331	20 450	22 177
Coal, lignite	603	329	486
Coal, nes	7	11	18
Natural gas and other crude bituminous substances	15	20	4
Oil, crude	291	293	172
Total mineral fuels	21 432	21 263	22 982
Total crude minerals	107 694	127 162	124 415
Total revenue freight moved by Canadian railways	238 824	257 874	254 447
Per cent crude minerals of total revenue freight	45.1	49.3	49.1

nes Not elsewhere specified.

TABLE 59. CANADA, CRUDE MINERALS TRANSPORTED BY CANADIAN RAILWAYS, 1951-80

	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)		
1951	146.3	47.6	32.5	1966	194.5	80.6	41.5
1952	147.1	45.9	31.2	1967	190.0	81.2	42.7
1953	141.7	44.7	31.5	1968	195.4	86.7	44.4
1954	129.8	45.0	34.6	1969	189.0	81.9	43.4
1955	152.2	61.2	40.2	1970	211.6	97.5	46.1
1956	172.0	68.7	39.9	1971	214.5	95.6	44.6
1957	157.9	64.2	40.6	1972	215.8	89.4	41.4
1958	139.2	52.4	37.6	1973	241.2	113.1	46.9
1959	150.6	62.8	41.7	1974	246.3	115.3	46.8
1960	142.8	57.1	39.9	1975	226.0	110.6	49.0
1961	138.9	54.1	38.9	1976	238.5	116.6	48.9
1962	146.0	60.3	41.3	1977	247.2	121.1	49.0
1963	154.6	62.9	40.7	1978	238.8	107.7	45.1
1964	180.0	74.6	41.5	1979	257.8	127.2	49.3
1965	186.2	80.9	43.5	1980	254.4	124.9	49.1

TABLE 60. CANADA, FABRICATED MINERAL PRODUCTS TRANSPORTED BY CANADIAN RAILWAYS, 1978-80

	1978	1979	1980
		(000 tonnes)	
Metallic mineral products			
Ferrous mineral products			
Ferroalloys	129	100	75
Pig iron	87	70	80
Ingots, blooms, billets, slabs of iron and steel	338	577	425
Other primary iron and steel	36	133	64
Castings and forgings, iron and steel	253	207	198
Bars and rods, steel	837	905	728
Plates, steel	442	566	553
Sheet and strip, steel	1 137	1 164	992
Structural shapes and sheet piling, iron and steel	421	469	445
Rails and railway track material	91	92	101
Pipes and tubes, iron and steel	461	550	546
Wire, iron or steel	49	46	39
Iron and steel scrap	1 806	2 018	2 087
Slag, dross, etc.	97	107	128
Total ferrous mineral products	6 184	7 004	6 461
Nonferrous mineral products			
Aluminum paste, powder, pigs, ingots, shot	212	81	128
Aluminum and aluminum alloy fabricated material, nes	250	278	230
Copper matte and precipitates	1	3	3
Copper and alloys, in primary form	396	374	389
Copper and alloys, nes	60	66	58
Lead and alloys	156	143	128
Nickel and nickel-copper matte	92	85	96
Nickel and alloys	28	28	30
Tin and alloys	1	-	-
Zinc and alloys	444	417	447
Other nonferrous base metals and alloys	28	22	29
Nonferrous metal scrap	116	114	103
Total nonferrous mineral products	1 784	1 611	1 641
Total metallic mineral products	7 968	8 615	8 102
Nonmetallic mineral products			
Natural stone basic products, chiefly structural	221	226	227
Bricks and tiles, clay	52	50	45
Fire brick and similar shapes	107	134	111
Dolomite and magnesite, calcined	72	81	85
Refractories, nes	30	32	36
Glass basic products	108	105	102
Asbestos and asbestos-cement basic products	27	27	33
Portland cement, standard	2 006	1 882	1 763
Concrete pipe	33	35	20
Cement and concrete basic products, nes	405	551	324
Plaster	18	19	21
Gypsum wallboard and sheathing	68	36	22
Gypsum basic products, nes	7	4	3
Lime, hydrated and quick	454	488	303
Nonmetallic mineral basic products, nes	817	638	458
Fertilizers and fertilizer materials, nes	2 139	2 183	2 092
Total nonmetallic mineral products	6 564	6 491	5 645

(continued on following page)

TABLE 60. (cont'd)

	1978	1979	1980
		(000 tonnes)	
Mineral fuel products			
Gasoline	1 720	1 601	1 455
Aviation turbine fuel	67	66	54
Diesel fuel	3 053	3 009	2 898
Kerosene	6	8	1
Fuel oil, nes	1 108	1 115	1 000
Lubricating oils and greases	412	404	389
Petroleum coke	656	613	626
Coke, nes	951	852	708
Refined and manufactured gases, fuel type	2 606	2 818	2 737
Asphalts and road oils	269	274	187
Bituminous pressed or molded fabricated material	2	1	1
Other petroleum and coal products	821	697	747
Total mineral fuel products	11 671	11 458	10 803
Total fabricated mineral products	26 203	26 564	24 550
Total revenue freight moved by Canadian railways	238 824	257 874	254 447
Fabricated mineral products as a percentage of total revenue freight	11.0	10.3	9.6

nes Not elsewhere specified; - Nil.

TABLE 61. CANADA, CRUDE AND FABRICATED MINERALS TRANSPORTED THROUGH THE ST. LAWRENCE SEAWAY, 1979-81

	Montreal-Lake Ontario Section			Welland Canal Section		
	1979	1980	1981	1979	1980	1981
	(tonnes)					
Crude minerals						
Coal	455 325	204 715	1 519 188	7 067 442	6 616 010	5 935 727
Iron ore	13 441 896	9 993 769	11 727 044	13 714 946	10 358 099	12 468 808
Aluminum ores and concentrates	161 999	112 581	149 932	161 999	112 581	144 525
Clay and bentonite	237 380	250 526	180 280	237 380	250 526	180 280
Gravel and sand	28 090	34 000	36 651	284 152	195 676	203 970
Petroleum, crude	11 254	-	-	11 254	3 515	-
Stone, ground or crushed	335 378	163 545	23 036	1 379 422	1 046 175	952 603
Stone, rough	3 796	167	122	2 114	167	122
Salt	756 422	709 809	1 029 608	1 354 097	1 286 050	1 599 337
Phosphate rock	75 225	38 036	27 432	27 243	75	-
Sulphur	138 700	142 592	25 615	138 700	142 592	25 613
Other crude minerals	762 041	598 101	706 831	471 808	475 227	620 819
Total crude minerals	16 407 506	12 247 841	15 452 739	24 850 557	20 486 693	22 131 804
Fabricated mineral products						
Coke	2 103 300	1 271 222	773 992	2 270 269	1 301 705	880 911
Gasoline	171 284	202 471	112 348	210 704	157 557	136 566
Fuel oil	2 110 957	1 418 321	1 667 865	1 519 327	1 510 057	1 652 474
Lubricating oils and greases	67 394	83 667	64 677	60 393	83 605	51 026
Other petroleum products	139 244	139 139	151 924	98 147	83 453	111 501
Tar, pitch and creosote	27 352	46 573	39 613	32 111	26 822	37 482
Pig iron	120 302	183 667	183 752	111 350	174 772	173 884
Iron and steel: bars, rods, slabs	206 007	159 477	314 656	196 935	107 989	299 479
Iron and steel: nails, wire	23 907	7 284	7 364	22 799	6 657	6 949
Iron and steel: manufactured	2 589 384	1 724 459	2 313 521	2 400 906	1 072 857	1 861 767
Scrap iron and steel	524 197	689 676	79 254	494 846	611 508	57 564
Cement	20 817	82 864	2 512	522 117	268 433	259 002
Total fabricated minerals	8 104 145	6 008 820	5 711 478	7 939 904	5 405 415	5 528 605
Total crude and fabricated minerals	24 511 651	18 256 661	21 137 217	32 790 461	25 892 108	27 660 409
Total all products	50 187 359	42 142 459	45 875 658	60 023 466	54 073 636	53 388 616
Crude and fabricated minerals as a per cent of total	48.8	43.3	46.1	54.6	47.9	51.8

- Nil.

TABLE 62. CANADA, CRUDE MINERALS LOADED AND UNLOADED IN COASTWISE SHIPPING, 1980

	Loaded				Unloaded			
	Atlantic	Great Lakes	Pacific	Total	Atlantic	Great Lakes	Pacific	Total
	(tonnes)							
Metallic minerals								
Aluminum and bauxite ores	12 588	-	-	12 588	-	12 588	-	12 588
Copper ore and concentrates	24 322	-	-	24 322	24 322	-	-	24 322
Iron ore and concentrates	5 793 757	1 534 046	281	7 328 084	1 900 998	5 426 805	281	7 328 084
Titanium ore	2 585 946	-	-	2 585 946	2 585 946	-	-	2 585 946
Zinc ore and concentrates	33 482	-	14 729	48 211	33 482	-	14 729	48 211
Ores and concentrates, nes	8 399	-	54	8 453	-	8 399	54	8 453
Iron and steel scrap	5 584	-	22 389	27 973	5 584	-	22 389	27 973
Total metals	8 464 078	1 534 046	37 453	10 035 577	4 550 332	5 447 792	37 453	10 035 577
Nonmetallic minerals								
Bentonite	-	-	-	-	-	-	-	-
Dolomite	-	82 286	-	82 286	82 286	-	-	82 286
Gypsum	576 948	-	30 781	607 729	491 309	85 639	30 781	607 729
Limestone	6 271	1 519 912	972 132	2 498 315	6 271	1 519 912	972 132	2 498 315
Phosphate rock	23 206	-	-	23 206	23 206	-	-	23 206
Salt	379 860	1 049 817	54 799	1 484 476	970 012	459 665	54 799	1 484 476
Sand and gravel	210 137	14 354	3 666 737	3 891 228	224 491	-	3 666 737	3 891 228
Stone, crude, nes	37	454 177	177 467	631 681	20 285	433 929	177 467	631 681
Sulphur in ores	10 685	19 788	2 931	33 404	30 473	-	2 931	33 404
Crude nonmetallic minerals, nes	103	-	749	852	103	-	749	852
Total nonmetals	1 207 247	3 140 334	4 905 596	9 253 177	1 848 436	2 499 145	4 905 596	9 253 177
Mineral fuels								
Coal, bituminous	51 555	2 600 191	162 627	2 814 373	164 132	2 650 241	-	2 814 373
Oil, crude	589 816	-	254 325	844 141	844 141	-	-	844 141
Total mineral fuels	641 371	2 600 191	416 952	3 658 514	1 008 273	2 650 241	-	3 658 514
Total crude minerals	10 312 696	7 274 571	5 360 001	22 947 268	7 407 041	10 597 178	4 943 049	22 947 268
Total, all commodities	22 273 694	26 649 317	33 838 283	82 761 294	32 284 128	17 087 258	33 389 908	82 761 294
Crude minerals as a per cent of all commodities	46.3	27.3	15.8	27.7	22.9	62.0	14.8	27.7

- Nil; nes Not elsewhere specified.

TABLE 63. CANADA, CRUDE MINERALS LOADED AND UNLOADED AT CANADIAN PORTS IN INTERNATIONAL SHIPPING TRADE, 1978-80

	1978		1979		1980P	
	Loaded	Unloaded	Loaded	Unloaded	Loaded	Unloaded
	(tonnes)					
Metallic minerals						
Alumina, bauxite ore	-	3 388 740	-	2 981 940	15 945	3 934 926
Copper ores and concentrates	678 868	35 208	709 050	-	587 352	26 223
Iron ore and concentrates	33 519 200	5 415 103	49 187 843	6 408 111	35 239 362	5 202 888
Lead ore and concentrates	98 224	-	118 655	-	74 749	5 092
Manganese ore	9 079	277 525	16 147	78 015	19 800	129 682
Nickel-copper ore and concentrates	44 685	18 517	64 568	624	71 262	1 463
Titanium ore	112 601	-	89 294	-	130 913	-
Zinc ore and concentrates	890 239	-	1 026 594	800	292 799	524
Ores and concentrates, nes	89 760	132 765	39 969	121 416	603 092	603 071
Iron and steel scrap	454 632	1 344	327 879	-	355 042	6 162
Nonferrous metal scrap	10 197	46	1 910	3 172	74 565	8 523
Slag, dross, residue	667 367	43 761	485 618	45 315	3 861	247
Total metals	36 574 852	9 313 009	52 067 527	9 639 393	37 468 742	9 918 801
Nonmetallic minerals						
Asbestos	316 566	1 637	453 339	306	891 831	10 682
Barite	46 950	-	1 981	3 625	-	36
Bentonite	9 551	155 331	-	294 799	14 317	151 649
China clay	-	45 463	-	48 321	93	19 059
Clay materials, nes	54	30 137	58 656	23 309	15 258	78 405
Dolomite	1 143 594	14 154	1 032 139	-	907 715	38 413
Fluorspar	9 979	214 974	23 567	143 842	-	145 838
Gypsum	5 472 451	112 536	5 505 915	147 189	4 733 725	175 759
Limestone	1 111 317	2 896 475	239 852	2 953 876	1 842 439	1 365 421
Phosphate rock	27 497	1 420 347	16	1 515 346	-	1 368 116
Potash (KCl)	1 717 967	27 297	2 703 604	-	3 843 013	32 723
Salt	1 590 162	968 154	1 649 916	899 917	1 879 269	991 855
Sand and gravel	233 535	1 297 394	38 959	884 694	78 678	804 079
Stone, crude, nes	74 656	9 771	118 508	36 307	235 805	548 113
Stone, crushed	18	-	-	33 290	100 974	330 230
Sulphur	2 412 609	5 171	3 287 497	4 990	5 011 131	43 550
Crude, nonmetallic minerals, nes	65 871	10 361	67 671	183	60 891	120 844
Total nonmetals	14 232 777	7 209 202	15 181 620	6 989 994	15 772 126	6 192 049

(continued on following page)

TABLE 63 (cont'd)

	1978		1979		1980P	
	Loaded	Unloaded	Loaded	Unloaded	Loaded	Unloaded
			(tonnes)			
Mineral fuels						
Coal bituminous	11 087 496	13 443 184	12 328 621	17 178 491	13 735 346	15 137 034
Coal, nes	-	247 295	-	197 976	1 093	13
Oil, crude	395 850	15 772 012	107 231	16 188 498	920 578	15 198 039
Total fuels	11 483 346	29 462 491	12 435 852	33 564 965	14 657 017	30 335 086
Total crude minerals	62 290 975	45 984 702	79 684 999	50 194 352	67 897 885	46 445 936
Total, all commodities	116 521 506	61 792 786	134 638 829	67 414 437	138 161 219	67 834 656
Crude minerals as a per cent of all commodities	53.5	74.4	59.2	74.5	49.1	68.5

P Preliminary; - Nil; nes Not elsewhere specified.

TABLE 64. CANADA, FABRICATED MINERAL PRODUCTS LOADED AND UNLOADED AT CANADIAN PORTS IN INTERNATIONAL SHIPPING TRADE, 1978-80

	1978		1979		1980P	
	Loaded	Unloaded	Loaded	Unloaded	Loaded	Unloaded
			(tonnes)			
Metallic products						
Aluminum	392 695	1 729	215 076	16 385	398 230	174 109
Copper and alloys	50 449	5 401	37 055	9 023	480 212	25 843
Ferroalloys	807	36 607	29 986	65 092	18 426	28 958
Iron and steel, primary	161 838	41 513	78 164	15 224	28 884	53 666
Iron, pig	505 384	2 562	221 359	19 350	468 308	20
Iron and steel, other						
bars and rods	16 818	126 638	17 545	214 058	343 034	103 467
castings and forgings	283	6 372	13 370	21 815	225 155	62 617
pipes and tubes	17 955	44 616	16 346	49 799	58 664	191 210
plates and sheet	106 243	249 725	108 606	490 158	1 438 646	442 783
rails and track material	78 051	4 877	76 751	12 198	99 726	7 028
structural shapes	58 569	301 058	69 596	342 272	97 094	69 109
wire	1 774	7 591	859	6 252	35 685	70 625
Lead and alloys	19 224	3	25 225	-	103 421	21 173
Nickel and alloys	1 562	515	2 212	915	52 520	12 385
Zinc and alloys	100 046	1 070	73 428	50	388 341	3 707
Nonferrous metals, nes	9 708	5 740	6 279	11 049	115 726	144 951
Metal fabricated basic products	7 135	20 755	6 713	11 682	470 038	607 827
Total metals	1 528 541	856 772	998 570	1 285 322	4 822 110	2 019 478
Nonmetallic products						
Asbestos basic products	28	-	1 642	-	5 349	1 345
Bricks and tiles, nes	9 342	6 654	23 880	12 469	38 490	25 126
Cement	1 542 891	137 458	2 829 351	61 244	1 704 324	75 130
Cement basic products	4 573	511	439	57	42 639	4 289
Drain tiles and pipes	-	30	-	-	5	104
Glass basic products	1 947	4 540	1 151	1 893	32 801	15 773
Nonmetallic mineral basic products	10 018	12 709	12 056	24 969	45 401	201 778
Fertilizers, nes	142 277	271 472	144 528	286 157	148 320	57 843
Total nonmetals	1 711 076	433 374	3 013 047	386 789	1 869 009	323 545

(continued on following page)

TABLE 64 (cont'd)

	1978		1979		1980P	
	Loaded	Unloaded	Loaded	Unloaded	Loaded	Unloaded
			(tonnes)			
Mineral fuel products						
Asphalts, road oils	27	2 635	129	14 475	16 366	14 001
Coal tar, pitch	4 169	69 322	13 004	69 959	9 819	42 693
Coke	169 401	680 497	740 027	1 085 687	1 059 856	1 319 773
Fuel oil	3 363 319	1 559 443	3 710 585	1 858 914	2 101 989	2 352 355
Gasoline	540 964	4 237	385 648	26 638	1 250 230	221 458
Lubricating oils and greases	708	22 590	1 683	9 446	355 314	457 521
Petroleum and coal products, nes	238 157	119 924	38 048	71 274	285 609	242 793
Total fuels	4 316 745	2 458 648	4 889 124	3 136 393	5 079 183	4 650 594
Total fabricated mineral products	7 556 362	3 748 794	8 900 741	4 808 504	11 770 302	6 993 617
Total, all commodities	116 521 506	61 792 786	134 638 829	67 414 437	13 816 219	67 834 656
Fabricated mineral products as a per cent of all commodities	6.5	6.1	6.6	7.1	8.5	10.3

P Preliminary; - Nil; nes Not elsewhere specified.

TABLE 65. 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 65 apply to this table. Figures may not add to totals due to rounding.
[1] Classification of the industry is the same as in Table 27.
-- Amount too small to be expressed; - Nil.

TABLE 66. 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	.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 28. [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 67. 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 68. CANADA, CAPITAL AND REPAIR EXPENDITURES IN MINING[1] AND MINERAL MANUFACTURING INDUSTRIES, 1980-1982

	1980			1981P			1982f		
	Capital	Repair	Total	Capital	Repair	Total	Capital	Repair	Total
					($ million)				
Mining industry									
Metal mines									
Gold	160.9	34.7	195.6	360.0	39.8	399.8	311.5	45.3	356.8
Silver-lead-zinc	228.0	68.4	296.4	239.0	85.3	324.3	190.8	100.8	291.6
Copper-gold-silver	490.9	235.2	726.1	434.5	267.4	701.9	285.7	272.7	558.4
Iron	168.0	337.2	505.2	200.8	323.8	524.6	218.8	357.4	576.2
Other metal mines	528.5	229.5	758.0	529.5	235.8	765.3	657.5	248.8	906.3
Total metal mines	1,576.3	905.0	2,481.3	1,763.8	952.1	2,715.9	1,664.3	1,025.3	2,689.3
Nonmetal mines									
Asbestos	88.2	113.4	201.6	73.1	85.4	158.5	79.7	93.8	173.5
Other nonmetal mines[2]	525.8	312.2	838.0	978.8	319.9	1,298.7	1,312.2	369.2	1,681.4
Total nonmetal mines	614.0	393.1	425.6	1,051.9	382.5	405.3	1,391.9	463.0	1,854.7
Mineral fuels									
Oil, crude and gas[3]	6,253.4	941.2	7,194.6	6,621.3	1,185.1	7,806.4	8,398.0	1,278.7	9,676.7
Total mining industries	8,443.7	2,271.8	10,715.5	9,437.0	2,542.5	11,979.5	11,454.2	2,766.7	14,220.9
Mineral manufacturing									
Primary metal industries									
Iron and steel mills	584.2	709.5	1,293.7	686.1	735.6	1,421.7	733.2	931.1	1,664.3
Steel pipe and tube mills	59.9	48.4	108.3	171.1	66.9	238.0	249.1	73.8	322.9
Iron foundries	19.7	21.0	40.7	25.9	21.6	47.5	27.0	22.6	49.6
Smelting and refining	566.0	303.5	869.5	545.9	315.9	861.8	728.5	340.3	1,068.8
Aluminum rolling, casting and extruding	28.7	18.5	47.2	34.0	24.5	58.5	18.7	30.0	48.7
Copper and copper alloy rolling, casting and extruding	14.5	4.6	19.1	28.2	6.0	34.2	21.8	5.9	27.7
Metal rolling, casting and extruding	16.1	15.1	31.2	17.3	12.5	29.8	13.3	15.6	28.9
Total primary metal industries	1,289.1	1,120.6	2,409.7	1,508.5	1,183.0	2,691.5	1,791.6	1,419.3	2,210.9
Nonmetallic mineral products									
Cement	121.0	63.8	184.8	130.2	69.2	199.4	76.5	83.3	159.8
Stone products	2.4	1.3	3.7	3.9	0.9	4.8	3.6	1.0	4.6
Concrete products	30.5	31.8	62.3	21.0	30.5	51.5	17.8	28.5	46.3
Ready-mix concrete	40.7	48.5	89.2	40.8	61.3	102.1	31.6	68.1	99.7

Clay products	9.1	8.9	18.0	16.0	11.0	27.0	13.1	11.2	24.3
Glass and glass products	51.1	16.8	67.9	50.3	19.4	69.7	47.4	19.5	67.0
Abrasives	13.0	16.0	29.0	27.1	18.6	45.7	19.3	18.2	37.5
Lime	0.9	1.8	2.7	2.5	2.2	4.7	2.5	2.4	4.9
Other nonmetallic mineral products	51.0	41.6	92.6	56.8	42.1	98.9	54.6	48.0	102.6
Total nonmetallic mineral products	319.7	230.5	550.2	348.6	255.2	603.8	266.5	280.2	546.7
Petroleum and coal products	324.7	266.7	591.4	615.8	283.7	899.5	994.0	355.5	1,349.5
Total mineral manufacturing industries	1,933.5	1,617.8	3,551.3	2,472.9	1,721.9	4,194.8	3,052.1	2,055.0	5,107.1
Total mining and mineral manufacturing industries	10,377.2	3,889.6	14,266.8	11,909.9	4,264.4	16,174.3	14,506.3	4,821.7	19,328.0

[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 70.

P Preliminary; [f] Forecast.

TABLE 69. CANADA, CAPITAL AND REPAIR EXPENDITURES IN THE MINING INDUSTRY[1], 1976-1982

	1976	1977	1978	1979	1980	1981P	1982f
	($ million)						
Metal mines							
Capital							
Construction	597.6	626.8	407.3	606.4	1,109.1	1,244.6	1,149.9
Machinery	305.3	352.0	169.3	281.6	467.2	519.2	514.4
Total	902.9	978.8	576.6	888.0	1,576.3	1,763.8	1,664.3
Repair							
Construction	61.5	63.1	53.7	70.2	137.3	104.3	110.1
Machinery	521.6	536.7	487.6	632.1	767.7	847.8	914.9
Total	583.1	599.8	541.3	702.3	905.0	952.1	1,025.0
Total capital and repair	1,486.0	1,578.6	1,117.9	1,590.3	2,481.3	2,715.9	2,689.3
Nonmetal mines[2]							
Capital							
Construction	161.3	214.8	187.5	248.8	346.4	617.1	836.3
Machinery	214.6	225.8	236.4	202.6	267.6	434.8	555.6
Total	375.9	440.6	423.9	451.4	614.0	1,051.9	1,391.9
Repair							
Construction	20.0	20.8	18.2	14.6	32.5	22.8	25.3
Machinery	226.2	273.2	289.1	332.5	393.1	382.5	437.7
Total	246.2	294.0	307.3	347.1	425.6	405.3	463.0
Total capital and repair	622.1	734.6	731.2	798.5	1 039.6	1 457.0	1 854.7
Mineral fuels							
Capital							
Construction	1,598.0	1,998.0	2,520.9	3,820.3	5,453.1	5,691.7	7,241.9
Machinery	564.1	447.5	382.0	494.9	800.3	929.6	1,156.1
Total	2,162.1	2,445.5	2,902.9	4,315.2	6,253.4	6,621.3	8,398.0
Repair							
Construction	287.4	318.3	389.6	444.1	627.6	661.9	753.3
Machinery	82.9	101.2	100.2	242.1	313.6	523.2	525.4
Total	370.3	419.5	489.8	686.2	941.2	1,185.1	1,278.7
Total capital and repair	2,532.4	2,865.0	3,392.7	5,001.4	7,194.6	7,806.4	9,676.7
Total mining							
Capital							
Construction	2,356.9	2,839.6	3,115.7	4,675.5	6,908.6	7,553.4	9,228.1
Machinery	1,084.0	1,025.3	787.7	979.1	1,535.1	1,883.6	2,226.1
Total	3,440.9	3,864.9	3,903.4	5,654.6	8,443.7	9,437.0	11,454.2
Repair							
Construction	368.9	402.2	461.5	528.9	797.4	789.0	888.7
Machinery	830.7	911.1	876.9	1,206.7	1,474.4	1,753.5	1,878.0
Total	1,199.6	1,313.3	1,338.4	1,735.6	2,271.8	2,542.5	2,766.7
Total capital and repair	4,640.5	5,178.2	5,241.8	7,390.2	10,715.5	11,979.5	14,220.9

[1] Does not include cement, lime and clay products (domestic clays) manufacturing, smelting and refining. [2] Includes coal mines, asbestos, gypsum, salt, potash, miscellaneous non-metals, quarrying and sand pits.

P Preliminary; f Forecast.

TABLE 70. CANADA, CAPITAL AND REPAIR EXPENDITURES IN THE MINERAL MANUFACTURING INDUSTRIES[1], 1976-1982

	1976	1977	1978	1979	1980	1981p	1982f
	($ million)						
Primary metal industries[2]							
Capital							
Construction	144.8	171.2	130.7	153.4	328.2	318.3	385.3
Machinery	496.1	549.1	475.4	621.1	960.9	1,190.2	1,406.3
Total	640.9	720.3	606.1	774.5	1,289.1	1,508.5	1,791.6
Repair							
Construction	63.2	85.3	80.8	87.6	122.1	133.1	147.3
Machinery	632.4	662.8	780.1	887.7	998.5	1,049.9	1,272.0
Total	695.6	748.1	860.9	975.3	1,120.6	1,183.0	1,419.3
Total capital and repair	1,336.5	1,468.4	1,467.0	1,749.8	2,409.7	2,691.5	3,210.9
Nonmetallic mineral products[3]							
Capital							
Construction	46.6	63.3	62.0	102.0	70.0	66.6	39.7
Machinery	195.4	215.5	217.9	293.5	249.7	282.0	226.8
Total	242.0	278.8	279.9	395.5	319.7	348.6	266.5
Repair							
Construction	15.4	16.1	17.5	20.2	16.7	24.4	27.1
Machinery	164.9	169.5	190.3	206.1	213.8	230.8	253.1
Total	180.3	185.6	207.8	226.3	230.5	255.2	280.2
Total capital and repair	422.3	464.4	487.7	621.8	550.2	603.8	546.7
Petroleum and coal products							
Capital							
Construction	255.9	268.2	215.6	180.0	215.6	455.4	732.2
Machinery	88.3	98.4	99.5	94.0	109.1	160.4	261.8
Total	344.2	366.6	315.1	274.0	324.7	615.8	994.0
Repair							
Construction	101.2	125.7	117.5	158.1	190.5	203.5	253.5
Machinery	35.8	45.8	57.4	61.3	76.2	80.2	102.0
Total	137.0	171.5	174.9	219.4	266.7	283.7	355.5
Total capital and repair	481.2	538.1	490.0	493.4	591.4	899.5	1,349.5
Total mineral manufacturing industries							
Construction	447.3	502.7	408.3	435.4	613.8	840.3	1,157.2
Machinery	779.8	863.0	792.8	1,008.6	1,319.7	1,632.6	1,894.9
Total	1,227.1	1,365.7	1,201.1	1,444.0	1,933.5	2,472.9	3,052.1
Repair							
Construction	179.8	227.1	215.8	256.9	329.3	361.0	427.9
Machinery	833.1	878.1	1,027.8	1,155.1	1,288.5	1,360.9	1,627.1
Total	1,012.9	1,105.2	1,243.6	1,412.0	1,617.8	1,721.9	2,055.0
Total capital and repair	2,240.0	2,470.9	2,444.7	2,865.0	3,551.3	4,194.8	5,107.1

[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 71. CANADA, CAPITAL EXPENDITURES IN THE PETROLEUM, NATURAL GAS AND ALLIED INDUSTRIES[1], 1976-1982

	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)			
1976	1,998.8	337.3	164.9	182.3	344.2	163.3	3,190.8
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
1981P	6,094.6	1,778.7	251.8	432.5	615.8	435.7	9,609.1
1982f	7,592.3	2,407.7	334.2	627.4	994.0	698.6	12,654.2

[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 67.

P Preliminary; f Forecast.

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