MINERAL REPORT 17

CANADIAN MINERALS YEARBOOK 1967

MINERAL RESOURCES BRANCH

DEPARTMENT OF ENERGY, MINES AND RESOURCES

OTTAWA

1969

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Foreword

This issue of the Canadian Minerals Yearbook is a report of developments in the industry for 1967. The 59 chapters dealing with specific commodities were issued in advance under the title Preprints, Canadian Minerals Yearbook 1967 to provide information as soon as possible to interested persons. Chapter One, General Review, written specifically for the Yearbook each year, deals with the overall position of the industry in its national and international perspectives; it is supported by 63 statistical tables not readily available from other sources. The Index to Companies provides full and accurate company names and a complete cross-reference to corporate activities in the Canadian industry, supported again by pocket map 900A, Principal Mineral Areas of Canada.

The Yearbook is the permanent official record of the growth of the mineral industry in Canada and is preceded by similar reports under various titles dating back to 1907 and earlier. Those wishing to refer to previous reports should consult departmental catalogues, available in most libraries.

The basic statistics on Canadian production, trade and consumption were collected by the Dominion Bureau of Statistics, unless otherwise stated. Company data were obtained directly from company officials or corporate annual reports by the authors. Market quotations were mainly from standard marketing reports.

The Department of Energy, Mines and Resources is indebted to all who contributed the information necessary to compile this report.

W. Keith Buck
Director
Mineral Resources Branch

October 1968

Editor: G.E. Thompson

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Readers wishing more recent information than that contained in the present volume should obtain the 1967 series of preprints: complete set available from the Queen's Printer, $5. Individual copies are available from the Distribution Office, Mineral Resources Division, Department of Energy, Mines and Resources, Ottawa, at 25¢ each.

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General Review

Canada's gross national product (GNP) was at a new high of $62.1 billion* in 1967, the seventh consecutive year of economic expansion. However, the rate of growth of the economy was lower. For example, the 1967 GNP represents an increase of 6.8 per cent compared with the rise of 11.3 per cent the previous year. About two thirds of the expansion took place in the first half of the year. The rise in prices in 1967 was 3.9 per cent, giving a gain, in real terms, of 2.9 per cent; in 1966 prices rose 4.5 per cent giving a real gain of 6.8 per cent. Figure 1 shows the behaviour of Canada's GNP in current dollars, and in real, or constant dollars.

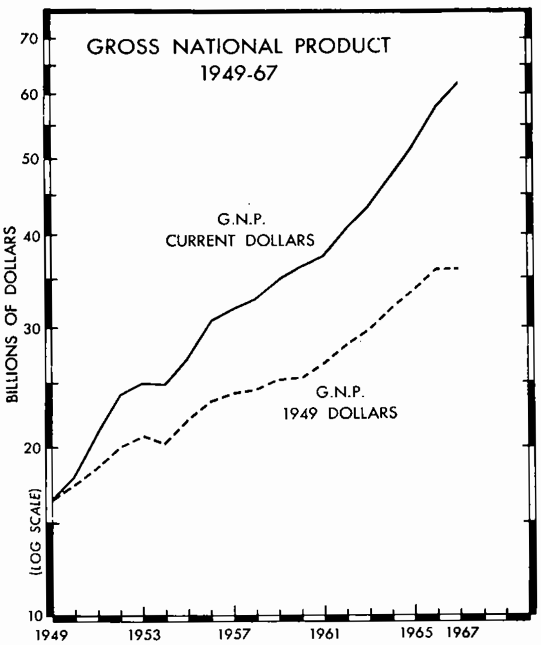


Figure 1

*All statistics used, in the text and in diagrams (figures), have been taken from publications of the Dominion Bureau of Statistics, unless otherwise noted.

The slow-down in the rate of economic expansion affected the rate of growth of employment opportunities in Canada. The labour force grew from an annual average of 7.42 million in 1966 to 7.69 million in 1967 an increase of 3.7 per cent, while the number employed rose from 7.15 million to 7.38 million, an increase of 3.2 per cent. That is, the labour force rose by 274 thousand but the number of people employed rose only to 227 thousand. The overall rate of people unemployed and seeking work in 1967 was 4.1 per cent of the labour force compared with 3.6 in 1966. Figure 2 shows the historical trend in the size of the Canadian labour force and the unemployment rate.

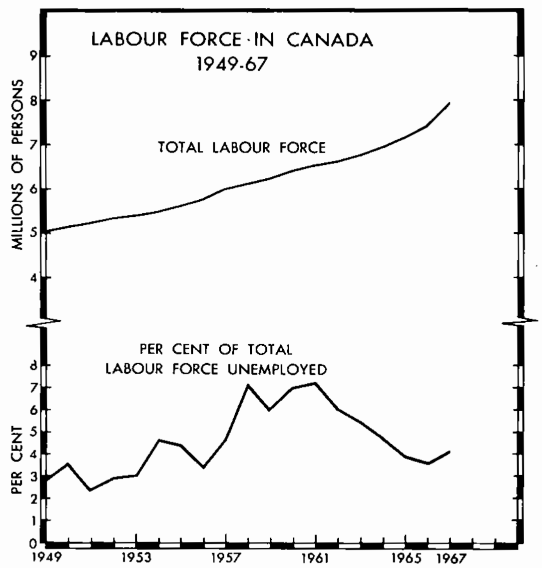


Figure 2

Not all of the five sectors of Gross National Expenditure (GNE), which is numerically the same as GNP, rose in 1967. The five sectors are Personal Expenditures on Goods and Services, Government Expenditures on Goods and Services and Fixed Capital Formation, Fixed Capital Formation by Business, Change in Inventories and Net Foreign Trade. Of these sectors, Personal Expenditures rose from $34.8 billion in 1966 to $37.7 billion, an increase of 8 per cent compared with an 8.5-per-cent rise in 1966; large expenditures by foreign tourists are not included in this element of demand.

Business gross fixed capital formation, including housing, was $12.4 billion in 1967, a decline of 1 per cent from 1966. Within this total, investment in housing increased 7.5 per cent and business expenditure on plant and equipment fell by 29 per cent compared with a 21.5-per-cent increase in 1966 (Figure 3). Government expenditures amounted to $12.4 billion in 1967 compared with $11.3 billion in 1966, an increase of 9.7 per cent.

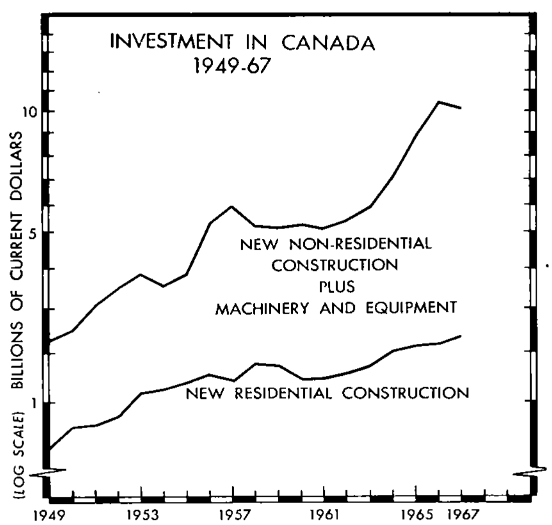
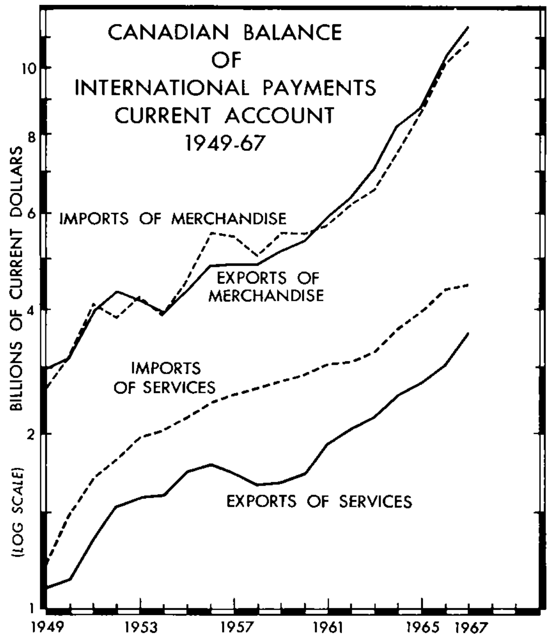


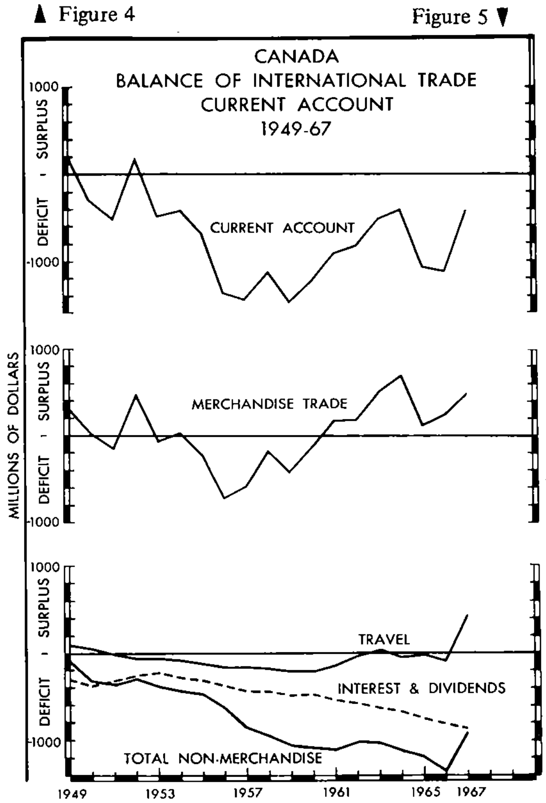
Figure 3

Exports of goods and services rose by 11.5 per cent from the previous year to $14.6 billion in 1967. Imports rose by 6 per cent to $15.2 billion, giving a deficit on international current account of $0.6 billion compared with the deficit of $1.2 billion in 1966. Current account comprises merchandise and non-merchandise trade. Merchandise exports were $11.4 billion in 1967, which is $1.06 billion or 10.3 per cent higher than in 1966. Most of this increase was in trade in manufactured goods with the United States with automobiles, trucks and parts, and aircraft engines and parts being a large part of it. Increases in wheat sales to Japan, Italy and the Netherlands offset the fall in sales to eastern Europe and Asia. Merchandise imports were 8 per cent higher in 1967 than in 1966 and totalled $10.9 billion. Most of the $803 million increase was due to increased imports of automotive parts, aircraft and parts, and crude petroleum from the United States.



▲ Figure 4

Figure 5 ▼



On the non-merchandise or service account the deficit was reduced from $1.43 billion in 1966 to $1.03 billion. The 17.5-per-cent increase in receipts was due, in part, to a surplus of nearly half a billion dollars on the net travel and tourist account, that was attributed to Expo 67 and other Centennial attractions. This was only the second time a surplus had been registered on this account since 1950. The largest single item in the current payments out of Canada on non-merchandise account is interest and dividends; this increased by $14 million in 1967 from the 1966 total and amounted to $1,149 million. Interest and dividends following into Canada fell by $42 million to $281 million in the same period; thus the net deficit on this item of the current account increased by 6.9 per cent to $868 million in 1967. Canada's Balance of International Payments on Current Account is shown in Figure 4. The balance of merchandise trade is also shown in Figure 5, together with the chief components contributing to the deficit in non-merchandise trade.

The deficit on Current Account must be balanced by capital movements and official transactions. Figure 6 shows the behaviour of Net Capital Movement and the major components of the Capital Account in 1947-67. The large surplus in the net capital movement indicates the inflow of capital into Canada that was, in part, responsible for the rapid growth of the mineral industry into the important position it holds today. The two major components of this capital flow are: (a) Net Direct Investment, i.e., the difference between investment in Canada by foreigners and investment abroad by Canadians and (b) Trade in Canadian Securities, i.e., Canadian bonds, debentures and stock delivered to non-residents, and payments to non-residents on the retirement of Canadian securities.

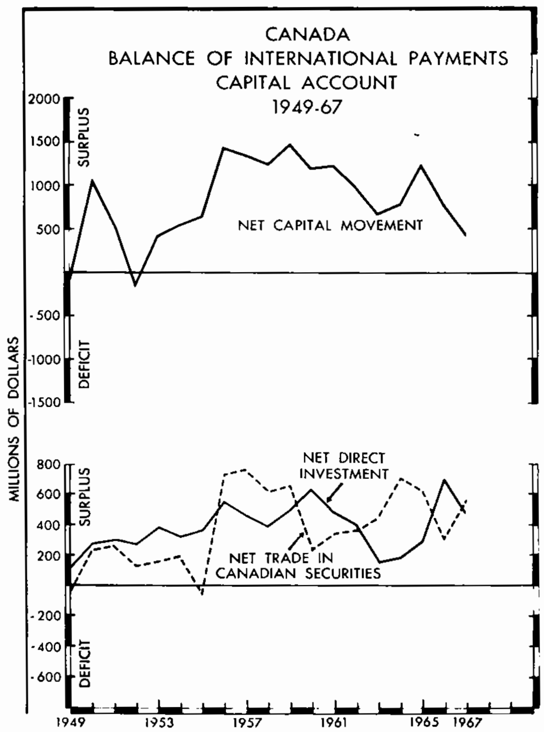


Figure 6

A REVIEW OF THE MINERAL ECONOMY

The Canadian mineral industry enjoyed another year of outstanding progress in 1967. Value of output was a record for the ninth consecutive year. Exploration activity, highlighted by the renewed interest in uranium, was at high levels in all producing provinces and territories and development continued on a number of properties that were being prepared for production.

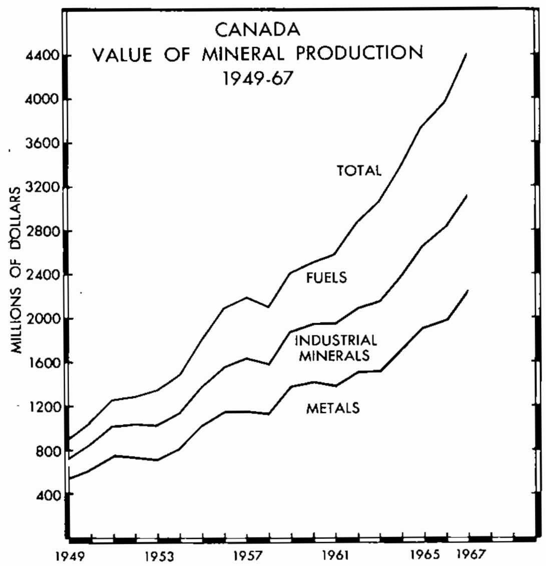


Figure 7

The value of Canadian mineral production in 1967 was $4,414* million, an increase of 11.1 per cent from the 1966 production total of $3,973* million (Figure 7). Each of the three sectors reached new records in value of production: metallic minerals increased 13.7 per cent from $1,985 million to $2,257 million, nonmetallic minerals and structural materials increased 5.5 per cent from $837 million to $884 million, and production of fuels increased 10.7 per cent from $1,151 million to $1,273 million (Table 1).** In

*1966 figures are revised, 1967 figures are revised preliminary.

**Table numbers refer to the statistical tables at the end of the article.

terms of physical volume of production the mining, including milling quarrying and oil well index rose 6.4 per cent to 145.2 (1961=100) from 136.5 in 1966; the values of the index of industrial production in Canada rose 1.9 per cent, from 148.9 to 151.7 in the same time.

Output of many mineral products increased and contributed to the 11.1 per cent in total value of production. Crude petroleum was the commodity with the highest value of production at $884 million, up $92 million from 1966. Copper was again the second most valuable product as its output rose over 86,000 tons to 592,000 tons valued at $563 million. Nickel production and iron ore production were each valued at $467 million in 1967. Zinc production exceeded one million tons for the first time and at 1,086,557 tons it was more than 120,000 tons above 1966 production although the value of production rose only $25 million to $315 million. The value and volume of natural gas production in 1967 were down slightly from 1966, as were both value and production of asbestos, cement, and gold. Production of coal and uranium, which have been declining for some years, stabilized in 1967, with tonnages about the same as in 1966. Value of silver production rose 35 per cent to $63 million although production rose only about 10 per cent to 36 million ounces.

Canada's ten leading minerals, in terms of output value were worth $3.48 billion, 78.8 per cent of the total. The accompanying table shows their individual values and percentages of Canada's total output.

In 1967 Ontario became the first province with an annual mineral production to exceed one billion dollars. Its total of $1,198 million compared with $958 million in 1966 and represented 27.2 per cent of Canadian production, an increase of three per cent from 1966 (Figure 8, Tables 7 and 8). Alberta had the second highest value of mineral production, a position that province has held since 1961. The value of Alberta's production in 1967 was $997 million, 22.6 per cent of total Canadian production and an increase of $150 million or nearly 18 per cent from 1966. Quebec, Nova Scotia, and Prince Edward Island showed declines in their value of mineral production. Quebec's production decreased $26 million to $737 million; Nova Scotia's production, $7 million to $79 million; and Prince Edward Island's production $1 million to $2 million.

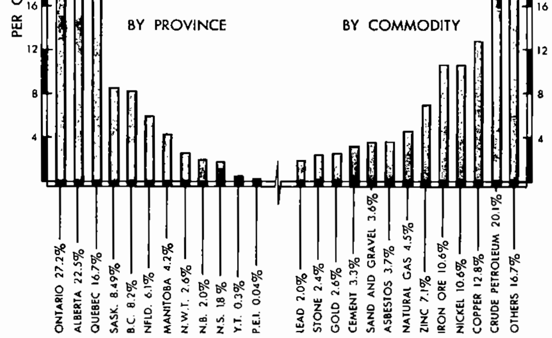


Figure 8

Canada's Ten Leading Minerals, 1965-67

	Value in Millions of Dollars			Per Cent of Total Mineral Production		
	1965	1966	1967	1965	1966	1967
Petroleum	722	792	884	19.3	19.9	20.0
Copper	381	454	564	10.2	11.4	12.8
Nickel	430	377	467	11.5	9.5	10.6
Iron Ore	413	432	467	11.0	10.9	10.6
Zinc	248	291	315	6.6	7.3	7.1
Natural Gas	187	178	199	5.0	4.5	4.5
Asbestos	146	164	163	3.9	4.1	3.7
Sand and gravel	134	152	158	3.6	3.8	3.6
Cement	142	156	146	3.8	3.9	3.3
Gold	136	125	113	3.6	3.1	2.6
Total	2,939	3,121	3,476	78.5	78.4	78.8
All others	806	852	938	21.5	21.6	21.2
Total	3,745	3,973	4,414	100.0	100.0	100.0

Canada's mineral production and Gross National Product (GNP), both expressed in terms of dollars per head of the population, are shown in Figure 9 (Table 2). The GNP increased about 4.8 per cent in 1967, and the mineral production increased 8.8 per cent per head. The figure shows that these growth rates have been relatively constant since 1960.

Figure 9 also shows, for comparison, the same two series for the United States. The GNP per head there is larger than the Canadian figure and is growing at about the same annual rate. The United States mineral value per head series is lower than Canada's and a much lower annual rate of growth is exhibited.

The indexes of production shown in Figure 10 are part of a new series, "Real Domestic Product by Industry", based on the 1960 Standard Industrial Classification (SIC) with 1961 = 100. The Composite Index of Industrial Production has an annual compound rate of growth of 6.0 per cent for the period shown in the figure (1949 to 1967). The rate of growth for Electric Power Utilities is 9.1 per cent a year. For Total Mining, including milling, quarries, and oil wells the rate of growth is 8.2 per cent a year. For Total Manufacturing the rate of growth is 5.3 per cent a year for the 1949-67 period.

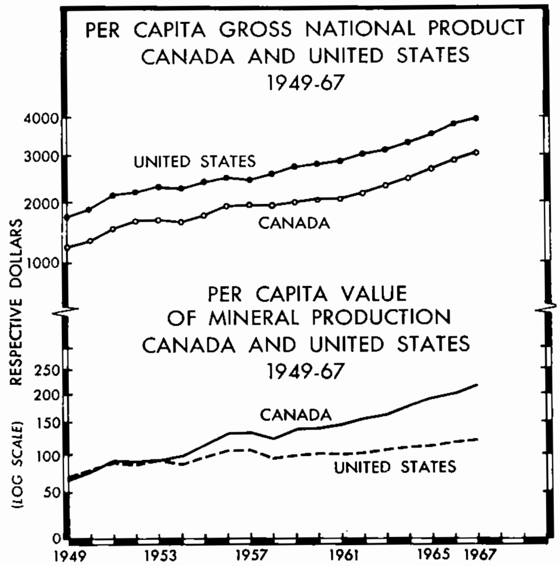


Figure 9

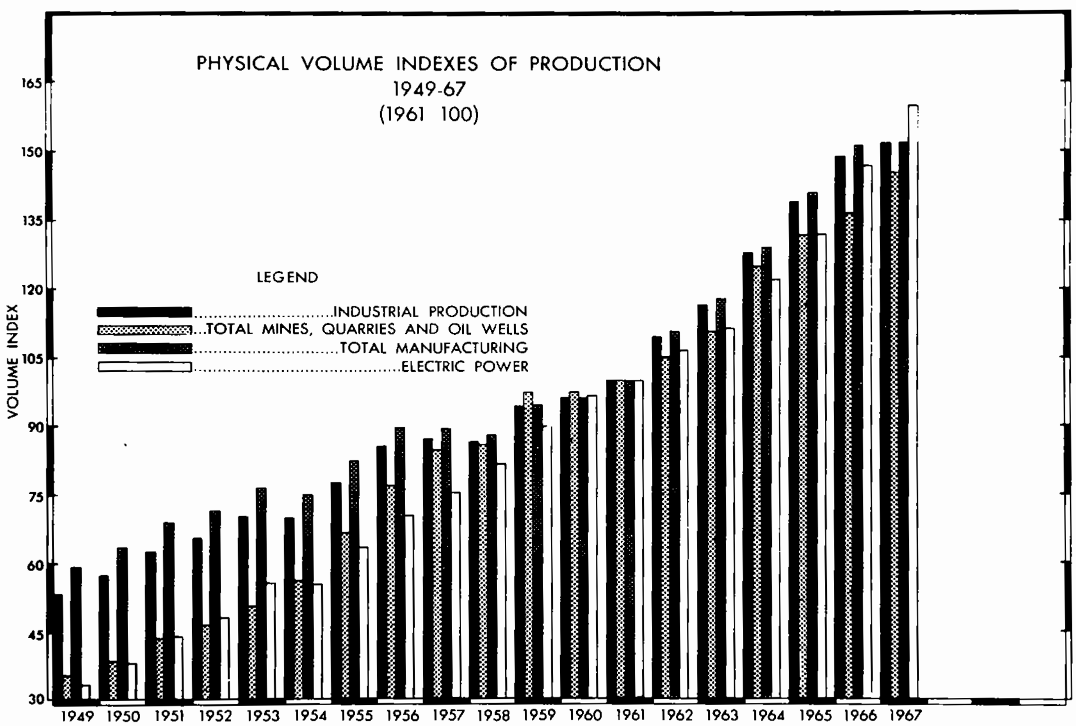


Figure 10

The relation between output and employment in mining and in manufacturing for Canada and for the United States is shown in Figure 11. Each graph represents the ratio:

$$\frac{\text{Index of Industrial Production, by Sector*}}{\text{Index of Employment, by Sector}}$$

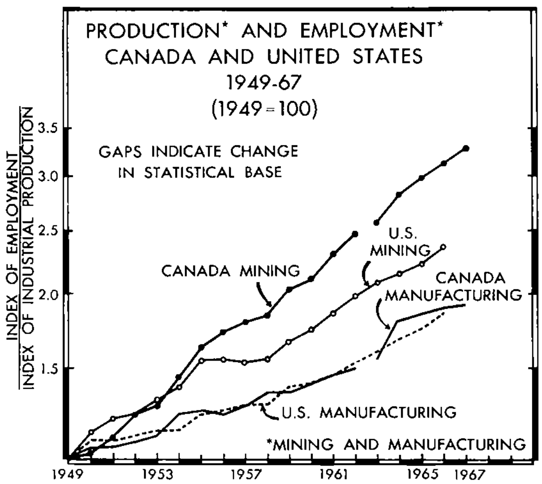


Figure 11

The Canadian and United States ratios should not be correlated directly since their statistical basis are not necessarily the same. However, the series do have statistical continuity within themselves and the figure is used to illustrate the different rates of growth between sectors. The manufacturing series in Canada and the United States exhibit a similar growth rate. The growth rate in the mining series in both countries is higher than the rate in manufacturing, and the Canadian mining series has a higher rate of growth than the American series.

Capital expenditures in the mining industry reached a peak in 1966 at $1,030 million. Preliminary estimates of capital expenditures in 1967 indicate the total may be more than $25 million less than 1966, and the mid-year intentions of the industry for 1968, as reported to the Dominion Bureau of Statistics, are almost identical with the 1967 estimate. Figure 12 shows the extent of capital investment since 1949 in petroleum and natural gas extraction and in all other mining, including quarrying and in oil wells.

METAL AND MINERAL PRICES

Mineral markets remained generally strong in 1967, although there was evidence of weakening demand and oversupply in some commodities. Price changes in the major mineral commodities are summarized in the following paragraphs but for details of price behaviour of any one the individual commodity review in the Yearbook should be consulted. On November 18, 1967, the pound sterling was devalued by 14.3 per cent, relative to the American dollar, to a parity of $2.40. The effect of this action was to raise metal prices on the London Metal Exchange (LME) by a similar proportion.

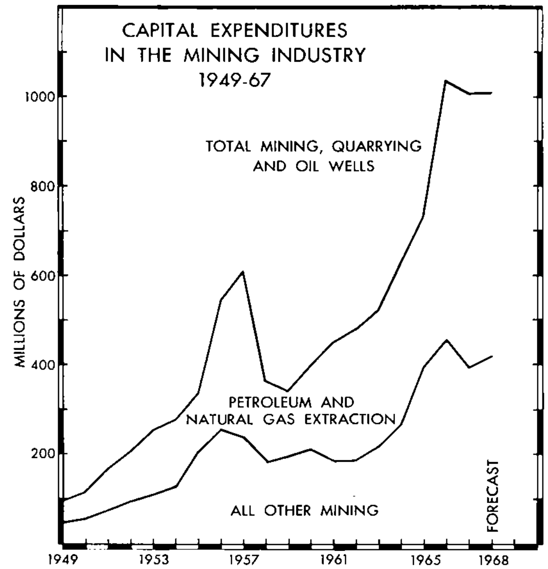


Figure 12

Nonferrous metal prices were mixed. The Canadian Producers' Domestic Price of copper rose from 45 cents a pound to 47 cents in January and to 51 cents early in November, remaining at that level until the end of the year. In the United States the Producers' Price remained at 38 cents throughout 1967. On the LME the price of copper started about £450 a long ton, or 56 cents (US) a pound. From February to April it fell to about 44 cents a pound and fluctuated in the 44-to 50-cent range until October when it climbed to 64 cents, equivalent to about £510 a long ton. Copper prices remained high for the remainder of the year and in London reached a post devaluation peak of £599 a long ton, about 65 cents (US) a pound. The European Producers' Price followed the LME price closely.

Canadian and United States zinc producers dropped their price from 14.5 cents a pound, which had prevailed since October 1965, to 13.5 cents a pound during 1967. Overseas Producer Basis Price fell from £102 to £98 a long ton, 12.8 cents (US) to 12.25 cents a pound, in June. On the LME the price of zinc was £102.5 a long ton, about 12.8 cents (US) a pound, at the beginning of 1967. During the year, it fluctuated between a high of £104 in February and a low

*United States data are from the Federal Reserve Board, the Department of Labor, Bureau of Labor Statistics.

of £94.75 a long ton in September, equivalent to 13 cents and 11.8 cents (US) a pound.

The price of lead in Canada remained at 14 cents a pound, f.o.b. Montreal and Toronto throughout 1967. In the United States, the price of lead also remained at 14 cents a pound, f.o.b. New York. The LME price fluctuated between £86.4 and £78.1 a long ton, equivalent to 10.8 cents and 9.8 cents (US) a pound, until devaluation in November; and between £95.500 and £93.375 a long ton, 10.0 cents and 10.2 cents, during the remainder of the year.

Nickel prices rose about ten per cent in 1967, from 92.15 cents to 101.5 cents a pound for electrolytic nickel, f.o.b. refinery, in Canada. In the United States the price increase was from 85.25 cents to 94 cents a pound.

Prices of a number of other metals rose. Aluminum went from 26 cents to 26.5 cents a pound. Silver rose from $1.293 (US) a troy ounce to an average price of $2.066 in the United States in December 1967 after the US Treasury stopped sales of the metal from stockpile. The price of molybdenum rose by 3.7 per cent during the year, and prices of the platinum-group metals all rose. Magnesium remained at 31 cents a pound and the Lake Erie base price of iron ore was unchanged.

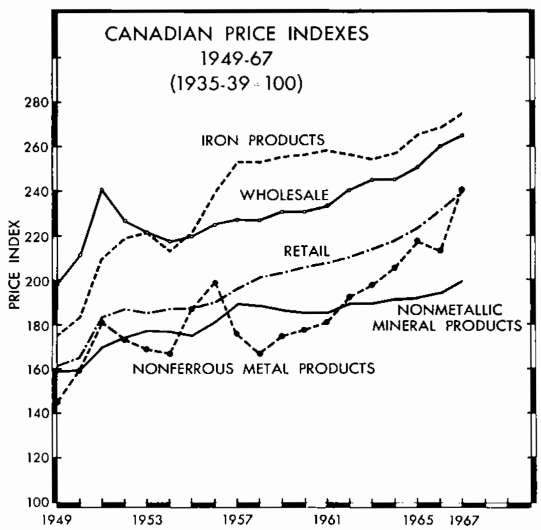


Figure 13

The posted price of sulphur rose in 1967. In the United States it stood at $38 a long ton at the end of the year, 35 per cent higher than at the end of 1966. Potash prices in Canada averaged $30.00 a ton K_2O equivalent in 1967, compared with $31.49 in 1966 and $37.53 in 1965. Price indexes are shown in Figure 13 for iron products, nonferrous metal products and nonmetallic mineral products. The general wholesale price index and the retail price index, reduced to 1935-39 basis = 100, are included for comparison. All indexes advanced in 1967 with the iron products index remaining above all other sectors. Nonferrous metal products showed the largest single increase in 1967.

MINERAL TRADE

The value of crude mineral and fabricated mineral product exports rose to $3.47 billion in 1967, which was $346 million or 11 per cent higher than in 1966. All main commodity groups showed increases (Table 12) with mineral fuels showing the largest percentage increase. The 20.9-per-cent increase for the crude material class was mainly because of a 22-per-cent increase in exports of crude petroleum to the United States. An increase of 38 per cent in the fabricated materials class in the minerals group was largely because of an increase in fuel oil exports to the United States and new markets for liquid propane in Japan. The value of mineral imports increased in aggregate although some commodity groups showed a decline in value (Table 13).

Crude and fabricated mineral exports comprised 31 per cent of total Canadian merchandise exports in 1967, the same proportions as the previous year (Figure 14). Mineral imports, on the other hand, fell from 18.5 per cent of total merchandise imports in 1966 to 17.5 per cent in 1967 although in absolute terms they rose from $1,824 million to $1,936 million.

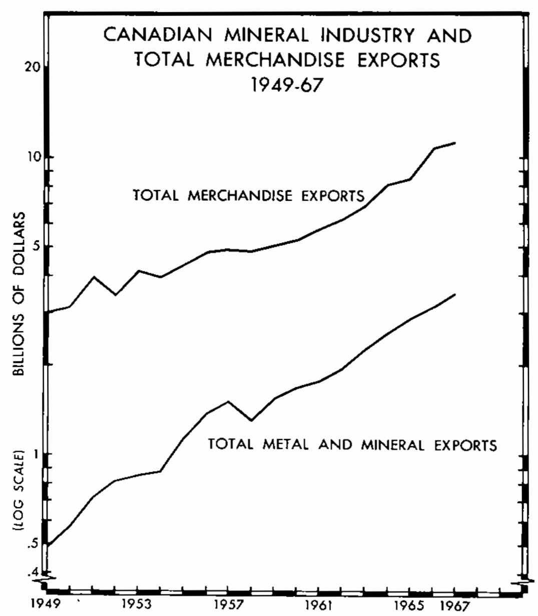


Figure 14

Canadian mineral exports to the United States were $127 million more than in 1966. This represented only 37 per cent of the total increase in mineral exports and the United States' share of total mineral exports declined to 58.3 per cent from 60.7 per cent in 1966 (Figure 16). Of the major mineral commodities exported to the United States more of them decreased in total export value than increased. Iron ore, primary ferrous metals, aluminum, lead, zinc, asbestos, and uranium exports were all down in 1967 while copper, nickel and fuels were higher.

Mineral exports to Britain in 1967 were $34 million, or 7 per cent higher than in 1966 and comprised 14.5 per cent of total Canadian mineral exports, about the same proportion as the previous year. The major increases were in iron ore, nickel and zinc. Commodities that were lower in total export value in 1967 were aluminum, copper, and asbestos.

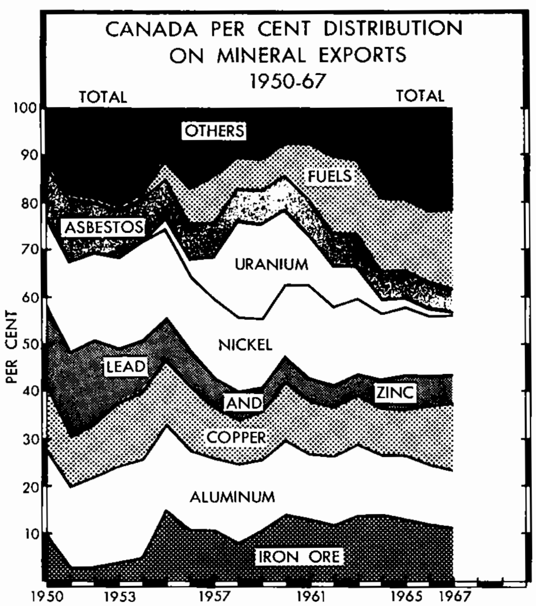


Figure 15

The share of Canadian mineral exports to EFTA* nations other than Britain fell to 2.9 per cent in 1967, from 4.1 per cent in 1966. The value of mineral exports to EEC** countries rose from $209 million in 1966 to $260 million in 1967; this represented an increase from 6.7 per cent to 7.5 per cent of total Canadian mineral exports. Exports to Japan almost doubled from $145 million in 1966 to $272 million in 1967, equal to 4.6 per cent and 7.8 per cent of total mineral export trade.

Copper exports in 1967 were valued at $494 million up $98 million from 1966, or nearly double the 1964 figure, and made copper the most valuable mineral commodity export, a position that had been held for a number of years by crude petroleum. Most other main mineral commodity exports increased in total export value in 1967 with iron ore exports increasing nearly 4 per cent; nickel exports, 8.5 per cent; zinc exports, 15 per cent; and aluminum exports increasing 7.5 per cent. The value of exports of uranium and asbestos declined slightly (Figure 15).

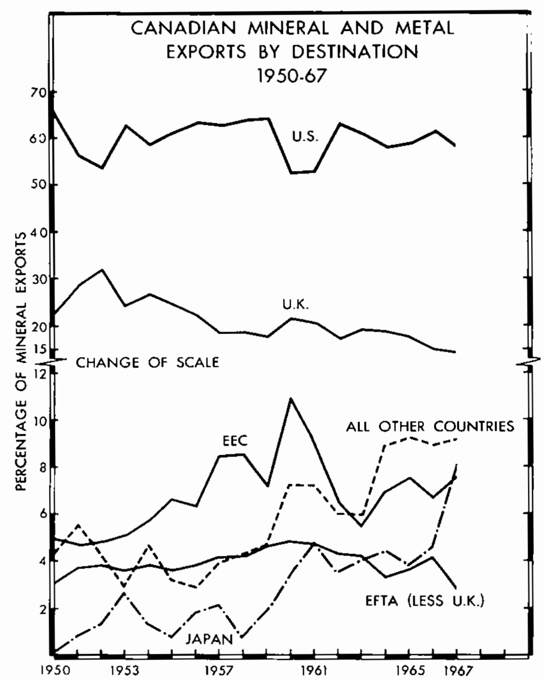


Figure 16

*European Free Trade Association countries are Britain, Austria, Denmark, Norway, Portugal, Sweden, and Switzerland.

**European Economic Community (Common Market) countries are Belgium, France, Italy, Luxembourg, Netherlands, and West Germany.

REVIEW BY PROVINCES

BRITISH COLUMBIA

Value of mineral production was $360.4 million, $29 million more than 1966. There were slight declines in the value of output of the nonmetallic and structural materials and good increases for the metals and fuels. Metals accounted for almost 60 per cent of the province's mineral production value and fuels for 21 per cent. Copper accounted for most of the increase in metals output but there was also a substantial gain for molybdenum. (See Table below.)

Production Changes From 1966 to 1967 For Leading Minerals of British Columbia

	Per Cent Change	
	Quantity	Value
Copper	54.9	64.3
Iron Ore	2.6	3.0
Lead	−3.2	−9.3
Molybdenum	2.3	13.4
Zinc	−26.0	−29.1
Natural Gas	21.5	27.9
Crude Oil	17.9	11.1
Structural Materials	..	−1.6

.. Not applicable.

Two new mines and expansion of production facilities at two producing mines accounted for the increase in copper output. Several large, low-grade properties were receiving serious consideration for early development. All nickel production was from the Hope mine of Giant Mascot mines, Limited. The operations of Cominco Ltd. in the southeastern part of the province continued to be a major source of lead, zinc and silver as well as of industrial chemicals and fertilizers. Wesfrob Mines Limited officially opened its copper and iron mine and plant at Tasu in the Queen Charlotte Islands. The annual rated capacity of iron ore is 400,000 tons of sinter concentrate and 550,000 tons of pellet concentrate. One of the two lode gold mines closed in 1967 but there was a production increase because more gold was recovered from base-metal operations. The newest Canadian molybdenum producer, British Columbia Molybdenum Limited, a subsidiary of Kennecott Copper Corporation, started mill tune-up in November and was expected to have an annual output of 4 to 5 million pounds. This will constitute a 20 per cent increase in molybdenum output in the province where 80 per cent of Canada's molybdenum is now produced. Properties under production that have a molybdenum content in the ore include Lornex Mining Corporation Ltd., Brenda Mines Ltd. and Highmont Mining Corp. Ltd. Drilling for oil and gas was carried on by Shell Canada Limited in British Columbia offshore areas using a semi-submersible drilling platform that is capable of drilling in water up to 600 feet deep. The Kitimat smelter of Aluminum Company of Canada, Limited shared with Quebec smelters the necessary production cutbacks required by temporary oversupply.

YUKON TERRITORY AND NORTHWEST TERRITORIES

The Yukon Territory had a mineral output value of $14.7 million, $2.7 million more than in 1966. Metals accounted for 96 per cent of the output. New copper production more than made up for the declines in the quantity and value of lead, silver and zinc. The first production of asbestos was recorded in the Yukon Territory in 1967.

Copper production was resumed after a gap of four years when New Imperial Mines Ltd. at Whitehorse, Yukon Territory, came into operation. Anvil Mining Corporation Limited continued to develop its Faro deposit, near Ross River. The deposit has been estimated to contain some 40 million tons of zinc-lead ore averaging about 10 per cent combined lead and zinc and one ounce of silver a ton on which open-pit mining is scheduled to begin in the last half of 1969; construction of a 5,500-ton mill began in 1967. Annual output will be about 130,000 tons of zinc and 90,000 tons of lead in concentrates. Cassiar Asbestos Corporation Limited began operation of its mine at Clinton Creek late in 1967. Exploration of asbestos properties in this area is being undertaken by other groups. The large decline in gold production was due to the closure of Canada's principal placer operation, that of The Yukon Consolidated Gold Corporation, Limited in 1966.

The Northwest Territories increased its value of output by $4.5 million to $115.7 million. Metals accounted for almost all the production. The increase in lead more than compensated for the decline in gold while production of other mineral commodities remained about the same. Copper output declined in both quantity and value.

Regular shipments of lead and zinc concentrates and high-grade ore were made by Pine Point Mines Limited. A new 3,000-ton-a-day addition to the mill was under construction and scheduled for completion in the latter part of 1968. One lode gold mine was scheduled to close at the end of 1967 or in early 1968. In December, arrangements were completed for the formation, through a consortium of twenty companies in financial partnership with the federal government, of a new company, Panarctic Oils Ltd. It was formed to conduct extensive geological and geophysical work in the Arctic Islands and to drill a number of wells in an oil exploration program over the next three years.

ALBERTA

Mineral production value rose by $150 million to $997.2 million in 1967 with fuels accounting for almost 90 per cent of 1967 output and 75 per cent of the year's increase. There were favourable production value increases for the structural material and the nonmetals with elemental sulphur accounting for most of the value gain of the latter. The year's advance for crude oil was $89 million, by far the largest single commodity increase in value of output.

Oil and gas exploration activity was concentrated in the northwestern part of the province, particularly in the Zama Lake area where the same Middle Devonian producing horizons that occur in the Rainbow Lake pools immediately to the south were encountered; the productive zones in the Zama Lake area are more limited. The Great Canadian Oil Sands Limited's bituminous sands project near Fort McMurray was officially opened on September 30. The $235-million plant is designed to process 100,000 tons of oil sands a day to produce 45,000 barrels of high-grade synthetic crude oil. This oil will be delivered to Edmonton by pipeline and will be marketed to refineries in eastern Canada and the United States. Oil and gas pipeline construction continued in 1967. Most of the increase in elemental sulphur production in Canada resulted from expansion and new construction of sour gas sulphur recovery facilities in this province. Sulphur recovery in the Great Canadian Oil Sands operation is expected to be about 330 tons a day. There continues to be a high degree of shut-in capacity in the oil-producing fields of Alberta pending the development of larger markets, particularly in the United States. In this connection, much attention was given during the year to a proposal that would provide for the expansion of the Interprovincial Pipeline system by means of a loop through Chicago.

Production Changes From 1966 to 1967 For Leading Minerals of Alberta

	Per Cent Change	
	Quantity	Value
Sulphur	14.8	78.9
Coal	3.9	3.9
Natural Gas	8.4	11.0
Crude Oil	13.9	17.0
Natural Gas Byproducts	–	8.7
Structural Materials	. .	22.4

.. Not applicable; – Nil.

SASKATCHEWAN

The province's mineral output rose by $19.2 million to $368 million. Fuels declined very slightly and nonmetals accounted for most of the gain, almost entirely because of a $14.7-million rise in value of potash output. Fuels and nonmetals accounted for 61 and 24 per cent of total mineral value. Almost half of the metals value came from copper production and most of the fuels' output value was based on crude oil production.

Saskatchewan's copper production came from the mines of Hudson Bay Mining and Smelting Co., Limited, near Flin Flon, Manitoba, and Anglo-Rouyn Mines Limited at Waden Bay. A 350-ton-a-day lead-zinc-copper mill at Hanson Lake was opened in mid-year by Share Mines & Oils Ltd. There was a marked increase in uranium exploration activity, particularly in the Beaverlodge and Stony Rapids area. Eldorado Mining and Refining Limited essentially completed the preparation of surface facilities at its new Hab mine 7 miles northeast of Beaverlodge. Shaft sinking will begin early in 1968 and production is scheduled for early 1969. The three potash mines of International Minerals & Chemical Corporation (Canada) Limited, Kalium Chemicals Limited, and Potash Company of America operated at or near capacity and IMC brought its second mine on stream. Two more mines were partially readied for start-up by mid-1968, another three were well advanced in construction, one new project was started, and expansion plans were announced by Kalium. Already the world's largest potash exporter, Canada is expected to become the world's largest potash producer in 1968 and by 1971, with an anticipated capacity of 7.2 million tons, will supply one third of the world's potash requirements.

Production Changes From 1966 to 1967 For Leading Minerals of Saskatchewan

	Per Cent Change	
	Quantity	Value
Copper	16.2	23.2
Zinc	4.5	0.3
Potash	29.5	23.4
Natural Gas	0.2	0.4
Crude Oil	0.8	–0.8
Structural Materials	. .	16.8

.. Not applicable.

MANITOBA

Mineral production value was $186.6 million, an increase of $7.4 million from 1966. Structural materials declined very slightly; the main increase was in the metals sector. Metals accounted for 80 per cent of the province's output value with the increase in nickel output being the principal growth item. Nickel is the province's most important mineral; its production value was 56 per cent of the provincial total in 1967.

Production Changes From 1966 to 1967 For Leading Minerals of Manitoba

	Per Cent Change	
	Quantity	Value
Copper	–5.9	–0.3
Nickel	–3.9	6.5
Zinc	1.9	–2.2
Crude Oil	6.8	7.6
Structural Materials	..	–1.1

.. Not applicable.

Hudson Bay Mining and Smelting Co., Limited with a mine, mill and smelter at Flin Flon and three satellite mines produced most of Manitoba's copper. Lesser amounts came from the Lynn Lake nickel mine of Sherritt Gordon Mines, Limited and as a byproduct from the Thompson refinery of The International Nickel Company of Canada, Limited (Inco). Hudson Bay is developing three mines near Snow Lake and Sherritt Gordon is developing the Fox Lake copper-zinc deposit southwest of Lynn Lake. Inco was enlarging its mine, mill, smelter and refinery and preparing three new mines for production by the end of 1969. The main output of zinc and lead content continued to come from the operations of Hudson Bay at Flin Flon and Snow Lake.

ONTARIO

Ontario's mineral production value increased by $240.0 million to $1,198 million. There were very small decreases in the output of the fuels and structural materials and a modest increase for nonmetals. The metals accounted for most of the increase and for 81 per cent of the province's mineral output. In the metals sector, nickel and copper accounted for 63 per cent of the output and for a major part of the increased value of the metals; however, there were also important increases for zinc and silver. Gold production continued to decline and only accounted for 6 per cent of the province's metal output.

Production Changes From 1966 to 1967 For Leading Minerals of Ontario

	Per Cent Change	
	Quantity	Value
Copper	32.9	41.6
Iron Ore	7.4	8.1
Gold	−9.5	−9.4
Nickel	19.0	31.7
Platinum	1.6	6.6
Zinc	231.0	217.6
Structural Materials	..	0.1

.. Not applicable.

The increased copper production is attributed to increased output from the nickel-copper mines of the Sudbury area and of production from the Kidd Creek mine of Texas Gulf Sulphur Company near Timmins. A major expansion program by Inco and Falconbridge Nickel Mines, Limited will provide for production from six new mines in the Sudbury area by 1970. Both companies are expanding their smelting facilities to handle the increased mine output. The zinc-copper-lead concentrator of Texas Gulf Sulphur Company at Timmins was brought up to its 9,000-ton-a-day capacity in 1967. Production in concentrates was at an annual rate of about 250,000 tons of zinc, 50,000 tons of copper, 10,000 tons of lead and several million ounces of silver, making this one of the largest base-metal operations in Canada. Ontario's zinc production was more than three times greater than in 1966 and was the largest of any province. Copper, lead and silver output each was also significantly higher. Gold production continued to decline and the number of lode mines in operation decreased from 25 in 1966 to 19. Uranium exploration activity was evident in many areas, particularly in the Elliot Lake area and, to the east and north, in the Agnew Lake area. A uranium deposit of significant proportions in the latter area was under development by Kerr Addison Mines Limited, which had plans for production at a rate of some 3,000 tons of ore a day in 1971. The Sherman iron ore mine, near Timagami, completed preparation for mining and will be shipping pellets early in 1968. Steep Rock Iron Mines Limited company's production is now largely in pellet form. Ontario was again the leading silver-producing province. The large increase in production resulted mainly from substantial byproduct output at Texas Gulf's Kidd Creek Mine near Timmins which completed its first full year's operations. Helman Mines Limited produced asbestos on a pilot-scale basis in 1967 and completed plans to develop its Matheson property for regular production. Johns-Manville is also planning for asbestos production from its property near Timmins in 1968 at an estimated rated capacity of 25,000 tons a year.

QUEBEC

Quebec mineral production declined by $26.0 million to $737 million. There were declines for metals and structural materials and only a small increase for the nonmetals. Within the metals sector, declines occurred for gold, copper, lead, nickel and particularly for zinc. There were small increases for iron ore and silver. Metals accounted for 57 per cent of total value of mineral output. The principal strength in the nonmetals group was titanium dioxide; there was no significant increase for asbestos, which contributed 80 per cent to the value of this sector. The decline in output of structural materials reflected the downturn in construction following the increase of the previous year that was partly related to preparation for Expo 67.

Production Changes From 1966 to 1967 For Leading Minerals of Quebec

	Per Cent Change	
	Quantity	Value
Copper	−7.5	−2.0
Gold	−10.1	−10.0
Iron Ore	5.4	4.5
Molybdenum	6.5	−6.9
Zinc	−17.1	−20.5
Asbestos	−6.0	0.2
Structural Materials	..	−6.3

.. Not applicable.

Quebec maintained its position as Canada's second largest copper producer and exploration for new deposits was widespread. Exploratory work at two properties in the Gaspé area continued from the surface and underground. In Joutel Township, a new copper mine came into production and, in the Eastern Townships, D'Estrie Mining Company Ltd. was preparing for production near Stratford Place. A major exploration program was being conducted at the nickel property of New Quebec Raglan Mines Limited in the Cape Smith-Wakeham Bay area of Ungava. The pellet plant of Wabush Mines at Pointe Noire was increased in capacity from 5.9 million to 6 million tons annually. Two lode gold mines closed during the year. Output was interrupted in October at Canada's oldest operating molybdenum producer when a fire destroyed the mill of Molybdenite Corporation of Canada Limited at Lacorne. Many companies joined in the search for uranium with most of the activity concentrated in the Johan Beetz and St. Simeon areas on the north shore of the St. Lawrence River, and the Mistassini area, northeast of Chibougamau. In the Chibougamau district, the McAdam Mining Corporation Limited is planning an underground asbestos development program to assess fibre grade. The Asbestos Hill development in the Ungava area was suspended by Asbestos Corporation Limited pending a re-appraisal of the property. Aluminum Company of Canada, Limited announced the closing of its Wakefield magnesite plant that it had been operating at Wakefield since 1942. Titanium dioxide pigment facilities were expanded by Canadian Titanium Pigments Limited at Varennes and by Quebec Iron and Titanium Corporation at Sorel. A lower-than-usual growth rate in world markets resulted in production cutbacks at the Quebec smelters of Aluminum Company of Canada, Limited. A strike at the Baie Comeau smelter of Canadian British Aluminum Company Limited resulted in lower output because of the need to rehabilitate potlines.

NEW BRUNSWICK

New Brunswick's mineral output declined slightly by $534,000 to $89.7 million. This reflected contractions in both the metals and fuels sectors that more than cancelled a favourable increase for structural materials. Metals accounted for 75 per cent of total output; the decline in the value of this sector was largely attributable to decreases in lead and copper production. Zinc, which made up 66 per cent of the metals output, increased a small amount.

Near Bathurst, copper was produced as a byproduct of zinc mining at the No. 12 and the No. 6 mines of Brunswick Mining and Smelting Corporation Limited. The Wedge mine of Cominco Ltd. continued to ship ore to the mill of Heath Steele Mines Limited. Heath Steele prepared to expand production at its zinc-copper mine. Brunswick Mining and Smelting continued to be the province's major producer of base metals and byproduct silver. The company's wholly owned subsidiary, East Coast Smelting and Chemical Company Limited, began production of primary lead and zinc at Belledune, 20 miles north of Bathurst. Late in the year, Brunswick Mining and Smelting and Electric Reduction of Canada, Ltd. completed a phosphate fertilizer complex at Belledune to produce phosphoric acid and phosphate fertilizer using imported phosphate rock. Nigadoo River Mines Limited brought into production its lead-zinc-copper-silver mine and 1,000-ton mill near Bathurst.

Production Changes From 1966 to 1967 For Leading Minerals of New Brunswick

	Per Cent Change	
	Quantity	Value
Copper	−20.9	−16.2
Lead	−12.5	−18.0
Zinc	8.0	3.6
Coal	−6.7	−5.1
Structural Materials	..	13.1

.. Not applicable.

NOVA SCOTIA AND PRINCE EDWARD ISLAND

Production in Nova Scotia declined by $6 million to $79.0 million with decrease in all sectors but the fuels. Coal production, which accounted for 65 per cent of the province's value of mineral output, declined by a minor amount in quantity but a price increase raised the output value slightly. The decline in the nonmetals sectors was chiefly because of a reduction in output of gypsum and salt.

Production Changes From 1966 to 1967 For Leading Minerals of Nova Scotia and Prince Edward Island

	Per Cent Change	
	Quantity	Value
Barite	−13.8	−24.8
Gypsum	−17.2	−12.8
Salt	−0.8	12.1
Coal	−3.0	0.3
Structural Materials	..	−17.7

.. Not applicable.

A $7-million chemical complex to produce caustic soda, chlorine and related products is being planned for Point Tupper in the Canso Strait area and is scheduled to come on stream early in 1969. The plant is to be constructed by Canadian Industries Limited and Nova Soctia Pulp Limited. Gypsum output declined because of reduced export demand. Coal production continued its downward trend notwithstanding increasing government aid In an attempt to reduce coal production costs, the Bras d'Or Coal Company, Limited placed into operation the first long-wall coal production face in Canada that is equipped with powered roof supports and for which a shearer-type mining machine is used.

Prince Edward Island's mineral production consists of structural materials and were valued at $1.7 million in 1967.

NEWFOUNDLAND AND LABRADOR

This province's mineral production value increased by $22.0 million to $266.0 million. Metals accounted for 93 per cent of total output and for most of the increase. Iron ore is by far the most important mineral with its production value being 79 per cent of the provincial total in 1967. Copper, zinc and lead were the other principal metals. There was no fuels production.

The Tilt Cove mine of First Maritime Mining Corporation Limited closed but this was offset by the start of production at the company's Gull Pond mine near Badger. Consolidated Rambler Mines Limited completed expansion at its copper mine near Baie Verte. The largest producer of base metals was the Buchans mine of American Smelting and Refining Company. Iron Ore Company of Canada increased the capacity of its Carol concentrator from 7 million to 10 million tons and its Carol pellet plant from 5.5 million to 10 million tons annually. A plant for the production of magnesium hydroxide and calcined magnesia products from sea-water is being planned for the Stephenville area by Frederick J. Gormley Limited of Fredericton and Continental Ore Corporation of New York.

Production Changes From 1966 to 1967 For Leading Minerals of Newfoundland and Labrador

	Per Cent Change	
	Quantity	Value
Copper	1.5	7.6
Iron Ore	1.3	11.4
Lead	8.0	1.2
Zinc	−0.2	−4.2
Asbestos	10.3	10.0
Structural Materials	..	−24.9

.. Not applicable.

Section I – Production
Tables 1 to 11

TABLE 1

Mineral Production of Canada, 1966 and 1967

	Unit of Measure	1966		1967p	
		Quantity	$000	Quantity	$000
Metals					
Antimony	000lb	1,406	745	1,243	659
Bismuth	"	526	1,972	546	2,055
Cadmium	"	3,237	8,351	4,772	13,385
Calcium	"	249	245	622	591
Cobalt	"	3,511	7,108	3,724	7,399
Columbium (Cb_2O_5)	"	2,638	3,182	2,207	2,627
Copper	000 st	506	453,524	592	563,513
Gold	000 troy oz	3,319	125,177	2,986	112,719
Indium	000 oz	. .	. .	. .	. .
Iron ore	000 lt	36,331	431,659	37,788	467,063
Iron remelt	000 st	. .	17,421	. .	18,332
Lead	"	301	89,827	322	90,058
Magnesium	000 lb	13,446	4,176	17,369	4,950
Mercury	"	–	–	–	–
Molybdenum (Mo content)	"	20,596	34,671	21,224	37,874
Nickel	000 st	224	377,479	250	467,196
Platinum group	000 troy oz	396	32,370	403	34,587
Selenium	000 lb	575	2,791	752	3,467
Silver	000 troy oz	33,418	46,752	36,426	63,095
Tellurium	000 lb	72	470	82	530
Thorium	"	87	211	117	223
Tin	"	711	917	532	909
Titanium ore	000 st	–	–	–	–
Tungsten (WO_3)	000 lb	. .	. .	. .	. .
Uranium (U_3O_8)	"	7,864	54,335	7,448	49,238
Yttrium	"	21	130	160	1,690
Zinc	000 st	964	291,160	1,087	314,905
Total metals			1,984,673		2,257,065

TABLE 9 Production of Leading Minerals in

	Unit of Measure	Nfld.	P.E.I.	N.S.	N.B.	Quebec	Ontario
Petroleum	bbl	–	–	–	8,837	–	1,240,159
	$	–	–	–	26,511	–	3,908,318
Copper	st	19,689	–	40	5,608	159,088	269,855
	$	18,732,507	–	38,335	5,335,477	151,355,859	256,739,969
Nickel	st	–	–	–	–	1,679	190,684
	$	–	–	–	–	3,170,330	354,904,736
Iron ore	st	16,760,827	–	–	–	14,602,525	8,750,389
	$	210,025,224	–	–	–	136,263,587	99,144,399
Zinc	st	34,100	–	46	153,720	242,941	272,737
	$	9,882,180	–	13,203	44,548,213	70,404,291	79,039,259
Natural gas	Mcf	–	–	–	97,686	55,259	14,155,130
	$	–	–	–	83,127	7,247	5,378,731
Asbestos	st	63,000	–	–	–	1,260,468	1,600
	$	10,234,000	–	–	–	138,828,849	70,400
Sand and gravel	st	2,543,000	950,000	5,760,000	8,390,000	45,650,000	98,760,000
	$	2,380,000	1,404,000	7,630,000	4,450,000	21,350,000	70,670,000
Cement	st	90,003	–	196,113	228,214	2,207,966	2,720,929
	$	1,532,526	–	3,517,110	4,042,648	41,804,530	48,122,596
Gold	oz	24,497	–	–	1,632	841,245	1,502,590
	$	924,762	–	–	61,608	31,756,999	56,722,772
Stone	st	77,600	300,000	603,116	3,573,497	48,849,204	25,036,351
	$	94,700	300,000	1,679,265	3,222,818	53,176,475	36,624,829
Lead	st	23,500	–	393	45,361	2,095	5,055
	$	6,580,042	–	109,903	12,701,192	586,695	1,415,309
Coal	st	–	–	3,738,487	837,963	–	–
	$	–	–	51,681,004	7,489,617	–	–
Potash (K_2O)	st	–	–	–	–	–	–
	$	–	–	–	–	–	–
Elemental sulphur	st	–	–	–	–	–	447
	$	–	–	–	–	–	14,600
Silver	oz	1,056,734	–	89,238	2,785,198	4,921,250	15,582,832
	$	1,832,377	–	154,739	4,829,533	8,533,447	27,020,631
Uranium (U_3O_8)	lb	–	–	–	–	–	5,448,471
	$	–	–	–	–	–	39,237,508
Clay products	$	281,000	–	1,373,333	568,991	7,139,284	24,871,787
Molybdenum	lb	–	–	–	–	3,728,298	–
	$	–	–	–	–	6,575,733	–
Platinum metals	oz	–	–	–	–	–	402,200
	$	–	–	–	–	–	34,514,821
Salt	st	–	–	470,950	–	–	4,579,913
	$	–	–	4,152,500	–	–	20,240,156
Titanium dioxide	st	–	–	–	–	..	–
	$	–	–	–	–	23,704,420	–
Lime	st	–	–	–	3,172	309,568	931,456
	$	–	–	–	79,420	3,548,900	11,151,254
Cadmium	lb	–	–	–	52,412	377,280	1,874,980
	$	–	–	–	146,753	1,069,270	5,261,520
Gypsum	st	374,672	–	3,727,829	87,234	–	571,450
	$	936,680	–	7,100,355	244,990	–	1,451,000
Total leading minerals	$	263,435,998	1,704,000	77,449,747	87,830,898	699,275,916	1,176,504,595
Total all minerals	$	265,989,364	1,704,000	79,019,247	89,687,103	736,952,111	1,197,898,575
Leading minerals as % of all minerals		99.0	100.0	98.0	97.9	94.9	98.2

–Nil; . . Not available; p Preliminary.

Canada, by Provinces and Territories, 1967p

Manitoba	Sask.	Alberta	B.C.	Y.T.	N.W.T.	Total, Canada
5,585,375	92,538,966	231,543,449	19,652,975	–	677,937	351,247,698
13,940,358	211,174,248	613,126,177	40,803,579	–	779,775	883,758,966
29,459	22,738	–	81,921	3,675	226	592,299
28,027,719	21,632,992	–	77,939,139	3,496,395	215,016	563,513,408
55,543	162	–	2,112	–	–	250,180
104,827,800	305,856	–	3,987,456	–	–	467,196,178
–	–	–	2,208,661	–	–	42,322,402
–	–	–	21,630,124	–	–	467,063,334
35,629	30,205	–	112,766	4,413	200,000	1,086,557
10,325,302	8,753,286	–	32,679,698	1,299,214	57,960,000	314,904,646
–	49,975,781	1,181,806,329	225,467,026	–	40,589	1,471,597,800
–	5,996,091	162,279,035	24,801,373	–	17,116	198,562,720
–	–	–	72,640	3,000	–	1,400,708
–	–	–	13,365,000	513,000	–	163,011,249
12,060,000	8,100,000	14,920,000	24,770,000	–	–	221,903,000
8,140,000	5,335,000	14,310,000	22,460,000	–	–	158,129,000
406,564	280,039	880,586	703,942	–	–	7,714,356
8,390,839	6,801,520	17,910,266	14,279,419	–	–	146,401,454
51,905	49,721	119	116,528	16,963	380,745	2,985,945
1,959,414	1,876,968	4,492	4,398,932	640,353	14,373,124	112,719,424
1,836,507	–	180,444	3,196,040	–	–	83,652,759
2,872,699	–	702,122	5,739,382	–	–	104,412,290
1,926	1,000	–	102,332	7,401	132,500	321,563
539,375	280,000	–	28,652,840	2,092,164	37,100,000	90,057,520
–	2,008,147	3,601,559	1,207,686	1,912	–	11,395,754
–	3,620,962	12,418,414	7,534,128	15,791	–	82,759,916
–	2,578,200	–	–	–	–	2,578,200
–	77,346,000	–	–	–	–	77,346,000
4,853	40,923	2,220,000	56,000	–	–	2,322,223
77,000	1,452,887	66,600,000	1,877,000	–	–	70,021,487
647,824	642,272	12	5,492,062	3,769,533	1,439,124	36,426,079
1,123,327	1,113,700	21	9,523,235	6,468,370	2,495,441	63,094,821
–	2,000,000	–	–	–	–	7,448,471
–	10,000,000	–	–	–	–	49,237,508
501,700	1,231,470	4,121,742	3,460,112	–	–	43,549,419
–	–	–	17,495,609	–	–	21,223,907
–	–	–	31,297,937	–	–	37,873,670
–	1,070	–	–	–	–	403,270
–	72,175	–	–	–	–	34,586,996
25,800	91,145	134,150	–	–	–	5,301,958
647,000	1,671,000	1,911,650	–	–	–	28,622,306
–	–	–	–	–	–	..
–	–	–	–	–	–	23,704,420
44,441	–	65,626	–	–	–	1,354,263
739,214	–	1,219,172	–	–	–	16,737,960
202,821	134,032	–	1,076,479	53,673	1,000,000	4,771,677
567,898	375,290	–	3,014,141	150,284	2,800,000	13,385,156
133,770	–	–	225,000	–	–	5,119,955
353,510	–	–	675,000	–	–	10,761,535
183,033,155	359,039,445	894,603,091	348,118,495	14,675,571	115,740,472	4,221,411,383
186,635,303	368,512,637	997,184,075	360,405,737	14,675,571	115,740,472	4,414,404,195
98.1	97.4	89.7	96.1	100.0	100.0	95.8

TABLE 10 World Role of Canada as Producer

	Year		World Production	1
Nickel (mine production)	1967	st	456,315	Canada 250,180
		% of world total		55
Zinc (mine production)	1967	st	5,191,511	Canada 1,248,978
		% of world total		24
Asbestos	1966	st	3,360,000	Canada 1,489,055
		% of world total		44
Uranium (U_3O_8 concentrates) (Excludes communist nations)	1966	st	19,800	USA 9,483
		% of world total		48
Gypsum	1966	000 st	53,000	USA 9,647
		% of world total		18
Molybdenum (Excludes communist nations)	1966	st	62,650	USA 45,266
		% of world total		72
Titanium concentrates (ilmenite)	1966	st	2,888,700	USA 965,378
		% of world total		33
Lead (mine production)	1967	st	3,202,490	USSR 520,000
		% of world total		16
Aluminum (primary metal)	1967	st	8,474,183	USA 3,269,260
		% of world total		39
Platinum group metals (mine production)	1966	troy oz	2,960,000	USSR 1,700,000
		% of world total		57
Cobalt (mine production)	1966	st	22,100	Congo (Kinshasa) 12,453
		% of world total		56
Gold (mine production)	1966	troy oz	47,000,000	Rep. of S. Africa 30,879,700
		% of world total		66
Silver (mine production)	1966	troy oz	253,200,000	USA 43,668,988
		% of world total		17
Cadmium (smelter production)	1966	000 lb	27,800	USA 10,460
		% of world total		38
Iron ore	1967	000 lt	619,742	USSR 165,346
		% of world total		27
Magnesium	1967	st	206,600	USA 97,406
		% of world total		47
Copper (mine production)	1967	st	5,448,558	USA 950,000
		% of world total		17
Barite	1966	st	4,077,500	USA 1,006,965
		% of world total		25
Potash (K_2O equivalent)	1966	000 st	16,145,000	USA 3,320,000
		% of world total		21

Sources: For Canada, Dominion Bureau of Statistics. For other countries, nickel, zinc, aluminum, lead, copper cadmium, titanium concentrates, gypsum, gold, silver, barite, molybdenum and potash – U.S. Bureau

*Source: United States Bureau of Mines.

of Certain Important Minerals

Rank of the Six Leading Countries With % of World Total				
2	3	4	5	6
USSR 105,000 23	New Caledonia 67,856 15	USA 14,615 3	Rep. of S. Africa 6,300 1	Finland 3,300 –
USSR 565,000 11	USA 546,420 10	Peru 361,470 7	Japan 389,035 6	Mexico 255,433 5
USSR 925,000 28	Rep. of S. Africa 276,597 8	Southern Rhodesia 175,000 5	China 140,000 4	USA 125,928 4
Canada 3,932 20	Rep. of S. Africa 3,286 17	France 1,874 9	Gabon 600 3	Australia 330 2
Canada 5,976 11	France 5,512 10	USSR 4,850 9	Britain 4,804 9	Italy 3,638 7
Canada 10,298 16	Chile 5,220 8	Peru 835 1	South Korea 330 –	Japan 270 –
Australia 578,264 20	Canada* 524,773 18	Norway 407,546 14	Malaysia 130,364 5	Finland 129,588 4
Australia 406,927 13	Canada 339,701 11	USA 311,135 10	Mexico 184,852 6	Peru 174,376 5
USSR 1,270,000 15	Canada 975,439 12	Japan 421,189 5	Norway 399,633 5	France 398,166 5
Rep. of S. Africa 784,000 26	Canada 396,059 13	USA 51,432 2	Colombia 17,780 –	Japan 8,228 –
Morocco 2,198 10	Canada 1,756 8	Zambia 1,670 8	Finland 1,500 7	USSR 1,400 6
USSR 5,370,000 11	Canada 3,319,474 7	USA 1,803,420 4	Australia 912,385 2	Ghana 684,395 1
Mexico 41,983,529 17	Canada 33,417,874 13	Peru 32,841,243 13	USSR 27,000,000 11	Australia 18,278,000 7
USSR 4,200 15	Japan 3,307 12	Canada 3,237 12	France 1,048 4	Poland 950 3
USA 84,195 14	France 49,058 8	Canada 37,788 6	China 31,494 5	Sweden 27,824 4
USSR 45,000 22	Norway 31,400 15	Canada 8,685 4	Japan 7,438 4	Italy 6,996 3
USSR 850,000 16	Zambia 730,000 13	Chile 728,667 13	Canada 592,299 11	Rep. of the Congo 352,931 6
W. Germany 508,167 12	Mexico 321,306 8	USSR 250,000 6	Canada 221,376 5	Italy 190,411 5
USSR 2,800,000 17	West Germany 2,535,300 16	East Germany 2,204,600 14	France 2,105,410 13	Canada 1,990,053 12

and magnesium – American Bureau of Metal Statistics; asbestos, platinum group metals, uranium, cobalt, of Mines; Iron ore – American Iron and Steel Institute.

TABLE 11

Canada – Values Added of Commodity-Producing Industries, 1961 to 1965

($ millions)

	1961	1962	1963	1964	1965
Primary Industries					
Agriculture	1,613	2,322	2,568	2,199	2,535
Forestry	667	702	492	556	603
Fishing	111	131	130	149	160
Trapping	12	10	12	13	12
Mining	1,741	1,883	2,035	2,299	2,492
Electric power	840	876	912	970	1,036
Total	4,984	5,924	6,149	6,186	6,838
Secondary Industries					
Manufacturing	10,435	11,430	12,273	13,536	14,928
Construction	3,701	3,788	3,980	4,393	5,103
Total	14,136	15,218	16,253	17,929	20,031
Grand total	19,120[r]	21,142[r]	22,402[r]	24,115	26,869

[r] Revised

Section 2 - Trade
Tables 12 to 18

TABLE 12

Exports of Crude Minerals and Fabricated Mineral Products by Main Groups, 1966 and 1967

($ millions)

	1966	1967	Increase or decrease $ millions	Increase or decrease %
Ferrous				
Crude material	379.1	398.2	+ 19.1	+ 5.0
Fabricated material	273.8	286.0	+ 12.2	+ 4.5
Total	652.9	684.2	+ 31.3	+ 4.8
Nonferrous				
Crude material	555.0	617.7	+ 62.7	+ 11.3
Fabricated material*	1,040.3	1,170.0	+129.7	+ 12.5
Total	1,595.3	1,787.7	+192.4	+ 12.0
Nonmetals				
Crude material	259.4	274.7	+ 15.3	+ 5.9
Fabricated material	142.4	146.1	+ 3.7	+ 2.6
Total	401.8	420.8	+ 19.0	+ 4.7

TABLE 12 (Cont'd)

	1966	1967	Increase or decrease $ millions	%
Mineral fuels				
Crude material	444.2	537.1	+ 92.9	+ 20.9
Fabricated material	28.7	39.6	+ 10.9	+ 38.0
Total	472.9	576.7	+103.8	+ 21.9
Total minerals and products				
Crude material	1,637.7	1,827.7	+190.0	+ 11.6
Fabricated material	1,485.2	1,641.7	+156.5	+ 10.5
Total	3,122.9	3,469.4	+346.5	+ 11.1

*Includes gold.

Note: Crude materials include materials in primary stages of processing such as ores, metallic concentrates, milled asbestos, etc. Metallic waste and scrap are also included. Fabricated materials include all materials of minerals of mineral origin which have been fabricated to such an extent that they can be incorporated into a structure, machine, etc. They are products not useful in themselves, but are for incorporation into end products.

TABLE 13

Value of Imports of Crude Minerals and Fabricated Mineral Products, by Main Groups, 1966 and 1967

($ millions)

	1966	1967	Increase or Decrease $ millions	%
Ferrous				
Crude material	77.0	48.0	– 29.0	– 37.7
Fabricated material	491.2	551.0	+ 59.8	+ 12.2
Total	568.2	599.0	+ 30.8	+ 5.4
Nonferrous*				
Crude material	123.0	131.9	+ 8.9	+ 7.2
Fabricated material	281.8	269.0	– 12.8	– 4.5
Total	404.8	400.9	– 3.9	– 1.0
Nonmetals				
Crude material	63.4	66.2	+ 2.8	+ 4.4
Fabricated material	152.3	149.3	– 3.0	– 2.0
Total	215.7	215.5	– 0.2	– 0.1
Mineral fuels				
Crude material	458.1	521.8	+ 63.7	+ 13.9
Fabricated material	176.7	198.4	+ 21.7	+ 12.3
Total	634.8	720.2	+ 85.4	+ 13.5
Total minerals and products				
Crude material	721.5	767.9	+ 46.4	+ 6.4
Fabricated material	1,102.0	1,167.7	+ 65.7	+ 6.0
Total	1,823.5	1,935.6	+ 112.1	+ 6.1

* Includes gold, refined and unrefined.
See note bottom of Table 12 in respect to crude and fabricated materials.

TABLE 14

Value of Exports of Crude Minerals and Fabricated Mineral Products in Relation to Total Export Trade, 1966 and 1967

	1966		1967	
	$ Millions	% of Total	$ Millions	% of Total
Crude material	1,637.7	16.3	1,827.7	16.4
Fabricated material*	1,485.2	14.7	1,641.7	14.8
Total	3,122.9	31.0	3,469.4	31.2
Total exports* all products	10,070.6[r]	100.0	11,111.8	100.0

*Includes gold refined and unrefined which are considered non-trade items and not included in domestic exports.
[r] Revised from previously published figure.
(See note bottom of Table 12)

TABLE 15

Value of Imports of Crude Minerals and Fabricated Mineral Products in Relation to Total Import Trade, 1966 and 1967

	1966		1967	
	$ Millions	% of Total	$ Million	% of Total
Crude material	721.5	7.3	767.9	6.9
Fabricated material*	1,102.0	11.2	1,167.7	10.6
Total	1,823.5	18.5	1,935.6	17.5
Total imports* all products	9,866.4[r]	100.0	11,081.2	100.0

*Includes gold, refined and unrefined.
[r] Revised from previously published figure.
(See note bottom of Table 12)

TABLE 16

Value of Exports of Crude Minerals and Fabricated Mineral Products by Main Groups and Destination, 1967

($ millions)

	Britain	United States	Other Countries	Total
Ferrous materials and products	56.6	488.2	139.4	684.2
Nonferrous* materials and products	425.2	755.8	606.7	1,787.7
Nonmetallic mineral materials and products	22.6	220.6	177.6	420.8
Mineral fuels, materials and products	0.2	556.9	19.6	576.7
Total	504.6	2,021.5	943.3	3,469.4
Percentage	14.5	58.3	27.2	100.0

*Includes gold, refined and unrefined.
(See note bottom of Table 12)

TABLE 17

Value of Imports of Crude Minerals and Fabricated Mineral Products by Main Groups and Destination, 1967

($ millions)

	Britain	United States	Other Countries	Total
Ferrous materials and products	48.7	392.1	158.2	599.0
Nonferrous* materials and products	37.6	225.8	137.5	400.9
Nonmetallic mineral materials and products	12.7	152.7	50.2	215.6
Mineral fuels, materials and products	6.7	245.1	468.3	720.1
Total	105.7	1,015.7	814.2	1,935.6
Percentage	5.5	52.5	42.0	100.0

* Includes gold, refined and unrefined.
(See note bottom of Table 12)

TABLE 18

Value of Exports of Crude Minerals and Fabricated Mineral Products from Canada, by Commodity and Destination, 1967

($000)

	USA	Britain	Other (*) EFTA Countries	EEC(**) Countries	Japan	Other Countries	Total
Iron Ore	292,200	31,827	–	41,698	17,291	46	383,062
Primary ferrous metals	61,870	3,744	1	3,542	7,737	968	77,862
Aluminum	190,663	74,693	3,134	28,751	51,989	67,548	416,778
Copper	189,510	104,441	31,773	35,549	104,289	28,625	494,187
Lead	19,376	10,268	391	10,463	7,611	2,252	50,361
Nickel	220,748	121,838	51,233	15,048	14,989	9,423	433,279
Zinc	64,917	35,242	2,024	38,954	12,487	13,440	167,064
Molybdenum	2,722	12,211	1,086	16,135	8,572	1,016	41,742
Uranium	1,047	22,772	–	–	55	–	23,874
Asbestos	64,315	16,688	5,236	32,787	12,339	43,600	174,965
Fuels	556,885	182	23	18	18,034	1,499	576,641
All other minerals(†)	357,283	70,685	4,518	37,089	16,444	143,548	629,567
Total	2,021,536	504,591	99,419	260,034	271,837	311,965	3,469,382

(*) Other European Free Trade Countries: Norway, Sweden, Denmark, Switzerland, Austria and Portugal.
(**) European Economic Community (Common Market) Countries: France, West Germany, Italy, Belgium, Luxembourg and the Netherlands.
(†) Includes gold, refined and unrefined.
– Nil.
(See note bottom of Table 12 in respect to crude and fabricated materials.)

Section 3 · Consumption
Tables 19 to 22

TABLE 19

Reported Consumption of Minerals in Canada and Relation to Production, 1966

	Unit of Measure	Consumption	Production*	Consumption as % of Production
Metals				
Aluminum	st	243,065	889,915	27.3
Antimony	lb	1,098,162	1,405,681	78.1
Bismuth	lb	56,428	525,659	10.7
Cadmium	lb	170,605	3,236,862	5.3
Chromium (chromite)	st	64,550	–	–
Cobalt	lb	392,177	3,511,169	11.2
Copper	st	262,557	506,076	51.9
Lead	st	96,683	300,622	32.2
Magnesium	st	5,187	6,723	77.2
Manganese ore	st	152,536	–	–
Mercury	lb	171,588	–	–
Molybdenum (Mo content)	lb	1,448,888	20,596,044	7.0
Nickel	st	8,608	223,610	3.8
Selenium	lb	20,533	575,482	3.6
Silver	oz	21,303,704	33,417,874	63.7
Tellurium	lb	3,140	72,239	4.3
Tin	lt	4,972	317	1,568.5
Tungsten (W content)	lb	941,207	. .	. .
Zinc	st	110,481	964,106	11.5
Nonmetals				
Barite	st	15,184	221,376	6.9
Feldspar	st	11,503	10,924	105.3
Fluorspar	st	166,275	. .	. .
Mica	lb	2,750,000	540,720	508.6
Nepheline syenite	st	52,685	366,696	14.4
Phosphate rock	st	1,735,488	–	–
Potash (muriate of potash)	st	204,847	1,990,053	10.3
Sodium sulphate	st	333,550	405,314	82.3
Sulphur, elemental	st	813,111	2,041,528	39.8
Talc, etc	st	35,041	70,144	50.0
Fuels				
Coal	st	26,552,867	11,391,569	233.1
Natural gas	Mcf	635,508,883**	1,341,833,195	47.4
Petroleum, crude	bbl	378,743,448†	320,542,794	118.2

*Production for metals, in most cases, refers to production in all forms. This includes the recoverable metal content of ores, concentrates, matte, etc. exported and the 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.

**Sales in Canada.

†Refinery receipts (domestic and imported).

–Nil; . .Not available or not applicable.

TABLE 20

Reported Consumption of Minerals in Canada
and Relation to Production 1967

	Unit of Measure	Consumption	Production*	Consumption as % of Production
Metals				
Aluminum	st	217,494	975,439	22.3
Antimony	lb	1,190,179	1,243,000	95.8
Bismuth	lb	47,894	546,336	8.8
Cadmium	lb	154,761	4,771,677	3.2
Chromium (chromite)	st	70,549	–	–
Cobalt	lb	293,086	3,724,355	7.9
Copper	st	224,400	592,299	37.9
Lead	st	93,953	321,563	29.2
Magnesium	st	5,054	8,685	58.2
Manganese ore	st	137,395	–	–
Mercury	lb	245,121	–	–
Molybdenum (Mo content)	lb	1,430,895	21,223,907	6.7
Nickel	st	8,767	250,180	3.5
Selenium	lb	22,370	752,221	3.0
Silver	oz	14,576,608	36,426,079	40.0
Tellurium	lb	1,005	82,098	1.2
Tin	lt	4,812	237	2,030.4
Tungsten (W content)	lb	891,411	. .	. .
Zinc	st	110,487	1,086,557	10.2
Nonmetals				
Barite	st	12,781	199,576	6.4
Feldspar	st	9,021	10,555	85.5
Fluorspar	st	155,349	. .	. .
Mica	lb	2,758,000	. .	. .
Nepheline syenite	st	50,286	401,601	12.5
Phosphate rock	st	2,275,067	–	–
Potash (muriate of potash)	st	194,681	2,578,200	7.6
Sodium sulphate	st	284,645	425,033	67.0
Sulphur, elemental	st	743,278	2,322,223	32.0
Talc, etc	st	33,893	59,400	57.1
Fuels				
Coal	st	25,878,083	11,395,754	227.1
Natural gas	Mcf	697,586,005	1,471,597,800	47.4
Petroleum, crude	bbl	387,718,614	351,247,698	110.4

* Production for metals, in most cases, refers to production in all forms. This includes the recoverable metal content of ores, concentrates, matte, etc., exported and the metal content of primary products recoverable of domestic smelters and refineries. Production of non-metals refers to producers' shipments. For fuels, production is equivalent to actual output less waste.

–Nil; . . Not available or not applicable.

TABLE 21

Apparent Consumption of Minerals in Canada
and Its Relation to Production, 1966

	Unit of Measure	Apparent Consumption*	Production**	Consumption as % of Production
Asbestos	st	49,453	1,489,055	3.3
Cement	st	8,573,772	8,930,552	96.0
Gypsum	st	1,389,559	5,976,164	23.3
Iron ore	lt	9,960,379	36,331,003	27.4
Lime	st	1,403,422	1,555,037	90.3
Quartz (silica)	st	3,157,195	2,299,660	137.3
Salt	st	3,764,000[e]	4,492,034	83.8

*Production plus imports and less exports. Consumption of these commodities as reported by consumers is not readily available.

**Producers' shipments.

[e] Estimated.

TABLE 22

Apparent Consumption of Minerals in Canada
and Its Relation to Production, 1967

	Unit of Measure	Consumption*	Production**	Consumption as % of Production
Asbestos	st	65,957	1,400,708	4.7
Cement	st	7,430,456	7,714,356	96.3
Gypsum	st	1,292,933	5,119,955	25.3
Iron ore	lt	8,781,998	37,787,859	23.2
Lime	st	1,286,251	1,354,263	95.0
Quartz (silica)	st	3,130,731	2,234,330	140.1
Salt	st	4,290,000[e]	5,301,958	80.9

*Production plus imports and less exports. Consumption of these commodities as reported by consumers is not readily available.

**Producers' shipments.

[e] Estimated.

TABLE 23

Domestic Consumption of Principal Refined Metals(a) in Relation to Production(b) in Canada, 1958-67

	Unit of Measure	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Copper											
Domestic consumption(c)	st	122,893	129,973	117,637	141,808	151,525	169,750	202,225	224,684	262,557	224,398
Production	st	329,239	365,366	417,029	406,359	382,862	380,075	407,942	434,133	433,921	500,020
% Consumption of production		37.3	35.6	28.2	34.9	39.6	44.7	49.6	51.8	60.5	44.9
Zinc											
Domestic consumption(d)	st	56,097	64,788	55,803	60,878	65,320	73,653	88,494	93,796	107,052[r]	107,779
Production	st	252,093	255,306	260,968	268,007	280,158	284,021	337,728	358,498	382,612	405,098
% Consumption of production		22.3	25.4	21.4	22.7	23.3	25.9	26.2	26.2	28.0	26.6
Lead											
Domestic consumption	st	69,769	65,935	72,087	73,418	77,286	77,958	82,736	90,168	96,683[r]	93,953
Production	st	132,987	135,296	158,510	171,833	152,217	155,000	151,372	186,484	184,871	194,814
% Consumption of production		52.5	48.7	45.5	42.7	50.8	50.3	54.7	48.4	52.3	48.2
Aluminum											
Domestic consumption(g)	st	101,886	114,344	120,831	135,575	151,893	166,833	172,443	213,094	243,065	217,484
Production	st	634,102	593,630	762,012	663,173	690,297	719,390	842,640	830,505	889,915[r]	975,439
% Consumption of production		16.1	19.3	15.9	20.4	22.0	23.2	20.5	25.7	27.3	22.3

(a) Refined metal of primary and secondary origins. (b) Refined metal from all sources, including metal derived from secondary materials at primary refineries. (c) Producers' domestic shipments. (d) Primary refined zinc only. (g) Producers' domestic shipments – primary aluminum, 1958; primary and secondary aluminum consumption for 1959 and thereafter.

[r] Revised.

Section 4 · Prices
Tables 24 to 27

TABLE 24

Annual Averages of Prices of Main Minerals * 1966 and 1967

	Unit of Measure	Average 1966	Average 1967	Increase or Decrease Cents or Dollars	Increase or Decrease %
Aluminum ingot 99.5 %	cents/lb	24.500	25.000	+ 0.500	+ 2.0
Antimony, RMM f.o.b.					
Loredo, Texas	cents/lb	44.000	44.000	–	–
Bismuth, ton lots delivered	$/lb	4.000	4.000	–	–
Cadmiun	cents/lb	246.608	264.722	+ 18.114	+ 7.3
Calcium, ton lots, crowns	$/lb	0.95	0.95	–	–
Chromium metal, 98.5%, .05% C	$/lb	1.03	0.97	– 0.06	– 5.8
Cobalt metal, 500 lb lots	$/lb	1.650	1.850	+ 0.200	+ 12.1
Copper, U.S. domestic,					
f.o.b. refinery	cents/lb	36.170	38.226**	+ 2.056	+ 5.6
Gold, Canadian dollars	$ troy oz	37.71	37.75	+ 0.04	+ 0.1
Iron ore, 51.5% Fe, lower					
lake ports					
Bessemer					
Mesabi	$/lt	10.70	10.70	–	–
Old Range	$/lt	10.95	10.95	–	–
Non-Bessemer					
Mesabi	$/lt	10.55	10.55	–	–
Old Range	$/lt	10.80	10.80	–	–
Lead, common, New York	cents/lb	15.115	14.000	– 1.115	– 7.4
Magnesium, ingot	cents/lb	35.250	35.250	–	–
Mercury	$ flask (76 lb)	441.719	489.355	+ 47.636	+ 10.8
Molybdenum metal	$/lb	3.35	3.66	+ 0.31	+ 9.3
Molybdenite, 95% MoS_2					
contained Mo	$/lb	1.55	1.62	+ 0.07	+ 4.5
Nickel, f.o.b. Port Colborne					
(duty incl.)	cents/lb	78.900	87.774	+ 8.874	+ 11.2
Platinum	$/troy oz	99.167	108.509	+ 9.342	+ 9.4
Selenium	$/lb	4.50	4.50	–	–
Silver, New York	cents/troy oz	129.300	155.012	+ 25.712	+ 19.9
Tin, straits, New York	cents/lb	164.070	153.434	– 10.636	– 6.5
Titanium metal, 500 lb lots 99.3%	$/lb	1.32	1.32	–	–
Titanium ore (ilmenite) 54% TiO_2	$/st	21-24	21-24	–	–
Tungsten metal	$/st	2.75	2.75	–	–
Zinc, prime western, East					
St. Louis	cents/lb	14.500	13.843	– 0.657	– 4.5

* These prices, except for gold are in United States currency and are from Metals Week.

**Average 1st eight months. Price quotes suspended September through December.

–Nil.

TABLE 25

Wholesale Price Indexes of Minerals and Mineral Products, Canada, 1957 and 1965-67

(1935-39 = 100)

	1957	1965	1966	1967
Iron and products	252.7	264.5	268.0	274.4
Pig iron	293.6	289.1	290.3	289.9
Rolling mill products	241.3	260.2	263.0	264.0
Pipe and tubing	256.2	281.8	294.7	291.4
Wire	290.3	288.2	295.0	300.5
Scrap iron and steel	375.0	300.5	282.7	263.5
Tinplate and galvanized sheet	238.3	248.9	252.5	256.7
Nonferrous metals and products				
Total (including gold)	176.0	217.6	229.9	240.2
Total (excluding gold)	240.7	306.1	328.2	346.6
Antimony	169.6	412.9	362.9	. .
Copper and products	277.3	360.8	425.0	446.9
Lead and products	290.6	323.9	312.2	293.2
Silver	224.8	360.2	360.0	425.8
Tin	177.3	367.8	339.1	317.3
Zinc and products	261.3	329.3	329.5	315.9
Solder	203.5	335.7	319.4	304.0
Nonmetallic minerals and products	189.3	191.6	193.7	199.2
Clays and clay products	239.5	243.4	247.1	251.7
Pottery	174.6	240.4	250.8	258.2
Coal	193.4	200.9	201.8	204.7
Coal tar	320.6	229.4	219.5	248.0
Coke	241.0	265.5	268.0	278.8
Window glass	270.2	320.0	342.1	350.3
Plate glass	217.0	284.3	292.1	292.1
Petroleum products	174.5	159.8	160.2	162.3
Crude oil	. .	192.0	191.6	191.7
Gasoline	143.0	126.4	127.1	. .
Coal oil	138.7	134.1	134.1	134.2
Asphalt	212.6	198.6	197.7	197.7
Asphalt shingles	167.9	92.1	93.3	101.9
Sulphur	204.3	226.2	271.5	342.6
Plaster	134.8	147.7	149.0	163.0
Lime	211.0	227.1	236.2	246.3
Cement	158.9	172.8	177.0	186.4
Sand and gravel	150.1	143.6	143.2	148.6
Crushed stone	164.8	158.3	160.4	162.1
Building stone	205.1	211.2	221.6	232.4
Asbestos	292.6	319.7	326.2	339.0
General wholesale price index (all products)	227.4	250.4	259.5	264.1

. . Not available

TABLE 26

General Wholesale Price Index and Wholesale Price Indexes of Mineral and Non-Mineral Industries, Canada, 1943–1967

(1935–39 = 100)

	Mineral Products Industries			Non-Mineral Products Industries					
	Iron Products	Non-ferrous Metal Products	Non-Metallic Mineral Products	Vegetable Products	Animal Products	Textile Products	Wood Products	Chemical Products	General Wholesale Price Index
1943	116.8	107.8	115.6	123.5	146.9	130.8	142.2	125.3	127.9
1944	117.8	107.8	114.3	129.1	146.6	130.7	151.6	124.9	130.6
1945	117.9	107.6	113.5	131.6	150.0	130.8	154.9	124.0	132.1
1946	127.4	108.0	114.5	134.2	160.2	137.9	172.1	120.3	138.9
1947	140.7	130.2	129.1	157.3	183.0	179.5	208.8	136.7	163.3
1948	161.4	146.9	150.8	185.7	236.7	216.3	238.3	152.2	193.4
1949	175.5	145.2	158.3	190.5	237.5	222.5	241.6	155.2	198.3
1950	183.6	159.5	164.8	202.0	251.3	246.7	258.3	157.8	211.2
1951	208.7	180.6	169.8	218.6	297.7	295.9	295.9	187.3	240.2
1952	219.0	172.9	173.9	210.3	248.2	251.5	291.0	180.1	226.0
1953	221.4	168.6	176.9	199.0	241.7	239.0	288.6	175.7	220.7
1954	213.4	167.5	177.0	196.8	236.0	231.1	286.8	176.4	217.0
1955	221.4	187.6	175.2	195.1	226.0	226.2	295.7	177.0	218.9
1956	239.8	199.2	180.8	197.3	227.7	230.2	303.7	180.1	225.6
1957	252.7	176.0	189.3	197.0	238.4	236.0	299.4	182.3	227.4
1958	252.6	167.3	188.5	198.1	250.7	229.0	298.5	183.0	227.8
1959	255.7	174.6	186.5	199.5	254.3	228.0	304.0	187.0	230.6
1960	256.2	177.8	185.6	203.0	247.6	229.8	303.8	188.2	230.9
1961	258.1	181.6	185.2	203.1	254.7	234.5	305.1	188.7	233.3
1962	256.2	192.1	189.1	211.6	262.5	241.2	315.9	190.5	240.0
1963	253.6	197.5	189.5	227.8	255.6	248.0	323.4	189.3	244.6
1964	256.4	205.9	190.9	223.3	250.8	248.4	330.9	191.2	245.4
1965	264.5	217.6	191.6	218.4	270.7	246.6	334.0	200.2	250.4
1966	268.0	229.9	193.7	225.9	296.2	251.5	337.8	207.1	259.5
1967P	274.4	240.2	199.2	230.9	293.1	252.7	346.3	212.6	264.1

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TABLE 27

Industry Selling Price Indexes Mineral Based Industries, Canada

(1956 = 100)

	1964	1965	1966	1967
Iron and Steel Products Industries				
Agricultural implements industry	116.8	117.4	121.5	123.5
Hardware, tools and cutlery industry	116.1	120.2	124.7	129.1
Heating and cooking apparatus industry	94.3	93.5	92.2	93.7
Machinery, household, office and store industry	99.5	99.9	100.1	101.4
Castings, iron industry	107.7	110.6	113.8	117.5
Pig iron industry	104.3	104.1	104.3	104.3
Steel ingots and castings industry	120.3	122.2	122.4	128.0
Rolled iron and steel products industry	106.1	108.6	109.4	111.2
Wire and wire goods industry	106.6	109.6	110.6	111.4
Non-ferrous metal products industries				
Aluminum products industry	107.8	110.6	111.7	112.8
Brass and copper products industry	90.3	100.8	115.7	120.7
Jewellery and silverware industry	131.8	133.2	138.6	157.6
Non-ferrous metal smelting and refining industry	109.7	112.9	114.9	119.2
White metal alloys industry	104.4	118.7	120.1	116.6
Non-metallic mineral products industries				
Abrasives, artificial, industry	115.8	115.9	119.4	123.0
Cement, hydraulic industry	112.3	115.4	121.8	128.2
Clay products from imported clay industry	107.7	112.1	115.9	117.5
Glass and glass products industry	110.1	109.3	111.9	114.2
Lime industry	111.8	114.6	116.1	117.6
Gypsum products industry	107.2	107.9	109.2	114.3
Concrete products industry	102.4	105.5	110.9	114.2
Clay products from domestic clay industry	109.6	111.0	114.3	118.7
Coke and gas products industry	111.8	112.3	113.3	116.6
Petroleum refining and products industry	95.1	93.2	93.5	94.2
Lubricating oils and greases industry	117.9	118.2	120.9	124.8
Fertilizers industry	105.8	107.5	108.6	111.5

Industry selling price indexes are wholesale price indexes organized according to the Standard Industrial Classification.

TABLE 28

Principal Statistics of the Mineral Industry by Sectors, 1963

	Establish-ments	Employees	Salaries and Wages	Cost of Fuel and Electricity	Cost of Process Supplies Ores, Concentrates and Containers	Gross Value of Produc-tion	Net Value of Production
	No.	No.	$000	$000	$000	$000	$000
Metallics							
Placer gold	30	210	1,222	71	121	2,202	1,950
Gold	122	15,120	63,095	6,734	19,147	126,903	99,259
Copper-gold-silver	176	11,536	58,514	7,010	19,882	229,873	150,193
Silver-cobalt	21	705	3,004	346	413	6,957	5,592
Silver-lead-zinc	61	4,636	24,886	3,721	8,689	125,778	70,253
Nickel-copper	26	12,110	68,080	4,220	17,414	112,121	85,524
Iron	48	9,993	65,647	14,150	32,621	305,372	215,044
Other	35	4,468	27,925	4,755	19,752	144,413	118,642
Total	519	58,778	312,373	41,007	118,039	1,053,619	746,457
Industrial Minerals							
Asbestos	17	6,823	35,508	7,638	16,274	141,998	118,086
Feldspar, quartz, nepheline syenite	20	381	1,564	343	686	6,332	5,302
Gypsum	9	680	2,876	449	2,268	9,846	7,130
Salt	11	955	4,567	1,199	3,256	22,441	17,985
Sand and gravel	331	2,266	9,250	3,170	487	42,537	38,881
Stone	207	3,452	14,046	3,768	5,954	48,767	39,045
Clay products	89	3,519	14,319	5,406	4,966	37,565	27,193
Cement	20	3,566	20,559	17,920	16,292	122,028	87,816
Lime	21	886	4,058	2,427	2,211	14,915	10,277
Other	92	2,934	11,252	3,047	4,919	46,950	38,631
Total	817	25,462	117,999	45,367	57,313	493,379	390,346
Fuels							
Coal	97	8,903	35,624	3,731	13,011	71,295	54,553
Petroleum & natural gas*	634	5,840	36,397	10,533	10,785	811,101	789,783
Total	731	14,743	72,021	14,264	23,796	882,396	844,336
Total Mining Industry	2,067	98,983	502,393	100,638	199,148	2,429,394	1,981,139
Non-ferrous smelting and refining	23	28,644	160,118	46,038	918,660	1,520,160	555,462

*Includes natural gas processing.

TABLE 29

Principal Statistics* of the Mining Industry**, 1960–63

	Establish-ments	Employees	Salaries and Wages	Cost of Fuel and Electricity	Cost of Process Supplies, Ores, Concentrates and Containers	Gross Value of Production	Net Value of Production†
	No.	No.	$000	$000	$000	$000	$000
1960	2,473	103,556	480,011	89,219	180,760	1,972,796	1,560,682
1961	2,483	99,644	469,983	87,792	162,717	2,057,452	1,671,549
1962	2,221	98,959	485,984	94,515	180,319	2,279,854	1,867,920
1963	2,067	98,983	502,393	100,638	199,148	2,429,394	1,981,139

* Commencing in 1960 certain changes in the industrial classification of industries were made by the Dominion Bureau of Statistics. The definition of establishment was changed to include only that establishment considered a separate accounting unit, capable of reporting employment, salaries and wages, etc., on a unit basis. This substantially reduced the number of establishments in comparison with previous years. Also, some companies formerly included in the mining industry were transferred to other industries (manufacturing, construction, etc.) if their main revenue-producing activity was not mining.

** Does not include smelting and refining industries.

† Net value equals gross value of production less cost of process supplies, ores, concentrates, containers, treatment charges, freight, fuel and electricity.

TABLE 30

Principal Statistics of the Nonferrous Smelting and Refining Industries, 1960–63

	Establish-ments	Employees	Salaries	Cost of Fuel and Electricity	Cost of Process Supplies, Ores, Concentrates and Containers	Gross Value of Production	Net Value of Production
	No.	No.	$000	$000	$000	$000	$000
1960	22	30,024	155,415	50,787	896,613	1,506,008	558,608
1961	24	29,527	157,475	49,000	891,951	1,471,048	530,097
1962	23	29,303	159,439	45,703	915,967	1,549,049	582,653
1963	23	28,644	160,118	46,038	918,660	1,520,160	555,462

Note: See footnotes to Table 29 for references to changes in statistical classification and definition of net value of production.

TABLE 31

Consumption of Fuel and Electricity in the Canadian Mineral Industry, 1963

	Unit	Metal Mining	Nonferrous Smelting and Refining	Total	Production of Industrial Minerals	Production of Crude Mineral Fuels	Total Mineral Industry
Coal and coke	st	113,395	895,469	1,008,864	850,881	4,117	1,863,862
	$	1,788,706	13,495,225	15,283,931	8,907,179	33,964	24,225,074
Gasoline and kerosene	gal.	4,004,419	1,026,669	5,031,088	9,865,703	7,547,855	22,444,646
	$	1,454,530	300,569	1,755,099	3,321,066	2,350,271	7,426,436
Fuel oil	gal.	72,935,299	60,402,546	133,337,845	103,534,915	4,414,843	241,287,603
	$	11,580,263	5,159,394	16,739,657	11,290,960	870,813	28,901,430
Liquefied petroleum gas	gal.	285,845	674,247	960,092	246,149	1,068,170	2,274,411
	$	108,968	142,642	251,610	66,936	195,319	513,865
Natural gas	Mcf	651,323	14,736,545	15,387,868	23,839,128	23,088,699	62,315,695
	$	372,439	5,078,557	5,450,996	7,648,182	2,560,006	15,659,184
Other fuels	$	246,207	87,900	334,107	199,577	376,763	910,447
Total fuels	$	15,551,113	24,264,287	39,815,400	31,433,900	6,387,136	77,636,436
Electricity purchased	mil. kwh	3,711	5,215	8,926	1,766	602	11,294
	$	25,456,160	21,774,100	47,230,260	13,932,584	7,877,007	69,039,851
Total value, fuels and electricity purchased	$	41,007,273	46,038,387	87,045,660	45,366,484	14,264,143	146,676,287
Electricity generated by industry for own use	mil. kwh	432	13,735	14,167	36	47	14,250

TABLE 32

Cost of Fuel and Electricity Used in the
Canadian Mining Industry*, 1957-63

		1957	1958	1959	1960	1961	1962	1963
Fuel**	$ million	53.1	53.1	53.1	48.8	46.3	50.4	53.3
Electricity Purchased	million kwh	4,586	4,993	5,164	5,195	5,084	5,377	6,079
	$ million	35.8	38.1	39.5	42.8	41.5	44.1	47.3
Total Cost of Fuel and Electricity	$ million	88.9	91.2	92.6	91.6	87.8	94.5	100.6
Electricity Generated for Own Use	million kwh	590	527	551	575	581	638	515
Electricity Generated for Sale	million kwh	14	16	17	33	29	31	33

*Excludes non-ferrous smelting and refining.

**Coal, coke, fuel oil, gasoline, gas, wood.

Note: Total cost of fuel and electricity for year 1960, as shown in the above table, does not agree with later revised total for that year, as shown in Table 29.The overall costs of fuel and electricity were revised for that year, but the individual components (fuel and electricity) were not. It is, therefore, not possible to show the components, fuel and electricity, in a revised form for the year 1960 to agree with the total reported in Table 29.

TABLE 33

Cost of Fuel and Electricity Used in the
Nonferrous Smelting and Refining Industry*, 1957-63

		1957	1958	1959	1960	1961	1962	1963
Fuel**	$ million	27.3	23.4	26.3	26.9	27.2	24.8	24.2
Electricity Purchased	million kwh	13,668	15,081	14,575	18,225	5,389	5,046	5,215
	$ million	32.2	40.1	36.0	36.3	21.8	20.9	21.8
Total Cost of Fuel and Electricity Purchased	$ million	59.5	63.5	62.3	63.2	49.0	45.7	46.0
Electricity Generated for Own Use	million kwh	1,037	1,038	1,060	1,146	12,851	12,688	13,735
Electricity Generated for Sale	million kwh	–	33	31	33	36	3	3

*Coal, coke, fuel oil, gasoline, gas, wood.

**Commencing in 1961, changes in statistical classifications account for decreases in electricity purchased and increases in electricity generated for own use.

Note: See footnote Table 32 for explanation of differences between total values of fuel and electricity for 1960 as shown in above table and as reported in Table 30.

–Nil.

Section 6 - Employment, Salaries & Wages

Tables 34 to 43

TABLE 34

Employment, Salaries and Wages in the Canadian Mineral Industry
1946, 1951, 1956, 1961, 1963

	1946		1951		1956		1961		1963	
	Employees	$ million	Employees	$ million	Employees	$ million	Employees	$ million	Employees	$ million
Metal mining	35,445	77.5	52,271	170.9	57,564	243.0	59,597	298.8	58,778	312.4
Non-ferrous smelting and refining	14,546	30.6	22,814	75.5	30,788	130.1	29,527	157.5	28,644	160.1
Industrial minerals	20,500	31.5	25,296	69.7	30,021	107.1	24,685	107.5	25,462	118.0
Fuels*	28,705	57.1	28,490	81.1	24,187	85.8	15,362	63.7	14,743	72.0
Total	99,196	196.7	128,871	397.2	142,560	566.0	129,171	627.5	127,627	662.5
Annual averages of salaries and wages $	1,983		3,082		3,971		4,858		5,191	

*Coal, crude petroleum and natural gas (including natural gas processing after 1960).

TABLE 35

Number of Wage Earners-Surface, Underground and Mill-Canadian Mining Industry*, by Sectors, 1957-63.

	1957	1958	1959	1960	1961	1962	1963
Metallics**							
Surface	18,532	16,602	16,697	16,039	15,815	15,197	14,615
Underground	29,382	29,712	31,384	30,774	28,975	27,959	26,334
Mill	6,168	6,541	6,573	6,162	6,047	6,504	7,802
Total	54,082	52,855	54,654	52,975	50,837	49,660	48,751
Industrial Minerals							
Surface	14,347	14,029	13,988	10,321	9,485	9,656	9,464
Underground	1,749	1,458	1,327	1,164	995	951	879
Mill	11,573	11,216	11,639	10,741	10,511	10,770	10,561
Total	27,669	26,703	26,954	22,226	20,991	21,377	20,904
Fuels							
Surface	8,683	7,887	7,537	6,715	5,786	5,585	5,537
Underground	10,043	9,247	8,022	8,257	7,439	6,678	6,276
Mill	–	–	–	–	–	–	–
Total	18,726	17,134	15,559	14,972	13,225	12,263	11,813
Total							
Surface	41,562	38,518	38,222	33,075	31,086	30,438	29,616
Underground	41,174	40,417	40,733	40,195	37,409	35,588	33,489
Mill	17,741	17,757	18,212	16,903	16,558	17,274	18,363
Total	100,477	96,692	97,167	90,173	85,053	83,300	81,468

*Does not include nonferrous smelting and refining.

**Include placer operations.

–Nil.

TABLE 36

Labour Costs in Relation to Tons Mined from Metal Mines,
1945, 1955, 1963 – 1964

Types of Metal Mines	Number of Wage Earners	Total of Wages	Average Annual Wage	Tons Mined	Average Annual tons mined per worker	Wage Cost per ton mined
		($ millions)	($)	(000 st.)	s t	($)
1964						
Auriferous quartz	11,843	51.1	4,314	12,758	1,077	4.00
Copper-gold-silver	8,815	44.7	5,067	20,202	2,292	2.21
Nickel-copper	11,546	61.4	5,316	20,419	1,769	3.00
Silver-cobalt	559	2.3	4,081	253	453	9.00
Silver-lead-zinc	4,221	21.8	5,162	8,923	2,114	2.44
Iron ore	6,696	44.8	6,696	72,795	~~1,087~~ 10,871	0.62
Miscellaneous	2,872	17.4	6,065	5,901	2,055	2.95
Total	46,552	243.5	5,230	141,251	3,034	1.72
1963r						
Auriferous quartz	12,456	51.0	4,093	12,618	1,013	4.04
Copper-gold-silver	8,874	43.6	4,916	19,764	2,227	2.21
Nickel-copper	10,425	55.9	5,359	17,629	1,691	3.17
Silver-cobalt	545	2.2	4,079	307	563	7.24
Silver-lead-zinc	3,704	18.9	5,105	5,796	1,565	3.26
Iron ore	6,478	41.2	6,366	60,071	~~927~~ 9273	0.69
Miscellaneous	3,564	21.9	6,142	7,693	2,159	2.85
Total	46,046	234.7	5,098	123,878	2,690	1.89
1955						
Auriferous quartz	16,168	55.0	3,403	16,405	1,015	3.35
Copper-gold-silver	7,644	29.8	3,896	9,912	1,297	3.00
Nickel-copper	9,943	42.7	4,296	17,022	1,712	2.51
Silver-cobalt	663	2.2	3,279	303	457	7.18
Silver-lead-zinc	5,485	21.5	3,912	7,526	1,372	2.85
Iron ore	4,265	15.9	3,735	17,220	4,038	0.93
Miscellaneous	2,229	9.9	4,461	801	359	12.42
Total	46,397	177.0	3,815	69,189	1,491	2.56
1945						
Auriferous quartz	15,807	31.2	1,974	9,781	619	3.19
Copper-gold-silver	4,033	8.0	1,976	5,915	1,467	1.35
Nickel-copper	5,559	11.7	2,101	10,855	1,953	1.08
Silver-cobalt	147	0.2	1,394	30	208	6.72
Silver-lead-zinc	2,119	4.5	2,141	3,087	1,457	1.47
Iron ore						
Miscellaneous	807	1.7	2,127	1,605	1,989	1.07
Total	28,472	57.3	2,013	31,273	1,098	1.83

r = revised.

TABLE 37

Man-Hours Worked of Production and Related Workers, and Tons of Ore Mined and Rock Quarried for Metal Mines and Industrial Mineral Operations 1961 to 1964 incl.

		1961	1962	1963	1964
Metal Mines*					
Ore mined paid	million s t	99.4	114.3✓	~~123.9~~ 124.3	~~141.3~~ 141.1
Man-hours ~~worked~~†	millions	~~101.7~~ 101.2	~~99.9~~ 99.4	~~100.2~~ 99.7	~~102.0~~ 100.7
Man-hours worked per ton mined	number	~~1.26~~ 1.02	~~1.09~~ 0.87	~~0.99~~ 0.80	~~0.71~~ 0.71
Industrial Mineral Operations**					
Ore mined and rock quarried	million s t	94.6	100.9	119.0	132.9
Man-hours worked†	millions	26.9	27.2	27.6	24.1
Man-hours worked per ton mined	number	0.28 ✓	0.27 ✓	0.23 ✓	0.18 ✓

*Excludes placer mining.

**Excludes salt, cement, clay products, stone for cement and lime manufacture.

†Man-hours worked by production and related workers only.

	1965	1966
Metal mines		
Ore mined	166.5	162.8
Man hrs paid	106.4	101.4
Mn hrs per ton mined	0.64	0.62

TABLE 38

Basic Wage Rates per Hour in Canadian Metal Mining Industry on October 1st, 1966 and 1967

	Gold Mining		Iron Mining		Other Metal Mining	
	1966	1967	1966	1967	1966	1967
	$	$	$	$	$	$
Underground workers						
Cage and skiptenders	1.90	2.00	..	..	2.54	2.69
Chute blaster	1.81	1.93	..	..	2.66	2.84
Deckman	1.78	1.89	..	..	2.28	2.49
Hoistman	2.03	2.10	..	..	2.73	2.89
Labourer	1.75	1.84	..	..	2.30	2.49
Miner	1.91	2.04	2.85	3.16	2.56	2.73
Miner's helper	1.74	1.82	..	..	2.15	2.28
Motorman	1.81	1.87	..	..	2.54	2.66
Mucking machine operator	1.81	1.92	..	..	2.54	2.64
Mucker and trammer	1.76	1.90	..	..	2.50	2.65
Timberman	1.91	2.04	..	..	2.63	2.77
Trackman	1.87	1.98	..	..	2.56	2.72
Open-pit workers						
Blaster	..	..	2.74	2.92	..	..
Bulldozer operator	..	..	2.87	2.95	..	..
Driller, machine	..	..	2.91	3.03	..	..
Dump-truck driver	..	..	2.94	3.04	..	..
Oiler	..	..	2.64	2.71	..	..
Shovel operator (power)	..	..	3.34	3.44	..	..
Surface and mill workers						
Blacksmith	..	..	..	..	2.74	2.84
Carpenter, maintenance	1.99	2.17	3.13	3.31	2.67	2.82
Crusher operator	1.83	1.96	2.72	2.87	2.43	2.60
Electrician	2.07	2.19	3.26	3.38	2.91	3.10
Filter operator	..	..	..	..	2.43	2.55
Flotation operator	..	..	..	..	2.50	2.68
Grinding-mill operator	..	..	2.90	2.96	2.49	2.60
Hoistman	..	..	..	..	..	..
Labourer	1.66	1.77	2.34	2.51	2.19	2.35
Machinist, maintenance	2.13	2.31	3.26	3.45	2.96	3.29
Mechanic, diesel	..	..	3.23	3.34	2.81	3.00
Mechanic, maintenance	2.02	2.13	3.13	3.29	2.77	2.98
Millman	1.92*	2.05	..	..	..	..
Millwright	..	..	3.10	3.32	..	..
Pipefitter, maintenance	1.97	2.14	3.09	3.31	2.60	2.75
Solution man	..	..	..	..	2.49	2.52
Steel sharpener	1.93	2.10	..	..	2.56	2.68
Tradesman's helper	1.75	1.81	2.55	2.70	2.40	2.55
Truck driver, light and heavy	1.85	1.93	2.83	2.93	2.49	2.66
Welder, maintenance	2.09	2.20	3.12	3.25	2.80	2.94

* Includes filter operator, grinding-mill operator (ball-mill operator, rod-mill operator, tubeman) and solution man.

. . Not available or not applicable.

TABLE 39

Index Numbers of Average Wage Rates* by Industries
1962 to 1967 incl.
(1961 = 100)

	1962	1963	1964	1965	1966	1967
Lagging	103.9	110.1	117.5	126.4	140.2	156.0
Metal mining	104.0	107.0	109.6	113.3	122.7	130.2
Gold quartz	109.1	112.4	115.7	121.6	134.6	142.7
Iron	106.5	110.4	112.1	112.2	121.0	129.0
Other metal	101.4	104.1	106.6	110.3	118.4	125.6
Manufacturing	102.7	106.0	109.7	115.0	121.6	131.7
Non-durable	103.3	106.7	110.5	115.5	121.9	131.0
Petroleum refineries	103.6	106.8	109.8	112.6	123.1	131.4
Durable	102.1	105.1	108.9	114.4	121.2	130.0
Primary metal industries	103.6	105.9	109.3	114.8	116.5	123.1
Metal fabricating industries	101.7	104.9	109.3	115.7	125.0	131.2
Machinery industries	103.1	107.4	109.5	114.9	122.7	131.0
Transportation equipment industries	102.7	106.0	109.6	115.4	122.5	131.7
Electrical products industries	98.2	99.2	102.7	105.9	112.3	123.4
Construction	105.0	109.1	113.9	119.8	129.8	142.0
Transportation, communication and other utilities	103.1	106.0	109.8	114.3	122.3	132.8
Trade	103.5	107.9	111.0	116.9	123.9	132.5
Service	101.9	106.6	111.7	118.4	125.5	133.9
Local government (Municipal Government only)	103.3	107.4	111.5	118.1	124.6	136.9
General index – All industries	103.1	107.0	110.9	116.5	124.0	133.4

* Average wage rate = the weighted average of straight-time rates paid on a time basis in an occupation.

TABLE 40

Average Weekly Wages and Hours of Hourly-Rated
Employees in Canadian Mining, Manufacturing and Construction
Industries, 1961-1967

	1961	1962	1963	1964	1965	1966	1967P
Mining							
Average hours per week	41.8	41.7	42.0	42.2	42.5	42.3	41.9
Average weekly wage	88.82	90.98	93.87	97.43	103.30	110.29	119.50
Metals							
Average hours per week	41.8	41.5	41.5	41.7	41.9	41.6	41.3
Average weekly wage	92.32	93.92	96.22	99.48	105.76	112.99	123.25
Fuels							
Average hours per week	40.1	40.6	42.5	42.1	41.3	42.3	42.5
Average weekly wage	77.62	80.77	85.10	86.98	89.07	95.68	101.23
Nonmetals							
Average hours per week	41.1	41.1	41.1	41.7	42.7	42.1	42.4
Average weekly wage	84.69	86.02	89.66	94.42	99.49	104.00	112.77
Manufacturing							
Average hours per week	40.6	40.7	40.8	41.0	41.0	40.8	40.3
Average weekly wage	74.45	76.75	79.51	82.96	86.89	91.65	96.84
Construction							
Average hours per week	41.4	41.1	41.2	41.4	41.3	42.2	41.3
Average weekly wage	85.75	88.33	92.20	97.39	104.45	118.23	128.76

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TABLE 41

Average Weekly Wages of Hourly-Rated Employees in Canadian Mining Industry in Current and 1949 Dollars 1961-1967

	1961	1962	1963	1964	1965	1966	1967
Current Dollars							
All mining	88.82	90.98	93.87	97.43	103.30	110.29	119.50
Metals	92.32	93.92	96.22	99.48	105.76	112.99	123.25
Gold	73.34	75.76	77.38	80.27	84.71	91.12	95.72
Fuels	77.62	80.77	85.10	86.98	89.07	95.68	101.23
Coal	70.65	73.86	79.25	80.84	80.68	85.53	90.63
Nonmetallic	84.69	86.02	89.66	94.42	99.49	104.00	112.77
1949 Dollars							
All mining	68.75	69.61	70.58	71.96	74.48	76.64	80.20
Metals	71.46	71.86	72.35	73.47	76.25	78.52	82.72
Gold	56.76	57.96	58.18	59.28	61.07	63.32	64.24
Fuels	60.08	61.80	63.98	64.24	64.22	66.49	67.94
Coal	54.68	56.51	59.59	59.70	58.17	59.44	60.83
Nonmetallics	65.55	65.81	67.41	69.73	71.73	72.27	75.68

TABLE 42

Industrial Fatalities in Canada per Thousand Paid Workers in Main Industry Groups*, 1954–67

	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Agriculture	0.82	0.83	1.03	0.95	1.00	0.92	0.62	0.61	0.56	0.48	0.72	0.48	0.54	0.28
Forestry	2.50	2.00	1.90	1.50	1.70	1.70	1.50	1.32	2.04	1.79	2.21	1.64	1.53	1.39
Fishing and Trapping	3.10	3.20	1.80	2.30	3.80	7.20	2.70	4.00	1.20	3.40	3.70	4.00	3.60	3.30
Mining*	2.00	1.60	2.10	1.50	2.20	2.00	1.92	1.73	1.89	2.33	1.87	1.24	1.13	1.49
Manufacturing	0.16	0.16	0.14	0.14	0.11	0.13	0.19	0.12	0.15	0.15	0.14	0.14	0.12	0.10
Construction	0.86	0.79	0.89	0.91	0.77	0.79	0.56	0.77	0.63	0.70	0.75	0.72	0.66	0.52
Transportation, Communication and other utilities	0.53	0.56	0.56	0.50	0.40	0.44	0.37	0.36	0.38	0.42	0.43	0.49	0.41	0.36
Trade	0.08	0.07	0.08	0.09	0.05	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.05	0.06
Finance, Insurance and Real Estate	0.01	0.03	0.05	0.01	0.02	0.01	0.09	0.05	0.08	0.04	0.08	0.01	0.04	0.17
Service**	0.08	0.07	0.06	0.07	0.07	0.06	0.07	0.06	0.06	0.09	0.07	0.05	0.04	0.04
Total	0.32	0.32	0.33	0.30	0.27	0.28	0.21	0.22	0.22	0.23	0.24	0.23	0.19	0.17

* Includes quarrying and oil-well drilling.

** Includes Public Administration.

TABLE 43

Strikes and Lockouts in Existence, 1966 and 1967

	1966			1967		
	Strikes and Lockouts	Workers Involved	Duration in Man-Days	Strikes and Lockouts	Workers Involved	Duration in Man-Days
Agriculture	–	–	–	1	6	30
Forestry	7	14,365	64,630	5	1,817	18,930
Mines	36	43,990	450,430	24	7,084	32,050
Manufacturing	297	95,616	1,971,930	267	91,531	1,976,134
Construction	149	45,360	296,250	119	42,370	976,400
Transportation and Utilities	56	161,973	1,664,830	43	29,680	429,670
Trade	30	1,976	32,840	19	3,090	48,510
Finance	1	12	20	2	71	460
Service	25	37,898	426,370	31	66,101	361,720
Public Administration	16	10,269	169,300	11	10,373	130,730
All industries	617	411,459	5,076,600	522	252,123	3,974,634

– Nil.

Section 7 - Mining, Quarrying, Prosp. Drilling
Tables 44 to 51

TABLE 44

Ore Mined and Rock Quarried in the Canadian Mining Industry, 1964 and 1965

(short tons)

	1964	1965
Metallic ores		
Gold quartz	12,757,577	12,042,354
Copper-gold-silver	20,201,393	20,016,849
Silver-cobalt	253,170	279,091
Silver-lead-zinc	8,923,216	10,139,481
Nickel-copper	20,419,111	24,249,575
Iron	72,795,146	89,154,543
Miscellaneous metals	5,901,375	10,654,616
Total	141,250,988	166,536,509
Nonmetals		
Asbestos	50,032,255	53,399,988
Feldspar, nepheline syenite	390,336	448,777
Quartz (exclusive of sand)	1,506,574	1,471,830
Gypsum	6,420,038	6,112,078
Talc, soapstone	68,247	57,169
Rock salt	1,876,176	3,363,611
Other nonmetals	4,693,733	5,732,636
Total	64,987,359	70,586,089
Structural materials		
Stone, all kinds quarried	69,794,358	76,758,105
Stone used to make cement	10,275,353	11,236,634
Stone used to make lime	2,710,253	2,927,691
Total	82,779,964	90,922,430
Total ore mined and rock quarried	289,018,311	328,045,028

TABLE 45

Ore Mined and Rock Quarried, Canadian Mining Industry, 1932-1965

(millions of short tons)

	Metal Mines	Industrial Mineral Operations	Total
1932	14.0	8.2	22.2
1933	15.0	6.4	21.4
1934	18.8	8.8	27.6
1935	20.4	9.6	30.0
1936	22.7	13.0	35.7
1937	28.1	17.7	45.8
1938	31.4	14.9	46.3
1939	35.9	16.5	52.4
1940	39.6	20.3	59.9
1941	43.0	21.6	64.6
1942	42.5	21.7	64.2
1943	38.7	20.7	59.4
1944	35.3	19.3	54.6
1945	31.3	20.6	51.9
1946	28.9	24.8	53.7
1947	33.3	30.4	63.7
1948	36.9	33.5	70.4
1949	43.3	32.9	76.2
1950	45.9	41.8	87.7
1951	48.8	43.8	92.6
1952	52.3	44.2	96.5
1953	54.4	47.2	101.6
1954	59.0	61.5	120.5
1955	69.2	63.5	132.7
1956	77.4	73.0	150.4
1957	84.3	82.2	166.5
1958	78.8	78.5	157.3
1959	99.1	90.7	189.8
1960	101.6	97.8	199.4
1961	99.4	106.7	206.1
1962	114.2	114.5	228.7
1963	124.5	132.8	257.3
1964	141.2	147.8	289.0
1965	166.5	161.5	328.0

TABLE 46

Cost of Prospecting by Metal-Mining Industry, by Province and Types of Operation, 1963

	Placer Gold Operations	Gold Mines	Copper-gold silver Mines	Silver-Cobalt Mines	Silver-lead-zinc Mines	Nickel-Copper Mines	Iron Mines	Miscellaneous Metal Mines	Total
Newfoundland	3,304	84,625	88,601	–	483,702	–	223,576	14,294	898,102
Nova Scotia	–	12,201	117,184	–	58,142	–	–	88,881	276,408
New Brunswick	–	21,269	328,520	–	88,663	2,804	–	281,183	722,439
Quebec	3,299	2,787,178	7,925,089	1,925	493,307	2,408,984	752,551	1,419,179	15,791,512
Ontario	26,228	1,062,219	1,747,319	328,715	254,756	3,218,543	1,372,575	465,854	8,476,209
Manitoba	–	1,063	1,502,709	65,379	81,075	3,016,134	3,877	23,243	4,693,480
Saskatchewan	–	13,823	665,983	–	19,502	180,719	1,334	128,177	1,009,538
Alberta	–	18,850	55,892	–	201,204	–	–	88,433	364,379
British Columbia	174,989	285,223	4,442,302	114,572	1,928,269	659,548	253,247	672,036	8,530,186
Yukon	6,874	122,686	506,705	–	114,031	251,657	–	100,685	1,102,638
Northwest Territories	–	316,317	198,092	–	335,118	584,020	–	197,955	1,631,502
Total	214,694	4,725,454	17,578,396	510,591	4,057,769	10,322,409	2,607,160	3,479,920	43,496,393

NOTE: The amounts shown are the expenditures incurred by mining companies classified by their main type of metal mining activity. These expenditures, however, apply to prospecting conducted by such companies in all sectors of the mineral industry. If, for example, a company whose chief activity is gold-quartz mining expends funds on prospecting for lead and zinc, such expenditures are included in the column headed "Gold Mines" in this Table.

TABLE 47

Cost of Prospecting by Metal-Mining Industry in Canada by Types of Operation, 1957-1963

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	Placer-Gold Operations	Gold Mines	Copper-Gold-Silver Mines	Silver-Cobalt Mines	Silver-Lead-Zinc Mines	Nickel-Copper Mines	Mis-cellaneous Metal Mines*	Total
1957	75,468	3,370,252	17,545,591	9,065	2,781,917	12,220,660	18,421,466	54,424,419
1958	91,461	2,246,360	10,239,495	10,396	1,351,065	13,894,699	4,673,610	32,507,086
1959	65,139	3,649,286	22,226,933	87,883	1,559,613	8,512,264	6,916,517	43,017,635
1960	118,805	3,814,541	19,105,258	26,808	5,602,547	9,411,381	5,474,270	43,553,610
1961	99,484	3,663,420	18,367,148	95,958	7,051,755	8,827,546	5,379,760	43,485,071
1962	100,835	4,995,265	13,353,408	47,553	9,507,288	10,420,395	5,365,397	43,790,141
1963	214,694	4,725,454	17,578,396	510,591	4,057,769	10,322,409	6,087,080	43,496,393

*Includes iron, uranium, molybdenum mining, etc.

NOTE: See general footnote Table 46.

TABLE 48

Diamond Drilling on Canadian Metal Deposits by Mining Companies with Own Equipment and by Drilling Contractors 1952–1964

(footage)

	Gold-quartz Deposits	Copper-Gold-Silver and Nickel-Copper Deposits	Silver-Lead-Zinc Deposits	Other Metal-bearing Deposits*	Total Metal Deposits
1952	2,651,722	3,894,437	1,496,542	183,833	8,226,534
1953	2,216,528	3,203,785	1,206,902	214,171	6,841,386
1954	2,418,853	2,710,920	891,972	653,206	6,674,951
1955	2,354,572	2,873,826	1,121,578	1,763,820	8,113,796
1956	2,239,502	4,889,428	1,311,282	1,257,977	9,698,189
1957	2,317,170	3,603,971	1,062,020	942,794	7,925,955
1958	1,794,164	3,028,302	977,009	941,503	6,740,978
1959	1,831,234	3,643,912	925,486	1,258,106	7,658,738
1960	2,060,419	4,159,424	741,557	1,033,686	7,995,086
1961	1,952,693	3,701,085	836,945	725,325	7,216,048
1962	2,960,263	3,363,019	1,148,886	1,176,768	8,648,936
1963	1,738,710	3,206,225	945,553	487,872	6,378,360
1964	1,739,122	2,328,045	1,315,944	343,631	5,726,742

*Includes iron, chromite, titanium, uranium, molybdenum deposits.

TABLE 49
Exploration, Diamond Drilling Canadian Metal Deposits
1952–1964
(footage)

	By Mining Companies with Own Personnel and Equipment	By Diamond Drill Contractors	Total
1952	1,366,363	3,120,419	4,486,782
1953	1,046,490	2,863,084	3,909,574
1954	969,858	3,641,220	4,611,078
1955	1,522,696	5,072,263	6,594,959
1956	1,556,963	5,396,113	6,953,076
1957	1,175,526	4,046,336	5,221,862
1958	777,994	3,939,059	4,717,053
1959	786,701	4,485,109	5,271,810
1960	880,515	4,624,067	5,504,582
1961	993,099	4,387,051	5,380,150
1962	548,603	5,734,983	6,283,586
1963	1,184,977	3,836,262	5,021,239
1964	469,205	3,753,729	4,222,934

TABLE 50
Contract Diamond Drilling Operations in Canada 1956-1965

	Footage Drilled	Income from Drilling	Average Number of Employees	Total of Salaries and Wages
	ft.	$ millions	number	$ millions
1956	7,840,670	27.6	3,415	12.6
1957	6,296,128	21.2	2,951	10.8
1958	4,426,594	14.4	1,717	6.9
1959	5,435,971	17.9	1,902	8.0
1960	5,521,211	17.1	1,912	8.0
1961	5,290,813	16.2	2,025	7.8
1962	5,549,733	17.9	1,926	8.0
1963	5,702,168	20.1	2,201	9.0
1964	6,479,096	23.7	2,401	11.2
1965	7,404,834	30.7	2,776	14.1

Section 8
Transportation
Tables 52 to 56

TABLE 51

Contract Drilling in Canada for Oil and Gas, 1956-64

	Footage Drilled (feet)				Gross Income from Drilling	Average Number of Employees	Total Salaries & Wages
	Rotary	Cable	Diamond	Total	$ millions	number	$ millions
1956	15,424,310	376,663	–	15,800,973	93.3	5,793	28.8
1957	12,126,069	369,277	–	12,495,346	75.6	5,468	25.7
1958	12,998,094	446,451	–	13,444,545	69.3	5,261	24.1
1959	13,020,214	317,719	7,567	13,345,500	63.8	4,734	21.4
1960	13,538,783	231,748	–	13,770,531	75.2	4,860	23.2
1961	12,616,950	170,098	–	12,787,048	68.6	4,144	21.7
1962	12,459,736	252,467	–	12,712,203	62.2	3,800	20.8
1963	14,783,110	361,979	–	15,145,089	75.9	4,179	22.9
1964	14,803,776	229,726	6,230	15,039,732	81.9	4,158	25.2

–Nil.

TABLE 52

Crude Minerals* Transported by Canadian Railways 1966 and 1967

	1966 000's short tons	1967 000's short tons
Coal		
Anthracite	720	744
Bituminous	10,041	9,579
Iron ore	39,261	41,732
Aluminum ores and concentrates	2,864	2,924
Copper ores and concentrates	1,314	1,554
Copper-nickel ores and concentrates	4,034	4,909
Lead ores and concentrates	719	686
Zinc ores and concentrates	2,355	2,828
Ores and concentrates, other	682	777
Barite	38	48
Clay and bentonite	543	576
Sand	1,198	1,206
Sand and gravel	5,737	3,999
Stone, crushed and ground	6,080	5,475
Stone, fluxing and dolomite	689	337
Stone, rough	33	36
Stone, dressed	25	15
Petroleum, crude	295	316
Salt	1,282	1,358
Phosphate rock	1,799	1,900
Sulphur	1,984	2,256
Asbestos	1,253	1,173
Gypsum, crude	4,491	3,736
Products of mines, other	1,475	1,367
Total	88,912	89,531

TABLE 52 (Cont'd)

	1966 000's short tons	1967 000's short tons
Total revenue freight moved by Canadian railways	214,381	209,453
Crude minerals as a percentage of total revenue freight moved by Canadian railways	41.5	42.7

*Domestic and imported.

TABLE 53

Fabricated Mineral Products* Transported by Canadian Railways, 1966 and 1967

	1966 000's short tons	1967 000's short tons
Aluminum: bar, ingot, pig, shot	675	635
Aluminum metal, other	134	117
Copper: ingot and pig	522	575
Copper, brass and bronze, other	275	256
Lead and zinc; bar, ingot, pig	584	597
Lead and zinc, other	15	6
Alloys for manufacture of steel	160	133
Metals and alloys, other	129	93
Iron, pig	258	225
Iron and steel: billet, bloom, ingot	513	503
Iron and steel: bar, rod, slab	492	533
Iron and steel, other	59	53
Matte	258	321
Furnace slag	274	218
Cement, natural and portland	2,041	1,712
Cement, other	70	70
Brick, common	88	74
Brick, other and building tile	150	125
Refractories	332	300
Artificial stone	97	65
Lime	654	571
Plaster: stucco and wall	87	68
Sewer pipe and drain tile	10	9
Broken brick and crockery	17	13
Gasoline	2,828	2,988
Fuel oil and petroleum oil	4,268	4,526
Lubricating oils and greases	381	389
Petroleum products, refined	1,908	2,226
Coke	1,979	1,796
Asphalt	312	333
Total	19,570	19,530
Total all revenue freight	214,381	209,453
Fabricated minerals as a per cent of total freight	9.1	9.3

*Domestic and imported.

TABLE 54

Crude Minerals* Transported by Canadian Railways, 1957–1967

(millions of short tons)

	Total of Revenue Freight	Total of Crude Minerals	Crude Minerals as a % of Revenue Freight
1957	174.0	70.8	40.6
1958	153.4	57.8	37.6
1959	166.0	69.2	41.7
1960	157.4	62.9	39.9
1961	153.1	59.6	38.9
1962	160.9	66.5	41.3
1963	170.4	69.3	40.7
1964	198.4	82.3	41.5
1965	205.2	89.2	43.5
1966	214.4	88.9	41.5
1967	209.5	89.5	42.7

*Domestic and imported.

TABLE 55

Crude and Fabricated Minerals* Transported Through Canadian Canals**, 1966

	1966 000's short tons
Crude Minerals	
Alumina and bauxite ores	265
Copper ore, concentrates, matte, precipitates	11
Iron ore, crude, concentrated, calcined	32,544
Manganese ore	519
Nickel-copper ore, matte, concentrates	8
Ores, concentrates, precipitates, n.e.s.	90
Iron and steel scrap	250
Nonferrous and precious metal scrap	106
Slag, dross and byproducts	30
Coal, bituminous, subbituminous and lignite	8,867
Coal, n.e.s.	10
Crude petroleum and natural gasoline	80
Natural gas and other crude bituminous substances	19
Asbestos, unmanufactured	2
Bentonite	190
China clay	44
Dolomite	1,411
Clay and other crude refractory materials, n.e.s.	107
Sand and gravel	266
Limestone	30
Crushed stone, including stone refuse, excluding limestone	4
Stone, crude, n.e.s.	74
Fluorspar	236
Gypsum	130
Phosphate rock	15
Salt	1,307
Sulphur in ores, crude and refined	4
Crude nonmetallic minerals, n.e.s.	98
Total crude minerals	46,717
Fabricated	
Gasoline	781
Fuel oil	3,818
Lubricating oils and greases	524
Coke of petroleum and coal	445
Asphalt and road oils	38
Coal tar and coal pitch	131
Petroleum and coal products, n.e.s.	212
Ferroalloys	137
Pig iron	651
Primary iron and steel, n.e.s.	159
Castings and forgings (except pipes and fittings)	41
Bars and rods, steel	693
Plate, sheet, strip, steel	3,812
Structural shapes and sheet piling	1,094
Rails and railway track material	12
Pipes and tubes, iron and steel	91
Wire and wire rope	222
Aluminum, including alloys	73
Copper and alloys	18
Lead and alloys	8
Nickel and alloys	12
Zinc and alloys	37
Nonferrous metals, n.e.s.	22
Metal fabricated basic products, n.e.s.	270
Building brick, clay	1
Bricks, tiles, n.e.s.	23
Glass basic products	111
Asbestos and asbestos cement basic products	7
Cement	164
Cement basic products	10
Nonmetallic mineral basic products, n.e.s.	87
Total fabricated minerals	13,704
Total, Crude and Fabricated minerals	60,421
Total all freight transported	110,703
Per cent crude and fabricated minerals of total freight	54.6

* Domestic and imported.

** Canals and inland waterways include: St. Lawrence, Welland, Sault Ste. Marie, St. Peter's, Canso, Richelieu River, Ottawa River, Rideau, Murray, Trent and St. Andrews.

TABLE 56

Quantities* of Petroleum and Petroleum Products and Gas (Manufactured and Natural) Transported by Pipeline in Canada, 1954–1967

	Petroleum and Petroleum Products			Gas		
	Domestic Sales millions of bbl	Export Sales millions of bbl	Total millions of bbl	Domestic Sales 000 Mcf	Export Sales 000 Mcf	Total 000 Mcf
1954	156.8	15.7	172.5	102,500[e]	6,984	109,484
1955	178.8	45.5	224.3	136,738	11,356	148,094
1956	215.6	59.3	274.9	163,764	10,828	174,592
1957	258.2	32.6	290.8	184,738	15,731	200,469
1958	239.3	35.5	274.8	211,751	86,972	298,723
1959	273.5	35.0	308.5	283,808	84,764	368,572
1960	274.2	41.8	316.0	326,212	91,046	417,258
1961	286.1	67.3	353.4	379,044	168,180	547,224
1962	300.9	86.6	387.5	421,631	319,566	741,197
1963	339.8	91.3	431.1	452,943	340,953	793,896
1964	355.7	104.2	459.9	505,145	404,143	909,288
1965	373.3	110.3	483.6	573,016[r]	403,909	976,925[r]
1966	406.5	129.7	536.2	635,515[r]	426,224	1,061,739[r]
1967	419.2	154.5	573.7	699,674	505,165	1,204,839

*Domestic and Imported; [e]Estimated; [r]Revised.

Sept 9 - Taxes

TABLE 57

Taxes* Paid to Federal, Provincial and Municipal Governments
in Canada by Important Divisions of the
Mineral Industry, 1964
$

	Federal Income Tax	Provincial Tax	Municipal Tax	Total
Auriferous-quartz mining	2,234,928	2,054,364	893,124	5,182,416
Copper-gold-silver mining, smelting and refining	16,008,384	7,590,599	2,367,864	25,966,847
Silver-lead-zinc mining, smelting and refining	16,780,735	8,019,907	1,745,138	26,545,780
Nickel-copper-mining, smelting and refining	30,684,922	14,701,774	2,370,337	47,757,033
Iron mining	1,277,759	3,480,144	1,371,148	6,129,051
Miscellaneous metal mining	–	899,012	488,704	1,387,716
Asbestos mining	12,562,000	5,731,000	2,008,000	20,301,000
Feldspar, quartz, and nepheline syenite mining	30,536	44,533	20,864	95,933
Gypsum mining	353,809	319,384	273,944	947,137
Peat mining	90,571	41,141	56,111	187,823
Salt mining	–	189,087	268,633	457,720
Talc and soapstone mining	1,662	12,134	6,408	20,204
Stone quarries	2,260,056	773,964	476,658	3,510,678
Miscellaneous non-metal mining	1,792,292	1,061,756	377,403	3,231,451
Total	84,077,654	44,918,799	12,724,336	141,720,789

*The above amounts refer only to payments actually made within the calendar year specified. These tax payments do not necessarily reflect the tax assessments of a calendar year. Included are taxes on non-operating revenue.

TABLE 58

Taxes [a]* Paid by Six Important Divisions
of the Canadian Mineral Industry, 1959–1964
$ millions

	1959	1960	1961	1962	1963	1964
Auriferous-quartz mining	7.0	6.5	7.0	6.1	6.5	5.2
Copper-gold-silver mining	13.0	19.7	20.1	15.2	20.3	26.0
Silver-lead-zinc mining and smelting	12.2	15.3	15.7	17.7	20.5	26.5
Nickel-copper mining, smelting and refining	12.1	41.0	38.2	51.6	35.9	47.8
Iron mining	4.4	6.6	5.6	7.5	11.0	6.1
Asbestos mining	12.1	14.2	16.8	18.4	18.6	20.3
Total	60.8	103.3	103.4	116.5	112.8	131.9

[a]*See footnote Table 57.

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TABLE 59

Capital and Repair Expenditure of the Canadian Mining Industry, 1966, 1967 and 1968

($ millions)

	1966			1967[p]			1968[f]		
	Capital	Repair	Total	Capital	Repair	Total	Capital	Repair	Total
Metal Mines									
Gold mines	6.5	8.5	15.0	3.5	6.3	9.8	2.4	4.9	7.3
Silver-lead-zinc mines	32.7	10.0	42.7	35.2	9.5	44.7	16.2	9.5	25.7
Iron mines	137.7	71.9	209.6	99.8	73.0	172.8	44.1	78.1	122.2
Other metal mines*	171.5	50.6	222.1	168.3	58.2	226.5	166.0	58.9	224.9
Total metal mines	348.4	141.0	489.4	306.8	147.0	453.8	228.7	151.4	380.1
Nonmetal Mines									
Quarries and sandpits	11.5	15.0	26.5	9.3	11.7	21.0	7.1	10.9	18.0
Other nonmetallic minerals	164.1	37.8	201.9	183.1	42.7	225.8	169.3	43.7	213.0
Total nonmetal mines	175.6	52.8	228.4	192.4	54.4	246.8	176.4	54.6	231.0
Mineral Fuels									
Coal mines	2.2	8.5	10.7	2.3	9.4	11.7	1.7	3.0	4.7
Petroleum and gas wells*	503.6	41.4	545.0	503.4	53.6	557.0	499.2	62.1	561.3
Total mineral fuels	505.8	49.9	555.7	505.7	63.0	568.7	500.9	65.1	566.0
Total mining	1,029.8	243.7	1,273.5	1,004.9	264.4	1,269.3	906.0	271.1	1,177.1

[p]Preliminary; [f] Forecast.

*Includes copper-gold-silver, nickel-copper, silver-cobalt, uranium and other metal mines.

**Includes Natural Gas Processing Plants and Contract Drilling for Petroleum and Gas.

TABLE 60

Capital Investment in the Canadian Petroleum and Natural Gas Industries[(a)], 1949–1968

($ millions)

	Exploration	Development and Production	Oil[(e)] Pipelines	Gas Transmission Pipelines	Gas Processing	Petroleum Refining	Marketing		Capital Investment in Canada	
							Oil[(c)]	Gas[(d)]	Petroleum and Natural Gas Industry	All Industries
1949	(b)	45.1	7.7	–	–	21.6	11.3	4.3	90.0	3,539
1950	(b)	53.8	55.0	–	–	24.1	16.7	6.6	156.2	3,936
1951	(b)	72.1	10.7	–	–	50.9	18.1	6.8	158.6	4,739
1952	59.8	93.1	91.9	2.7	1.3	60.5	25.0	6.3	340.6	5,491
1953	59.1	107.2	75.7	3.8	0.7	66.1	36.7	11.2	360.5	5,976
1954	55.1	126.8	63.5	1.6	8.5	83.9	46.3	9.7	395.4	5,721
1955	67.4	201.6	28.5	17.5	2.9	102.9	56.5	9.4	486.7	6,244
1956	73.7	252.4	43.5	133.6	10.5	79.1	68.5	46.6	707.9	8,034
1957	77.3	237.8	68.0	242.1	34.5	81.5	74.9	69.8	885.9	8,717
1958	62.4	181.5	23.6	214.8	40.1	98.5	63.3	79.4	763.6	8,364
1959	51.0	191.9	10.7	48.5	24.4	95.0	73.1	89.8	584.4	8,417
1960	50.4	209.1	18.3	80.6	19.4	59.2	68.1	62.9	567.9	8,262
1961	52.3	182.4	49.3	115.5	77.9	31.2	56.0	59.3	623.9	8,172
1962	48.0	182.7	20.8	51.4	22.0	64.8	47.7	69.3	506.7	8,715
1963	46.6	216.2	26.0	81.9	53.6	44.2	53.0	84.1	605.6	9,393
1964	50.8	262.7	29.0	135.1	40.6	23.9	48.3	68.3	658.7	10,944
1965	61.6	396.1	52.5	59.6	41.5	39.8	55.2	72.5	778.8	12,865
1966	99.9	453.5	81.6	72.3	50.1	64.8	64.0	92.3	978.5	15,090
1967[p]	152.5	394.0	96.4	102.5	109.4	96.3	84.6	81.9	1,117.6	15,174
1968[f]	150.0[e]	418.8	87.1	178.6	80.4	124.8	90.7	90.9	1,221.3	15,802

(a) The petroleum and natural gas industries in this table include all companies engaged in whole or in part in oil and gas industry activities. The investment data under "Petroleum and Natural Gas" in Tables 61, 62, and 63 apply only to companies whose main revenues are derived from oil and gas activities.

(b) Capital investment in exploration prior to 1952 is included in the Development and Production column.

(c) Capital investment in this item includes chiefly outlets reported by major companies.

(d) Capital expenditures in gas marketing are for gas distribution pipelines.

(e) Capital investment in oil pipelines includes small expenditures for rail and water transport.

p Preliminary; f Forecast; e Estimated; –Nil.

TABLE 61

Ownership of Canadian Mining and Metallurgical Industries – Year End 1962 and 1963

($ millions)

	Estimated Total Investment	Investment Owned in Canada	U.S.A.	U.K.	Other
1962					
Petroleum and natural gas*	6,922	2,538	3,662	355	367
Mining, other	2,595	875	1,562	95	63
Smelting and refining nonferrous ores	1,042	465	436	89	52
Iron and steel mills	938	691	151	59	37
1963					
Petroleum and natural gas*	7,295	2,592	3,945	380	378
Mining, other	2,743	949	1,639	77	78
Smelting and refining nonferrous ores	1,066	513	415	84	54
Iron and steel mills	874	696	70	65	43

*Data apply to companies whose main revenues are derived from oil and gas activities.

TABLE 62

Estimated Book Value and Ownership Capital Employed in Selected Canadian Industries, 1956 and 1963

($ billions)

	1956	1963
Total capital employed		
Manufacturing	10.0	13.7
Petroleum and natural gas*	3.5	7.3
Other mining and nonferrous smelting and refining	2.5	3.8
Railways	4.4	5.3
Other utilities	6.4	12.2
Merchandising and construction	7.3	9.8
Total	34.1	52.1
Resident owned capital		
Manufacturing	5.2	6.2
Petroleum and natural gas*	1.3	2.6
Other mining and nonferrous smelting and refining	1.1	1.5
Railways	2.9	4.1
Other utilities	5.5	10.6
Merchandising and construction	6.6	8.8
Total	22.7	33.8
Nonresident owned capital		
Manufacturing	4.8	7.4
Petroleum and natural gas*	2.3	4.7
Other mining and nonferrous smelting and refining	1.3	2.3
Railways	1.4	1.2
Other utilities	0.9	1.5
Merchandising and construction	0.7	1.0
Total	11.4	18.3

*The investment data under "petroleum and natural gas" apply only to companies whose main revenues are derived from oil and gas activities.

NOTE: Owing to rounding, figures do not add to totals in all cases.

TABLE 63

Foreign Capital Invested in the Canadian Mineral Industry
Selected Years (End of Year) 1930-1964
($ millions)

	1930	1945	1956	1957	1958	1959	1960	1961	1962	1963	1964
Owned by all nonresidents											
Mining and nonferrous smelting and refining	311	356	1,330	1,570	1,657	1,783	1,977	2,094	2,297	2,347	2,473
Petroleum and natural gas*	150	160	2,275	2,849	3,187	3,455	3,727	4,029	4,384	4,703	4,786
Owned by United States residents											
Mining and nonferrous smelting and refining	234	277	1,129	1,307	1,386	1,513	1,701	1,821	1,998	2,054	2,115
Petroleum and natural gas*	147	152	2,063	2,570	2,866	3,108	3,184	3,444	3,662	3,945	3,964

*Data apply only to companies whose main revenues are derived from oil and gas activities.

Abrasives

D.H. STONEHOUSE*

Abrasives are divided into two general classes, natural and artificial, each being further sub-divided as high-grade, low-grade or mild, according to degree of abrasiveness. Canada's production of natural abrasives is extremely small and results from operations established primarily to produce materials for non-abrasive purposes. Included in this group are silica and beach sand, iron oxide, feldspar, granite and sandstone. Supporting production statistics are not available.

Canada produces a major portion of the world's annual output of crude fused alumina and crude silicon carbide, the two most widely used artificial abrasives. Domestic requirements for abrasive grains are met by imported material with which bonded and coated abrasives are made. Production of crude silicon carbide was valued at $14.8 million and of crude fused alumina at $21.0 million for 1966, continuing an established upward trend. Bonded abrasives including wheels and segments were valued at $12.1 million and coated abrasives made up the bulk of the $14.1 million realized from production of other abrasive products during 1966.

Imports of abrasives consist of both natural and artificial products and of the natural group industrial diamonds account for the greatest value. A large proportion of the diamond imports is re-exported to the United States as finished products. Artificial abrasives as a group constitute about 60 per cent of total import value. The largest single item in this group is abrasive grains brought in from the United States, having been refined from the crude artificial products made in Canada and exported to that country. Practically all the crude fused alumina and crude silicon carbide produced in Canada is exported to the United States and together account for over 90 per cent of the value of exported abrasives.

PRODUCERS

Although statistical support is not available to indicate the amount of product so used, some quartzite for sand-blasting purposes is produced by Industrial Minerals of Canada Limited at St. Donat de Montcalm, Quebec: by Nova Scotia Sand and Gravel Limited, near Shubenacadie, Nova Scotia and by the Winnipeg Supply and Fuel Company, Limited, Selkirk, Manitoba. International Minerals & Chemical Corporation (Canada) Limited, Buckingham, Quebec ships a small amount of feldspar for use in manufacturing soaps and cleansers and Industrial Minerals of Canada Limited, St. Canut, Quebec ships finely ground silica for the same purpose. Bog iron oxide is processed and shipped for use as crocus and jeweller's rouge by Red Mill Industries Limited at Red Mill, Quebec. Grindstones from sandstone are produced occasionally by H.C. Read, Sackville, New Brunswick.

The production of crude artificial abrasives in Canada began many years ago under conditions that favoured establishment of such plants in Canada and refining of the crude products in United States plants. Crude artificial abrasives are produced at four plants in Quebec, four plants in Ontario and from a newly established operation in Nova Scotia. The product is exported mainly to the United States but markets are being established in Britain as well. Demand for crude artificial abrasives is in proportion to the amount of metal fabrication taking place in a given country and is therefore a gauge of a country's development and prosperity. Producers of crude artificial abrasives in Canada are listed in Table 2.

Significant amounts of bonded abrasives in the form of abrasive wheels, segments, stones and shapes and of coated abrasives such as "sand" papers and "emery" cloths are produced in Canada as well.

*Mineral Processing Division, Mines Branch.

TABLE 1

Abrasives-Production, Trade and Consumption, 1966-67

	1966		1967P	
	Short Tons	$	Short Tons	$
Production				
Artificial abrasives				
Crude silicon carbide[1]	108,351	14,777,000		
Crude fused alumina[1]	183,917	21,036,000		
Abrasive wheels and segments	..	12,124,000		
Other products[2]	..	14,173,000		
Total		62,110,000		
Imports				
Natural abrasives				
Diamonds, industrial	..	6,709,000	..	6,528,000
Diamond dust	..	657,000	..	818,000
Pumice lava and volcanic dust, crude or ground	14,426	221,000	8,837	154,000
Abrasives, natural, n.e.s.	8,172	464,000	8,334	427,000
Abrasives, artificial				
Abrasives, artificial, crude and grains, n.e.s.	10,614	3,661,000	9,232	3,348,000
Abrasive wheels	..	2,790,000	..	2,739,000
Abrasive stones and blocks	..	614,000	..	568,000
Abrasive paper and cloth	..	1,718,000	..	1,840,000
Metal shot	..	1,965,000	..	1,873,000
Abrasive basic products n.e.s.		1,056,000		1,048,000
Total		19,855,000		19,343,000
Exports				
Natural and artificial abrasives				
Abrasives, natural, n.e.s.	30	3,000	62	6,000
Fused alumina, crude and grains	196,840	22,521,000	167,181	19,483,000
Silicon carbide, crude and grains	98,878	12,832,000	87,167	11,462,000
Abrasive paper and cloth	..	540,000	..	598,000
Abrasive wheels and stones	..	160,000	..	125,000
Abrasive basic products, n.e.s.	..	2,911,000	..	2,851,000
Total		38,967,000		34,525,000
Re-exports				
Abrasives, natural		2,008,000		2,012,000
Abrasive basic products		201,000		322,000
Total		2,209,000		2,334,000
Consumption				
Abrasives, natural and artificial, in the production of artificial-abrasive products				
Natural-abrasive grains:				
garnet	190	53,000		
emery	43	8,000		
quartz or flint	126	8,000		
other	..	5,000		
Total		74,000		

Table 1 (Cont't)

	1966		1967p	
	Short Tons	$	Short Tons	$
Artificial-abrasive grains for wheels, paper etc.				
fused alumina	4,004	1,310,000		
silicon carbide	1,668	757,000		
Total	5,672	2,067,000		
Silica sand	169,669	1,518,000		

Source: Dominion Bureau of Statistics.
[1]Includes material for refractories and for other nonabrasive purposes.
[2]Includes abrasive cloth, paper and tile, sharpening stones and files, artificial pulpstone, boron carbide, fused magnesia and firesand.
pPreliminary; . . not available; n.e.s. Not elsewhere specified.

TABLE 2

Canadian Producers of Crude Artificial Abrasives

Producer	Location of Plant	Product
Canadian Carborundum Company, Limited	Niagara Falls, Ont.	Fused alumina
	Shawinigan, Que.	Silicon carbide
Electro Refractories & Abrasives Canada Ltd.	Cap de la Madeleine, Que.	Silicon carbide
The Exolon Company of Canada, Ltd.	Thorold, Ont.	Silicon carbide
		Fused alumina
Lionite Abrasives, Limited	Niagara Falls, Ont.	Silicon carbide
		Fused alumina
Norton Company	Chippawa, Ont.	Silicon carbide
		Fused alumina
	Cap de la Madeleine, Que.	Silicon carbide
Simonds Canada Abrasive Company Limited	Arvida, Que.	Fused alumina
Pyrominerals Limited	Sydney, N.S.	Fused alumina

CONSUMPTION AND USES

Consumption statistics for natural and artificial abrasive grains are incomplete, but diamonds represent by far the largest part of the consumption value. Table 1 shows the consumption value and amount of most natural and artificial abrasives used in the production of abrasive products during 1966. This does not include the quantity consumed for final use as loose grains.

Abrasives are used to grind, abrade, scour, clean or polish solid material and therefore must possess physical qualities which permit their use in these ways. Of prime importance in this respect are properties of hardness, toughness, grain size and shape, cleavage and uniformity. Materials used to make bonded abrasive products must be able to withstand high temperatures, and grain surfaces must permit effective bonding.

The wide range of applications for abrasives, of the methods in which they are used, of the materials on which they are used and of the desired effects and results, each has an influence on the particular type of abrasive chosen. Rarely are abrasives interchangeable for critical applications and a preferred abrasive for each use is usually available. For most uses artificial or manufactured abrasives are now available to replace natural abrasives. But even this trend can be limited in such a specialized field, e.g., a suitable substitute for garnet grains in coated abrasive papers and cloths has not been produced.

All minerals and rocks can be used as natural abrasives but only a few are in demand. Natural and synthetic diamonds are employed in grinding, cutting and boring metallic and nonmetallic materials and in polishing glass. Emery is used in bonded and coated abrasives and in abrasive surfaces for floors of concrete, masonry and asphalt. Corundum may be employed in bonded shapes or loose grains for grinding and polishing. Silica and beach sand are used in sandblasting, silica flour in soaps and cleansers, and silica sand in coated abrasives. Garnet serves mainly in coated abrasives and as loose grains for sandblasting and polishing. Feldspar is used in soaps and cleansers, and iron oxide and diatomite are ingredients in polishes. Other industrial minerals are consumed for less common abrasive purposes.

Although not considered products of the abrasives industry, ores used in autogenous grinding temporarily perform as natural abrasives. They serve a twofold purpose, initially as grinding media and eventually as a semiprocessed ore. In Canada, many ores are subjected to this type of comminution.

Fused alumina and silicon carbide are the most popular artificial abrasives. Because they are both high-grade types, they compete in many applications and are used for grinding, polishing, sandblasting and for providing "nonslip" surfaces on concrete and masonry structures. When bonded, fused alumina is used in the metalworking, woodworking and leather industries. Silicon carbide is also bonded into wheels, sticks, stones, rubs, etc., and used to abrade metal, industrial mineral products, rubber, leather and wood. In coated abrasives, fused alumina and silicon carbide are used in the metalworking, woodworking and leather industries.

Non-abrasive uses for fused alumina and silicon carbide consume a small percentage of the former and about 40 per cent of the latter. Both materials are used in the preparation of some refractory brick and kiln muffles and in the manufacture of chemical laboratory ware. Silicon carbide is used also in the manufacture of electric furnace heating elements.

PRICES

Canada does not produce refined grains for the production of manufactured abrasive products. In 1966 the following average prices per short ton were for imported abrasives used at abrasive products plants:

Fused alumina	$327.
Silicon carbide	454.
Garnet	279.
Emery	186.

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Lightweight Aggregates

H.S. WILSON*

The value of the lightweight aggregates used in Canada in 1967 decreased 9.9 per cent from that of 1966 to $6.73 million. This is the second time since 1954 that the value for any year has shown a decrease; the first occurred in 1963.

Of the five lightweight aggregates involved, expanded perlite showed the most favourable production, decreasing 5.5 per cent in volume and 1.9 per cent in value. Production of exfoliated vermiculite decreased 9.0 per cent in volume and 1.7 per cent in value. Expanded clay and shale decreased 14.9 and 13.8 per cent in volume and value respectively. The value of pumice used as lightweight aggregate decreased by 17.8 per cent during 1967. Expanded slag showed the greatest decrease in production, 25.6 per cent in volume and 23.4 per cent in value.

Table 1 shows the volume and value of production of each of the lightweight aggregates for 1966 and 1967. The accompanying graph shows the production of the four principal aggregates for the period 1954-1967.

The total value of construction in Canada continued to increase in 1967, reaching a new high of $11.5 billion, an increase of 2.5 per cent over 1966. However, the value of construction on a constant 1957 dollar basis actually decreased 3.2 per cent during 1967. This was because of the continuing increases in the costs of materials and labour. Table 2 shows the year-to-year changes in construction from 1957 to 1967 both on a current dollar basis and on a constant dollar basis.

Table 3 shows the percentage changes of the various types of construction from 1965 to 1966 and from 1966 to 1967. It also shows the percentages of the totals represented by each type for 1965, 1966 and 1967, all on a current dollar basis.

RAW MATERIALS AND PRODUCERS

Common clays and shales are the most widespread of the raw materials used for the production of lightweight aggregates. All plants obtain the raw material locally. Nine plants were in operation at the end of 1967. Aggrite (1962) Inc., Laprairie, Quebec, was shut down during the year. Construction of a new plant near Minto, New Brunswick, began during 1967.

Expanded blast furnace slag is a processed by-product from the production of pig iron. The processing operation at Port Colborne was not put into production in 1967.

Vermiculite is similar to mica in appearance, but differs in that it exfoliates when heated to form a cellular material of low density and good insulating properties.

All the plants processed raw material imported principally from the United States and to a lesser degree from South Africa.

Perlite is a volcanic rock that 'pops' when heated to form a white, cellular product of low density and with good insulating properties. All raw material is imported from the western United States, for processing.

Pumice, a highly vesicular material of volcanic origin, is used in its natural state as a lightweight aggregate. All pumice used is imported from the United States, since known Canadian deposits are either too small or too far from transportation facilities.

*Mineral Processing Division, Mines Branch.

TABLE 1

Production of Lightweight Aggregates 1966-67

	1966		1967	
	Cubic Yards	$	Cubic Yards	$
From domestic raw materials				
Expanded clay and shale	530,244	2,931,706	451,285	2,527,575
Expanded slag	427,334	1,087,914	318,057	833,224
From imported raw materials				
Exfoliated vermiculite	314,916	2,594,819	286,593	2,551,796
Expanded perlite	82,720	690,277	78,176	676,876
Pumice		168,483		138,500
Total		7,473,199		6,727,971

Source: Statistics supplied to Mineral Processing Division by producers.

TABLE 2

Annual Variation in Construction

Year	Total Value ($ x millions)	Per Cent Change from Previous Year	
		Current Dollar Value	Constant (1957) Dollar Value
1957	7,023	8.8	5.1
1958	7,092	1.0	1.0
1959	7,077	−0.2	−3.5
1960	6,886	−2.7	−4.7
1961	6,974	1.3	2.1
1962	7,296	4.6	2.0
1963	7,716	5.8	2.1
1964	8,653	11.9	7.4
1965	9,868	14.3	7.1
1966	11,237	13.9	7.5
1967p	11,523	2.5	−3.2

Source: Dominion Bureau of Statistics.
p Preliminary.

Table 4 lists the lightweight aggregate processing plants in operation during 1967.

CONSUMPTION

EXPANDED CLAY AND SHALE

Concrete block utilized 79 per cent of sales in 1967, compared with 76 per cent in 1966 and 78 per cent in 1965. Precast concrete shapes and cast-in-place structural concrete consumed 3 and 17 per cent respectively in 1967, compared with 2 and 19 per cent in 1966 and 4 and 16 per cent in 1965. Minor uses, such as aggregate in refractory materials, soil conditioners, loose-fill insulation, accounted for 1 per cent in 1967, 2 per cent less than in 1966 and the same in 1965.

EXPANDED SLAG

As in the four previous years, 98 per cent of sales was used in concrete block. Precast concrete shapes and cast-in-place concrete accounted for 1 per cent, unchanged since 1965. One per cent, also unchanged since 1965, was consumed in minor uses such as loose fill insulation, racetrack surfacing and fill.

EXFOLIATED VERMICULITE

Loose insulation consumed 78 per cent in 1967, 6 per cent more than in 1966 but unchanged from 1965. Plaster accounted for 9 per cent, compared with 14 per cent in 1966 and 11 per cent in 1965. Insulating concrete utilized 7 per cent in 1967, 11 per cent in 1966 and 7 per cent in 1965. Six per cent was used for such purposes as aggregate in refractory materials, underground pipe insulation, fertilizer filler, barbecue base, soil conditioning and in horticulture. Such minor uses accounted for 3 per cent of sales in 1966 and 2 per cent in 1965.

EXPANDED PERLITE

Sixty-nine per cent of sales was employed as aggregate in plaster. This was 2 per cent less than in 1966, 5 per cent less than in 1965 and 12 per cent less than in 1964. Thirteen per cent was utilized as industrial fillers and 10 per cent as an insulating material. Insulating concrete consumed 6 per cent, 1 per cent less than in 1966, but unchanged from 1965. Minor uses such as in horticulture and agriculture accounted for 2 per cent of sales in 1967.

TABLE 3

Construction in Canada 1965-67

Type of Construction	Percentage Change		Percentage of Total Value		
	1965-66	1966-67P	1965	1966	1967P
Engineering	+15.5	+ 1.9	40.1	40.7	40.4
Residential	+ 3.3	+ 7.8	27.9	25.3	26.6
Commercial	+23.2	− 8.9	10.3	11.1	9.9
Institutional	+14.8	+17.9	10.3	10.4	12.0
Industrial	+29.0	−13.9	7.9	8.9	7.5
Other building	+15.4	+ 4.0	3.5	3.6	3.6

Source: Dominion Bureau of Statistics.
P Preliminary.

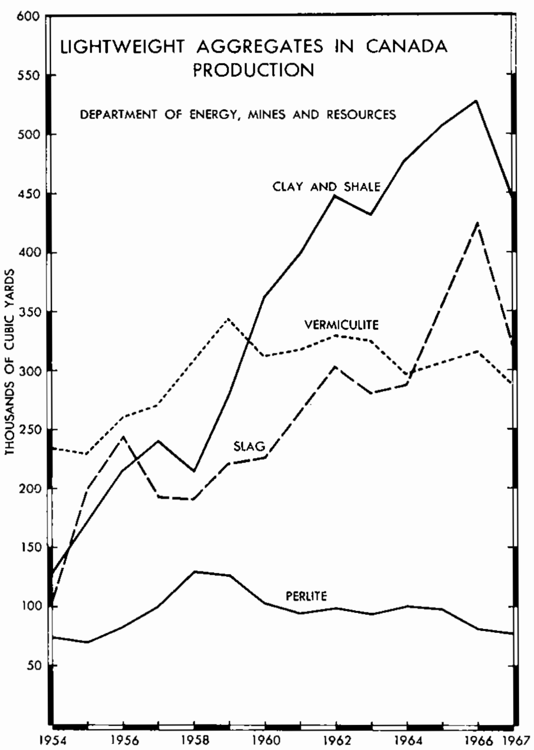
TABLE 4

Lightweight Aggregate Plants in Canada

Company	Location
Producing Plants	
Expanded clay	
Cindercrete Products Limited	Regina, Sask.
Consolidated Block and Pipe Ltd.	Regina, Sask.
Echo-Lite Aggregate Ltd.	St. Boniface, Man.
Edmonton Concrete Block Co. Ltd.	Edmonton, Alta.
Kildonan Concrete Products Ltd.	St. Boniface, Man.
Expanded shale	
British Columbia Lightweight Aggregates Ltd.	Saturna Island, B.C.
Cell-Rock Inc.	Lafleche, Que.
Consolidated Concrete Limited	Calgary, Alta.
Domtar Construction Materials Ltd.	Cooksville, Ont.
Expanded slag	
Dominion Iron & Steel Limited	Sydney, N.S.
National Slag, Limited	Hamilton, Ont.
Vermiculite	
Eddy Match Company, Limited (Grant Industries Division)	Vancouver, B.C.
	Calgary, Alta.
	Regina, Sask.
	Winnipeg, Man.
F. Hyde & Company, Limited	Montreal, Que.
	Toronto, Ont.
	St. Thomas, Ont.
P & V Products	St. Boniface, Man.
Vermiculite Insulating Limited	Lachine, Que.
Western Gypsum Products Limited	Vancouver, B.C.

TABLE 4 (Continued)

Company	Location
Perlite	
Canadian Gypsum Company, Limited	Hagersville, Ont.
Domtar Construction Materials Ltd.	Caledonia, Ont.
	Calgary, Alta.
Laurentide Perlite Inc.	Charlesbourg West, Que.
Perlite Industries Reg'd	Ville St. Pierre, Que.
P & V Products	St. Boniface, Man.
Vantec Industries Ltd.	Richmond, B.C.
Western Gypsum Products Limited	Vancouver, B.C.
Western Insulation Products Ltd.	Edmonton, Alta.
Pumice	
Miron Company Ltd.	Montreal, Que.
Ocean Cement Limited	Vancouver, B.C.



PUMICE

All pumice was used as aggregate in concrete block.

PRICES

Expanded clay and shale	$4.50 to $6.28/cu yd
Expanded slag	2.60 to 4.73/cu yd
Exfoliated vermiculite	0.25 to 0.40/cu ft
Expanded perlite	0.30 to 0.35/cu ft

All prices are f.o.b. plant.

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Aluminum

W.H. JACKSON*

CANADIAN INDUSTRY

Smelter production of primary aluminum increased from 889,915 tons in 1966 to 975,439 tons in 1967, an increase of 9.6 per cent. Shipments of primary forms to the domestic market decreased slightly to 194,096 tons from 196,318 tons. Supply was augmented by 8,176 tons of imported metal and 34,396 tons of secondary aluminum produced in Canada. Exports increased 6.2 per cent to 760,649 tons of which 47.7 per cent went to the United States, 18.5 per cent to Britain and 13.4 per cent to Japan. As markets in both the United States and Britain were slightly weaker in 1967, the unusual increase in exports to Japan was mainly responsible for the record level of exports; exports to several other countries were also higher.

Although 1967 was a good year compared with previous years, a strike at one smelter and production cutbacks at others combined to restrict output. A lower growth rate in world markets occurred in 1967 when Canadian plant modernization programs were nearing completion, and Canadian capacity was increasing. Estimated Canadian capacity at the end of 1967 was 1,065,000 tons. The lower growth rate of aluminum consumption reflected a levelling-off in the economies in a number of countries, that affected the fields of electrical conductors, new building construction and resulted in inventory drawdown by consumers.

Table 3 shows available data on Canadian aluminum consumption at the first processing stage. Primary and secondary aluminum and scrap from all sources are included in the data. Metal consumed in 1967 declined 11.7 per cent to 217,484 tons compared with a 14.0-per-cent increase in 1966. Production of extrusions and castings held up well during the year; the decline in the total for castings mainly reflects the completion of smelter expansion programs where aluminum was used in busbars. The data indicate a decrease in Canadian production of sheet and rod.

Canadian exports in the category of bars, rods, plates, sheet, circles, castings and forgings decreased slightly from 34,126 tons in 1966 to 30,671 tons in 1967. Imports of comparable items increased from 58,676 tons in 1966 to 79,814 tons in 1967. Imports of sheet and strip increased substantially. Details of imports, by category, are listed in Table 1.

The geographic locations of Canadian smelters shown on the accompanying map illustrate that to be viable they require low-cost power combined with low-cost transportation for an export-oriented industry that is based entirely on imported ore supplies.

Bauxite for the alumina plant at Arvida, Quebec, is imported mainly from Guyana via Trinidad and from Surinam. Alumina from Arvida is shipped to Quebec smelters. Alumina is imported from Guinea, and from Corpus Christi in the United States for the Baie Comeau smelter of Canadian British Aluminium Company Limited. It comes from alumina plants in Guyana, Jamaica and Australia for smelters owned by the Aluminum Company of Canada, Limited and supplements production at Arvida.

A decline in production was reported by Canadian British Aluminium Company Limited. A work stoppage in May and part of June resulted in frozen potlines and a few months elapsed before full production could be resumed in the smelter at Baie Comeau,

*Mineral Processing Division, Mines Branch.

Quebec. Production for the fiscal year ending July 31, 1967, was 87,686 tons compared with 102,062 tons the previous year. Early in 1968, plant modifications increased capacity to 115,000 tons annually. A smelter addition of 60,000 tons is planned. Reynolds Metals Company of the United States supplies the

TABLE 1

Canada, Aluminum Production and Trade, 1966-67

	1966		1967^{p}	
	Short Tons	$	Short Tons	$
Production				
Ingot	889,915		975,439	
Imports				
Bauxite ore				
Guyana	1,457,258	13,005,000	1,552,761	14,406,000
Surinam	726,434	8,150,000	771,596	8,137,000
Malaysia	323,542	1,596,000	173,786	908,000
Indonesia	–	–	42,865	256,000
Venezuela	–	–	15,769	136,000
United States	8,327	203,000	4,408	182,000
Other countries	9,006	75,000	128	4,000
Total	2,524,567	23,029,000	2,561,313	24,029,000
Alumina				
Jamaica	459,772	28,345,000	423,576	26,605,000
United States	183,751	13,684,000	163,793	12,187,000
Guyana	130,614	8,168,000	115,917	7,284,000
Republic of Guinea	33,560	2,086,000	36,392	2,265,000
Australia	–	–	20,906	1,384,000
Other countries	142	58,000	151	24,000
Total	807,839	52,341,000	760,735	49,749,000
Aluminum and aluminum alloy scrap	23,407	1,253,000	9,545	808,000
Aluminum paste and aluminum powder	893	588,000	587	503,000
Aluminum pigs, ingots, shot, slabs, billets, blooms and extruded wire bars	16,923	9,581,000	8,176	4,830,000
Aluminum castings*			1,129	3,108,000
Aluminum forgings	2,449	6,377,000	1,606	4,550,000
Aluminum bars and rods, n.e.s.	958	1,209,000	1,526	1,662,000
Aluminum plates	3,942	4,199,000	6,038	5,692,000
Aluminum sheet and strip up to .025 inch in thickness	5,929	4,945,000	8,866	7,393,000
Aluminum sheet and strip, over .025 inch up to .051 inch in thickness	2,430	2,505,000	3,535	3,574,000
Aluminum sheet and strip, over .051 inch up to .125 inch in thickness	7,972	6,033,000	40,446	26,698,000
Aluminum sheet and strip, over .125 inch in thickness	34,996	21,993,000	16,668	10,964,000
Aluminum foil or leaf	455	633,000	1,026	1,361,000
Converted aluminum foil		1,030,000		1,475,000
Structural shapes, aluminum	1,355	3,416,000	1,468	4,387,000
Aluminum pipe and tubing	350	658,000	435	814,000
Aluminum wire and cable excluding insulated	622	569,000	842	784,000
Aluminum and aluminum alloy fabricated materials, n.e.s.		9,433,000		9,171,000

TABLE 1 (Cont'd)

	1966		1967[p]	
	Short Tons	$	Short Tons	$
Exports				
Pigs, ingots, shot, slab, billets, blooms and extruded wire bars				
United States	382,147	172,256,000	362,713	169,004,000
Britain	145,097	76,559,000	140,960	78,853,000
Japan	32,076	15,319,000	102,261	50,872,000
West Germany	17,057	7,539,000	23,296	10,218,000
Republic of South Africa	29,914	15,230,000	18,563	9,739,000
Spain	13,526	5,897,000	11,807	5,215,000
India	3,827	1,906,000	11,569	5,740,000
Belgium and Luxembourg	3,730	1,917,000	10,669	5,424,000
Argentina	4,823	2,440,000	10,011	5,062,000
Brazil	10,529	4,829,000	9,923	4,727,000
Italy	9,169	4,079,000	8,164	3,840,000
Ireland	9,385	4,865,000	7,679	3,957,000
New Zealand	4,904	2,505,000	6,711	3,438,000
Hong Kong	5,518	2,794,000	5,241	2,637,000
Other countries	44,680	22,110,000	31,082	15,666,000
Total	716,382	340,245,000	760,649	374,392,000
Bars, rods, plates, sheet, circles, castings and forgings				
United States	12,041	9,421,000	9,607	8,411,000
Republic of South Africa	2,716	1,538,000	4,449	2,497,000
New Zealand	2,812	1,581,000	4,247	2,390,000
India	6,083	3,311,000	3,827	2,200,000
Venezuela	791	548,000	1,904	1,221,000
France	1,237	889,000	1,757	1,144,000
Jamaica	1,015	768,000	1,030	788,000
Pakistan	190	113,000	579	328,000
Britain	3,727	2,406,000	529	612,000
El Salvador	386	207,000	503	284,000
Portugal	494	281,000	443	254,000
Other countries	2,634	1,764,000	1,796	1,455,000
Total	34,126	22,827,000	30,671	21,584,000
Foil				
New Zealand	55	72,000	78	102,000
United States	111	132,000	48	51,000
Britain	55	79,000	41	64,000
Nigeria	4	5,000	17	19,000
Mexico	28	45,000	15	20,000
Other countries	41	60,000	32	46,000
Total	294	393,000	231	302,000
Fabricated materials, n.e.s.				
Mexico	3,163	1,621,000	3,200	1,604,000
United States	1,895	2,000,000	1,939	1,799,000
Jamaica	264	207,000	717	556,000
Peru	148	111,000	587	478,000
Venezuela	726	585,000	423	333,000
Pakistan	1,817	1,053,000	375	224,000
Bolivia	95	82,000	346	268,000
Other countries	4,230	3,151,000	2,528	2,370,000
Total	12,338	8,810,000	10,115	7,632,000

TABLE 1 (Cont'd)

	1966		1967p	
	Short Tons	$	Short Tons	$
In ores and concentrates				
United States	12,719	1,403,000	11,355	1,210,000
Italy	–	–	662	64,000
Spain	221	45,000	378	75,000
Britain	6	1,000	74	14,000
Australia	–	–	60	17,000
Other countries	109	10,000	101	32,000
Total	13,055	1,459,000	12,630	1,412,000
Scrap				
United States	28,919	7,211,000	36,292	10,188,000
Italy	12,936	4,869,000	11,038	4,287,000
Japan	2,005	703,000	2,738	983,000
West Germany	905	209,000	1,462	433,000
Netherlands	41	24,000	769	265,000
Taiwan	468	115,000	527	139,000
Other countries	497	159,000	463	161,000
Total	45,771	13,290,000	53,289	16,456,000

Source: Dominion Bureau of Statistics.
pPreliminary; –Nil; *Not available as a separate class prior to 1967; n.e.s. Not elsewhere specified.

TABLE 2

Canada, Primary Aluminum Production, Trade and Consumption 1958-67
(short tons)

	Prod.	Imports	Exports	Cons.*
1958	634,102	11,257	484,438	101,886
1959	593,630	852	507,290	89,000
1960	762,012	501	552,155	120,831
1961	663,173	636	487,034	135,575
1962	690,297	3,855	576,206	151,893
1963	719,390	1,954	635,187	161,833
1964	842,640	3,996	627,992	172,443
1965	830,505	6,945	707,512	213,094
1966	889,915	16,923	716,382	243,301
1967p	975,439	8,176	760,649	217,484

*Producers' domestic shipments to 1959; consumption reported by consumers from 1960, includes primary, secondary and scrap.
pPreliminary.

smelter with alumina for which payment in 1967 was made by the barter of 20,652 tons of aluminum.

Alcan Aluminium Limited is an international company based in Montreal with fully- or partially-owned smelters in Canada, Brazil, India, Italy, Norway, Sweden and Japan. Companies within the Alcan group have extensive interests in bauxite, alumina and fabricating production facilities in many countries. The company has changed in character as a result of the increasingly competitive circumstances of world trade. Ten years ago it was basically a producer of ingot for sale to fabricators but today a substantial portion of output is sold to fabricating companies within the corporate group. In Canada, the main subsidiary, Aluminum Company of Canada, Limited, (Alcan), operates smelters at Beauharnois, Shawinigan, Alma, and Arvida in Quebec and at Kitimat in British Columbia. A program of plant modernization and expansion has been under way over the last two years, with the result that total Alcan capacity in Canada was 950,000 tons at the end of 1967. Production in 1967 was a record 877,700 tons despite increasing inventories that resulted in production cutbacks in June and August after which period the annual operating rate was 845,000 tons. Alcan curtailed major expenditures on applied research directed toward commercial utilization of the monochloride process. This method involves producing aluminum metal directly from bauxite rather than by the conventional method of refining bauxite to aluminum oxide followed by electrowinning.

Subsidiaries and affiliates of the parent company in Brazil, India, Japan, Norway and Sweden produced 521,000 tons of aluminum ingot and had an effective capacity at year-end of 540,000 tons that will be increased by 90,000 tons in 1968.

TABLE 3

Canada, Consumption of Aluminum at First Processing Stage
(short tons)

	1964	1965	1966	1967p
Castings				
Sand	1,399	1,367	1,665	1,685
Permanent-mould	5,039	7,509	10,945	10,686
Die	7,702	13,202	15,647	17,481
Other	121	4,375	9,890*	62
Total	14,261	26,453	38,147	29,914
Wrought products				
Extrusions, including tubing	41,664	48,589	53,701	51,721
Sheet, plate, coil and other (including rod, forgings and slugs)	110,338	130,318	145,216	126,589**
Total	152,002	178,907	198,917	178,310
Destructive uses				
Non-aluminum-base alloys, powder and paste, deoxidizers, and other	6,180	7,734	6,237	9,260
Total	6,180	7,734	6,237	9,260
Total consumed	172,443	213,094	243,301	217,484
Secondary aluminum produced	19,342	23,570	30,532	34,396

Receipts and inventories at plants	Metal Entering Plants		on Hand Dec. 31	
	1966	1967p	1966	1967p
Primary aluminum ingot and alloys	232,555	197,179	47,740	52,528
Secondary aluminum	16,481	21,160	1,755	2,392
Scrap originating outside plant	30,128	37,959	5,143	4,098

Source: Dominion Bureau of Statistics as reported by consumers, adjusted.
pPreliminary; *Includes smelter busbar; **Includes re-roll stock imported from United States.

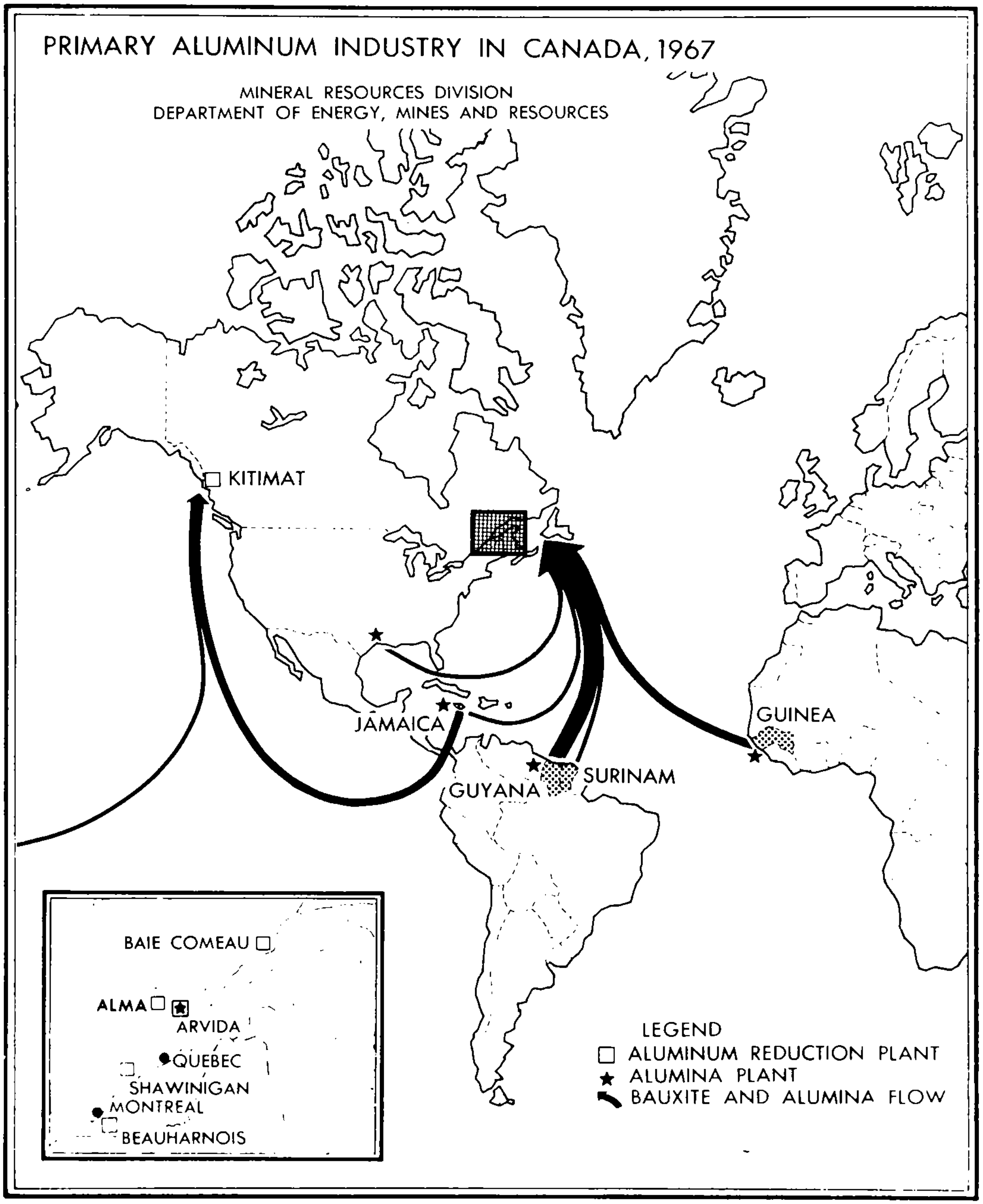
Noranda Mines Limited has been diversifying its operations. In December 1967, the company announced plans for the construction of an aluminum smelter with 70,000 tons annual capacity, at New Madrid, Missouri, USA. Completion is expected late in 1970 at a cost of \$60 to \$70 million. In Canada, Noranda rolls sheet aluminum and owns Canada Wire and Cable Company, Limited, a producer of both copper and aluminum wire and cable. In the United States, The Pacific Coast Company was acquired by Noranda in July 1967; it has fabricating plants in Cleveland, Ohio, and Jacksonville, Florida.

WORLD INDUSTRY

ORE SUPPLY

Bauxite is a mixture of clay minerals that are lateritic weathering products of rocks, such as limestone, nepheline syenite, basalt, or clays from which silica (SiO_2) has been leached and alumina (Al_2O_3) concentrated. The process is common in tropical or sub-tropical countries but deposits of ore grade are not easy to find or develop. Generally, metal-grade ore or concentrates contain over 40 per cent alumina and less than 4 per cent reactive silica. The better ores contain about 2 per cent reactive silica.

The alumina content of bauxite is preferably in the form of the mineral gibbsite ($Al_2O_3.3H_2O$) which can be leached with weak caustic soda solutions at 142°C at about 10 atmospheres pressure. Boehmite ($Al_2O_3.H_2O$) and diaspore ($Al_2O_3.H_2O$) are the other low silica aluminum minerals of commercial interest but these require stronger solutions and higher temperatures (225°C) and pressures up to 35 atmospheres. The other clay minerals, such as kaolinite and halloysite, are undesirable because of their silica content as this reacts with caustic soda. These must be minor constituents or be separable by washing and screening.


PRIMARY ALUMINUM INDUSTRY IN CANADA, 1967
MINERAL RESOURCES DIVISION
DEPARTMENT OF ENERGY, MINES AND RESOURCES
KITIMAT
JAMAICA
GUYANA
SURINAM
GUINEA
BAIE COMEAU
ALMA
ARVIDA
QUEBEC
SHAWINIGAN
MONTREAL
BEAUHARNOIS
LEGEND
ALUMINUM REDUCTION PLANT
ALUMINA PLANT
BAUXITE AND ALUMINA FLOW

Quartz is not a major impurity unless it is sufficiently fine-grained to react significantly. Phosphates, manganese minerals and, in particular, oxides or iron and titanium complicate recovery but are not as serious as the reactive silica content or the proportions of aluminous minerals which determine whether the Bayer or the Combination process must be used in recovering alumina.

High silica bauxites, clays, shales and other aluminous rocks such as nepheline syenites or anorthosites are common in many parts of the world. Recovery processes for alumina are technically feasible from such rocks but the cost of recovery from them is much higher than from commercial-grade bauxites because of the silica content.

The USSR is the only country known to use aluminous materials in addition to bauxite as the basis for an aluminum industry. These materials are nepheline syenite, with soda and cement as byproducts, and alunite with sulphuric acid as a byproduct. Other world producers will continue to use the lower cost alumina derived from bauxite in the foreseeable future.

Total world production of bauxite was 49.7 million tons in 1967 with the countries producing 2 million tons or more being Jamaica (10.3 million tons), Surinam (6.0), Australia (4.7), Guyana (3.7), France (3.1), USSR (5.3), Yugoslavia (2.3), United States (2.0) and Guinea (3.0). Exclusive of the needs of communist countries, over 50 million tons will be required by 1970 compared with 42.0 million tons in 1967. New mines, as always, must precede smelter construction.

Some 4 to 5 tons of bauxite must be refined to produce 2 tons of alumina. When the alumina is smelted one ton of metal is produced. Transportation economics are accelerating the establishment of new alumina plants close to the mines. Consortiums are becoming more common with each partner taking a share of output in proportion to equity. Financing is facilitated and economic viability assured by this "pay money or take the output" arrangement. The advantage is evident where the capacity of a mine-refinery complex is beyond the immediate needs or resources of a particular corporate group. The current development of the bauxite deposits of Boke in Guinea is a good example of the advantages of scale attributable to this type of venture.

Australia and Jamaica are the countries in which the main expansion is taking place. A brief review of mine developments in those countries is illustrative of the magnitude of the projects under way.

Australian bauxite and alumina are rapidly becoming major supply sources for an expanding world aluminum industry. The commercial importance of Australian bauxite was recognized only 10 years ago. The possibility of open-pit mining near ocean transport, the use of bulk carriers, and the safety of investment contributed to rapid development. From 21,000 tons in 1961, production of bauxite increased to 2 million tons in 1966 and to 4.66 million tons in 1967. The bauxite resources of the Darling Ranges at Kwinana, on the west coast, support the alumina plant of Western Aluminum Company whose annual capacity will be expanded to 620,000 tons by the end of 1968 and possibly 913,000 tons by the end of 1969. Output is shipped to the United States, to Japan, and to the Alcoa smelter of 40,000-ton annual capacity at Port Henry, Australia. At Weipa, on the northern tip of Queensland, Commonwealth Aluminum Corporation Limited (Comalco) ships bauxite to Japan and to the refinery of Queensland Alumina Company at Gladstone where capacity is being raised to 900,000 tons a year and later to 1.8 million tons a year. The alumina output is shared by consortium members, Kaiser Aluminum & Chemical Corporation of the United States, Alcan, Pechiney, Compagnie de Produits chimiques et Electrometallurgiques of France and Conzinc Riotinto of Australia Limited in proportion to their equity in the plant. Most of it is sold overseas but within Australia shipments are made to the Bell Bay smelter of Comalco, with an annual aluminum capacity of 72,000 tons, and shipments will also be made to 40,000-ton Alcan smelter at Kurri Kurri upon completion in 1969. Starting in 1972, Nabalco Pty. Limited will be producing from the Gove bauxite deposits in Northwest Territory and will be shipping some 500,000 tons of alumina annually to Europe. American Metal Climax, Inc. is investigating bauxite resources in the North Kimberleys and a related alumina project at Port Warrender. The Australian government indicated it would continue its control on imports of aluminum metal until 1971 to protect its growing aluminum smelting and fabricating industry.

Alcan Jamaica Limited, the first company to process bauxite to alumina in Jamaica, will have an alumina capacity of 1,215,000 tons annually in 1968. Alcoa Minerals of Jamaica will build a 200,000-ton refinery with further expansion to 800,000 tons a year planned. Another venture, Alumina Partners of Jamaica, composed of Kaiser Jamaica Corporation, Reynolds Jamaica Alumina Company and Anaconda Jamaica Limited, will construct a 950,000-ton-a-year alumina plant at a cost of $185 million. Kaiser Bauxite Company transferred its operations on the south coast to Alumina Partners of Jamaica and on the north coast completed a mining complex capable of shipping 6 million tons of bauxite annually. Revere Copper and Brass, Inc. is to complete a 220,000-ton alumina plant in 3 years with capacity rising to 660,000 tons annually over a 10-year period.

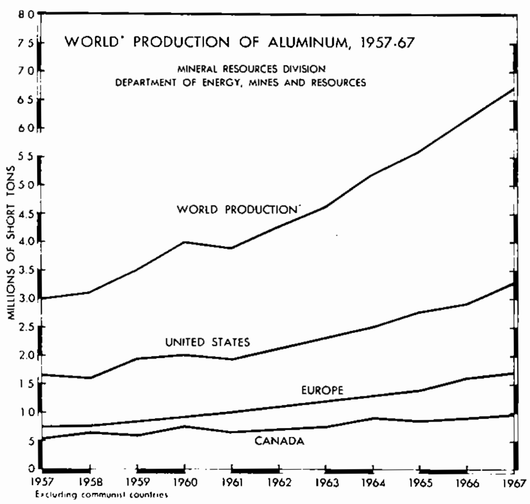
Projects of such magnitude tend to obscure the valuable contribution made by smaller mines to the economies of the developing countries. A consortium of Japanese interests comprising Nippon Light Metal, Showa Denko Kabushiki Kaisha and Sumitomo Chemical Co. are to develop at a cost of $3 million the bauxite deposits on Fiji. Production is expected in 3 years at a rate of some 250,000 tons annually. The grade of the ore is good at 50 per cent alumina and only 2 to 3 per cent silica. Reserves are currently in the order of 5 million tons but additional tonnages are likely to be found.

Prices for metal grade bauxite are not published. The basis is usually a stipulated price with bonus or penalty clauses for variations in the alumina or silica content. Transportation is an important consideration for the purchaser. Average prices per short ton in 1967 for material imported into Canada and valued at point of origin, grade not specified, were \$5.23 from Malaysia, \$9.28 from Guyana, and \$10.54 from Surinam. The *Metals Week* quotation is an indication of the value of other grades of bauxite. Values (US) per long ton f.o.b. Atlantic ports at year-end were: (a) \$16 for the dried chemical grade containing 60 per cent Al_2O_3, 6 per cent Si and 1 1/4 per cent Fe (b) \$35 for the calcined abrasive grade containing 86 per cent Al_2O_3 and less than 7 per cent silica, and (c) \$42 for the refractory grade, 87.5 per cent Al_2O_3 minimum. The latter is in limited supply and is essential for the manufacture of high alumina bricks used mainly in lining steel furnaces. Alumina f.o.b. prices range from \$63 to \$74 (Can.) per short ton depending upon source and contract.

METAL SUPPLY AND DEMAND

In smelting, the typical Hall electrolytic cell operating at 960°C, uses 8 kilowatt hours of electricity to produce one pound of aluminum. About 0.5 pound of carbon and 0.1 pound of aluminum fluorides are the other basic materials.

Historically, aluminum plants have been built near low-cost sources of power but in recent years regional markets have grown to the point where higher-cost power available in industrial areas is sometimes tolerable. Savings in transportation or tariffs are the main advantages but investment incentives in one form or another are also important. In the eastern United States, thermal power at 4 mills per kilowatt hour is the basis for a number of smelters which compete for certain markets with west coast smelters having power at 2 mills but higher transportation costs to the competitive market area. In the future, the availability of nuclear power should increase the number of alternative choices for smelter sites. For example, the costs of delivering alumina to Britain compared with delivery to other centres with access to sea transport are not significantly different. Nuclear power in Britain costs about 6 to 7 mills per kilowatt hour. The hope of power at lower cost, coupled with the possibility of investment incentives, resulted in a number of smelter proposals that were under consideration in 1967 by British authorities. In a number of countries, final assessment by industry of results of the Kennedy Round of trade negotiations should also have a bearing on future smelter locations.



The accompanying production graph shows the growth for the 1957-67 period. The Canadian position is becoming relatively less significant in the total picture but ingot of Canadian and Norwegian origin predominates in international aluminum trade. The relative importance of countries producing over 0.2 million tons of ingot in 1967 were: USA (3.26 million tons), USSR (1.27), Canada (0.97), Japan (0.42), France (0.40), Norway (0.40), and West Germany (0.28). Competition for non-captive markets becomes acute during periods of oversupply when metal becomes available from marginal supply sources. Table 4 shows, in a general way, areas of surplus production, areas of deficit whose needs must be met by imports, and the balance between production and consumption in 1967.

Aluminum has shown the largest increase in consumption of all nonferrous metals since World War II; and almost half of world production is consumed in North America. Because consumption in 1966 was a record high, available capacity was strained to meet demand but consumption levelled off in 1967 concurrent with capacity increases. Primary capacity, excluding communist countries, should increase to at least 7.62 million tons a year by the end of 1968. The recent static or low-growth trends in the economies of major consuming countries thus resulted in temporary oversupply as production capacity increased. Primary consumption in 1967 in non-communist countries was 6.5 million tons. A resumption in overall consumption growth is anticipated in 1968 when consumption could rise by about 6 per cent. World primary supply was augmented by 1.5 million tons of secondary ingot in 1967.

In the United States, primary production was 3.5 million tons, which was supplemented by secondary production of 867,000 tons. Primary production continued at record levels and producer inventories increased although sales from the United States government stockpile were less in 1967. Lower demand in the automobile industry as a result of strikes and the lower level of construction activity were factors contributing to increased availability of aluminum. Another was the drawdown from inventories by fabricators as a result of business uncertainties. As union contracts with the primary producers expire May 31, 1968, inventory buildup by fabricators and normal demand are expected to provide improved markets. At the end of 1967, there was 1,501,696 tons of aluminum in the United States government stockpile compared with the current objective for conventional warfare of 450,000 tons. Sales from the United States stockpile were 64,594 tons in 1967 compared with 326,000 tons in 1966.

TABLE 4

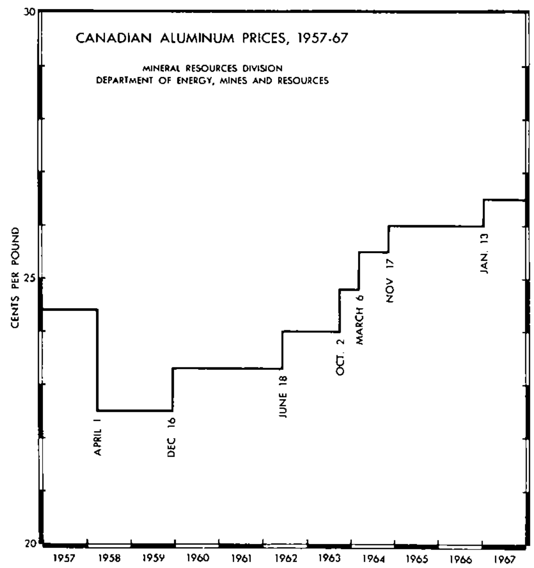
World Primary Aluminum Production and Consumption, 1967
(thousands of short tons)

	Production	Consumption
Non-communist		
Canada	975.4	194.0
United States	3,269.3	3,449.3
Europe	1,701.5	1,945.9
Japan	421.2	549.6
Australia	101.8	82.5
India	106.1	110.0
Africa	107.2	38.8
Sub Total (includes countries not listed)	6,699.2	6,512.8
Communist	1,712.8	1,570.0
Total	8,412.0	8,082.8

USES

Aluminum castings have varied end-uses such as automotive parts, electrical appliances and items for structural or decorative purposes. End-uses for sheet include building sheathing, cans, household utensils, foil and slugs for making collapsible tubes. Extrusions are typically used in conjunction with sheet in curtain-wall systems of building construction, in the manufacture of trucks, trailer bodies, railway cars, doors and windows, for pipe, and as tubing for lightweight furniture. Aluminum rod goes into the making of electrical wire and cable.

The main destructive uses are as a deoxidizer in steel manufacture, as an alloy with other metals such as magnesium or zinc, and as powder in the manufacture of paint and explosives.



PRICES

The price graph shows the range in the delivered price of primary aluminum in Canada from 1957 to 1967.

Effective January 13, 1967, the Canadian price was increased from 26 to 26.5 cents a pound for 50-pound ingots of 99.5 per cent purity and remained at this level throughout 1967. In the United States, a similar increase from 24.5 to 25.0 cents became effective January 18, 1967. The quoted Canadian producers export price, c.i.f. main European ports, remained unchanged at 24.5 cents (US) since November 1964. The devaluation of Sterling in Britain resulted in an increase in the British price to reflect the export quotation.

TARIFFS

	British Preferential	Most Favoured Nation	General
CANADA			
Bauxite and alumina	free	free	free
Aluminum and aluminum alloys, pigs, ingots, blocks, notch bars, slabs, billets, blooms and wire bars	free	1¼¢ a lb	5¢ a lb

TARIFFS (cont'd)

	British Preferential	Most Favoured Nation	General
UNITED STATES			
Bauxite	50¢ per long ton (temporarily suspended)		
Unwrought aluminum			
Of uniform cross section throughout its length, the least cross section dimension of which is not greater than 0.375 in. in coils	2.5¢ a lb		

OTHER	
Aluminum other than alloys of aluminum	1.25¢ a lb
Alloys of aluminum	
Aluminum silicon	2.125¢ a lb
Other	1.25¢ a lb
Aluminum waste and scrap	1.5¢ a lb (suspended)

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in some countries with reductions beginning on January 1, 1968 and final reductions occurring on January 1, 1972.

Antimony

J.G. GEORGE*

Canada's production of antimony is derived as a byproduct of lead smelting operations, principally in the form of antimonial lead. There has been no production of antimony metal or regulus in Canada since 1944. Primary output in 1967, expressed as the antimony content of antimonial lead alloys, was 1.24 million pounds compared with 1.41 million pounds in 1966.

Canadian requirements of antimony metal, antimony oxide and antimony salts are imported. Statistics on metal imports were discontinued in 1964 but in earlier years the main suppliers were Mainland China and Yugoslavia, which mine and refine antimony ores, and western European countries which import antimony ores and concentrates and export refined metal and salts. Imports of antimony oxide in 1967 totalled 530,300 pounds of which 75 per cent came from Britain and the remainder from the United States and Mainland China.

Cominco Ltd., which operates a lead smelter and refinery and an electrolytic zinc plant at Trail, British Columbia, is the sole producer of primary antimonial lead in Canada. The antimonial lead has a variable antimony content up to 35 per cent, depending on the customers' requirements. Secondary smelters recovered antimonial lead from scrap metal but no recent information is available concerning this production. Shipments of secondary antimonial lead amounted to 22,235 tons in 1965 and 20,225 tons in 1964.

DOMESTIC SOURCES AND OCCURRENCES

The main source of the antimonial lead produced at Trail is the lead concentrate obtained from ores of Cominco's Sullivan mine at Kimberley, British Columbia. Other sources are the 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 is recovered in anode residues from the electrolytic refining of the bullion and in furnace drosses produced during the purification of the cathode lead. 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.

Canadian occurrences of the principal antimony mineral, stibnite (Sb_2S_3), have been reported in widely separated locations. Over the years some of these occurrences have been explored and partially developed but usually the results have been discouraging. The better known occurrences are in the Atlantic Provinces, Quebec, British Columbia and the Yukon Territory. Proven and probable reserves of Yukon Antimony Corporation Ltd. were reported in 1965 to be 100,000 and 250,000 tons, respectively, averaging 5 per cent antimony. These deposits are on Carbon and Chieftain Hills in the Wheaton River district of the Yukon Territory, about 55 miles southwest of Whitehorse.

*Mineral Resources Branch.

TABLE 1

Antimony – Canadian Production, Imports and Consumption, 1966–67

	1966		1967p	
	Pounds	$	Pounds	$
Production				
Antimony content of antimonial lead alloys	1,405,681	745,000	1,243,000	659,000
Imports				
Antimony oxide				
Britain	568,100	237,000	400,800	165,000
Mainland China	27,200	8,000	88,100	23,000
United States	89,400	37,000	41,400	16,000
Belgium and Luxembourg	58,000	24,000	–	–
Total	742,700	306,000	530,300	204,000
Consumption				
Antimony regulus (metal) in production of:				
Antimonial lead alloys	744,446		802,362	
Babbitt	72,613		123,916	
Solder	21,594		25,606	
Type metal	176,572		174,080	
Other commodities*	82,937		64,215	
Total	1,098,162		1,190,179	

Source: Dominion Bureau of Statistics.
*Includes foil, bronze, lead-base alloys, drop shot and other minor commodities.
p Preliminary; – Nil.

TABLE 2

Antimony – Canadian Production, Imports and Consumption, 1958–67 (pounds)

	Production* (all forms)	Imports (regulus)	Consumption** (regulus)
1958	858,633	808,053	1,027,000
1959	1,657,797	1,170,796	1,135,000
1960	1,651,786	843,794	952,000
1961	1,331,297	832,547	1,029,000
1962	1,931,397	1,275,917	1,211,000
1963	1,601,253	1,036,235	976,000
1964	1,591,523	. .	558,000
1965	1,301,787	. .	660,000
1966	1,405,681	. .	1,098,000
1967p	1,243,000	. .	1,190,000

Source: Dominion Bureau of Statistics.
*Antimony content of antimonial lead alloy shipped.
**Consumption of antimony regulus (metal) as reported by consumers. Does not include antimony in antimonial lead produced by Cominco Ltd.
p Preliminary; . . Not available.

WORLD REVIEW

World mine production of antimony in 1967, as estimated by the United States Bureau of Mines, totalled 67,000 short tons, 1,200 tons more than in 1966. Antimony ores are mined in only a few countries, the largest producer being Mainland China where small quartz veins containing stibnite are mined in Hunan province in south-central China. Another large supplier is the Republic of South Africa where gold-antimony ore is mined by Consolidated Murchison (Transvaal) Goldfields and Development Company Limited near Pietersburg, in the north-eastern part of the country. Bolivia, Mexico and Yugoslavia are also important sources of antimony ore. National Lead Company operates the world's largest antimony smelter for ores and concentrates at Laredo, Texas, where it produces antimony metal, mainly from imported Mexican antimony ores. Several countries, including Canada and the United States, recover antimony as a byproduct in the smelting of lead ores and concentrates. Secondary sources provide an important part of the world's supply of antimony in the form of reclaimed antimonial lead.

The United States in 1967 was again the world's largest consumer of antimony and continued to depend on foreign supplies for a large portion of its requirements. Authorized sales of antimony metal from the US Government stockpile totalled only 62 tons in 1967. Stockpiled antimony metal at the end of 1967 amounted to 49,371 tons, of which 23,871 tons were considered to be surplus to the stockpile objective. Stockpiled antimonial lead amounted to 10,818 tons at the beginning of 1967, declining to 10,487 tons at the end of the year. A stockpile objective has not been established for antimonial lead.

TABLE 3

Canadian Consumption of Antimonial Lead Alloy*, 1965–67
(pounds)

	1965	1966	1967[p]
Storage batteries	2,042,475	1,892,067	1,863,805
Other uses, including babbitt, solder, type metal	732,766	701,666	632,227
Total	2,775,241	2,593,733	2,496,032

Source: Dominion Bureau of Statistics.
*Antimony content of primary and secondary antimonial lead alloy.
[p] Preliminary.

TABLE 4

Canadian Consumption of Antimonial Lead Alloy*, 1960–67
(pounds)

1960	2,269,507
1961	2,494,220
1962	2,662,400
1963	2,688,157
1964	2,506,454
1965	2,775,241
1966	2,593,733
1967[p]	2,496,032

Source: Dominion Bureau of Statistics.
*Antimony content of primary and secondary antimonial lead alloys.
[p] Preliminary.

USES

Antimony is used both in its metallic form and in the form of antimony compounds, oxides and salts. A relatively small amount of antimony is consumed as a pure metal. Its most important outlet is as an ingredient in many lead alloys in which it hardens and strengthens lead. Antimonial lead containing from 3 to 12 per cent antimony is the main constituent of lead storage batteries. Lead alloys containing antimony are also used for sheathing electric cables, in pipe and sheet, and in the production of lead-base type metal in which it imparts the expansion-on-solidification effect to lead. Various other alloys containing antimony, lead and other metals are employed in the production of antifriction bearing metal and solder.

TABLE 5

World Mine Production of Antimony, 1965–67

	1965	1966[p]	1967[p]
Mainland China	16,500	16,500	*
Republic of South Africa	13,901	12,534	13,000
Bolivia (exports)	9,663	11,759	11,000
USSR	6,800[e]	6,800[e]	*
Mexico	4,924	4,915	5,000
Yugoslavia	3,051	2,916	3,000
Morocco	2,425	1,480	*
Turkey	1,840	1,780	*
Czechoslovakia	2,200	2,200	*
United States	845	927	850
Canada	651	703	622
Other countries	3,900	3,286	33,528
Total	66,700	65,800	67,000

Source: Dominion Bureau of Statistics for Canada for all three years. Minerals Yearbook 1966, United States Department of the Interior, for other 1965 and 1966 figures, and Commodity Data Summaries, January 1968, Bureau of Mines, United States Department of the Interior, for other 1967 figures.
*Included in "Other countries".
[p] Preliminary; [e]Estimated.

Substantial amounts of antimony are used in the form of antimony oxide, Sb_2O_3, which is usually produced directly from high-grade ore (containing 60 per cent or more antimony). Antimony oxide may be added to paints, plastics and fabrics for flameproofing, and to paints as a white pigment. In the ceramics field, the trioxide adds hardness and acid resistance to enamel coverings for such products as bathtubs, sinks, and refrigerators. The pentasulphide of antimony is used as a vulcanizing agent by the rubber industry and as a red pigment.

Manufacturers of intermetallic compounds employ high-purity antimony metal for semiconductor use. An aluminum-antimony alloy is widely used as a semiconductor in transistors and rectifiers. Also employed by the electronics industry are alloys of antimony which exhibit thermoelectric properties.

A large portion of the antimony requirements of the United States is derived from secondary sources. Secondary production was 24,321 tons in 1965 and 24,258 tons in 1966. These tonnages, added to the amounts of primary antimony consumption shown in Table 6, give a total use in the United States of about 41,240 tons in 1965 and 43,940 tons in 1966.

TABLE 6

Industrial Consumption of Primary Antimony in the United States, by Class of Material Produced (short tons, antimony content)

Product	1965	1966
Metal Products:		
Ammunition	36	154
Antimonial lead	6,382	6,285
Bearing metal and bearings	821	731
Cable covering	68	164
Castings	76	62
Collapsible tubes and foil	49	44
Sheet and pipe	104	107
Solder	244	155
Type metal	642	515
Other	214	219
Total	8,636	8,436

TABLE 6 (Cont't)

Product	1965	1966
Nonmetal Products:		
Ammunition primers	16	27
Fireworks	46	50
Flameproofing chemicals and compounds	1,971	3,188
Ceramics and glass	1,853	2,074
Matches	*	*
Pigments	855	832
Plastics	1,469	2,224
Rubber products	477	870
Other	1,596	1,980
Total	8,283	11,245
Grand Total	16,919	19,681

Source: US Bureau of Mines Minerals Yearbook, 1966.
*Included with "other" to avoid disclosing individual company confidential data.

PRICES AND TARIFFS

The United States domestic price of antimony metal, as quoted in *Metals Week*, in bulk, 99.5 per cent, f.o.b. Laredo, Texas, remained unchanged throughout 1967 at 44.0 cents a pound. The United States price of imported antimony metal, as quoted in *Metals Week*, in 5-ton lots, 99.5 per cent, f.o.b. New York, 2 cents a pound duty paid, was 41 1/2 – 42 cents a pound throughout 1967.

Tariffs on antimony in 1967 were:	British Preferential	Most Favoured Nation	General
CANADA			
Antimony, or regulus of, not ground, pulverized or otherwise manufactured	free	free	free
Antimony oxide	free	12 1/2% ad val	15% ad val
UNITED STATES			
Antimony ore		free	
Antimony metal, unwrought		2¢ per lb	

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT) that was convened in 1964 to consider reductions in tariffs submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968 and final reductions on January 1, 1972.

Asbestos

A.A. WINER*

Production of Canadian asbestos declined slightly compared to that in 1966, shipments were 1.40 million tons valued at $163 million. Newfoundland was the only province that showed a gain in production. This was in contrast to the previous year when Newfoundland was the only province that showed a decrease compared to 1965. Reduced production in 1967 probably was due to lessening of construction, automobile manufacture and other economic activity. However, total exports of asbestos manufactured products showed a rise, from $2.37 million in 1966 to $2.57 million. The United States continues to remain the largest single market for Canadian asbestos fibre and in 1967, 45 per cent of the total Canadian production was shipped to that country.

PRODUCTION AND DEVELOPMENT

Chrysotile is the only variety of asbestos produced commercially in Canada. The largest known deposits of chrysotile asbestos in the free world are centred in the Eastern Townships of Quebec and reserves are adequate for many years. Deposits of chrysotile are also found in the Yukon Territory, British Columbia, Ontario, northern Quebec and Newfoundland. Open-pit and underground mining methods are both used in Canada.

Crocidolite from South Africa is the main Canadian asbestos import, but only in small amounts. Occurrence of asbestiform minerals such as crocidolite, fibrous tremolite and anthophyllite have been reported in Canada but none is presently produced.

Proposals for development of the Canadian North were made in 1967, and the Federal and Territorial Governments commissioned an economic study of the Yukon. Asbestos has been an important factor in northern development for a number of years and there are a number of asbestos producing plants situated in the Canadian North.

Cassiar Asbestos Corporation Limited began operation of its mine at Clinton Creek, Yukon Territory late in 1967 and fibre valued at over $0.5 million has been shipped for that year. Exploration of asbestos properties in the region is being undertaken by other groups.

In Ontario, Hedman Mines Limited is continuing to develop its Matheson property. The plant is expected to be operative in 1968. Work has continued on Canadian Johns-Mannville Company, Limited property near Timmins, Ontario and operation of the mine is scheduled for 1968. Annual production rate is estimated at 25,000 tons per year.

In the Chibougamau district of Quebec, the McAdam Mining Corporation Limited is planning an underground development program to assess fibre grade. The Asbestos Hill project of Asbestos Corporation Limited in Northern Quebec has been deferred pending a re-appraisal of the project.

*Mineral Processing Division, Mines Branch.

TABLE 1

Asbestos – Production and Trade, 1966-67

	1966		1967P	
	Short Tons	$	Short Tons	$
Production (shipments)				
By type				
Crude	215	315,516		
Milled fibre	735,972	124,802,184		
Shorts	752,868	38,537,163		
Total	1,489,055	163,654,863*	1,400,708	163,011,249*
By province				
Quebec	1,341,491	138,570,399	1,260,468	138,828,849
British Columbia	88,771	15,718,741	72,640	13,365,000
Newfoundland	57,097	9,301,204	63,000	10,234,000
Yukon	–	–	3,000	513,000
Ontario	1,696	64,519	1,600	70,400
Total	1,489,055	163,654,863	1,400,708	163,011,249
Exports				
Crude				
Japan	71	54,000	114	87,000
United States	65	68,000	47	41,000
Italy	10	8,000	35	31,000
West Germany	14	12,000	26	22,000
Other countries	12	9,000	7	8,000
Total	172	151,000	229	189,000
Total milled fibres groups 3,4 and 5)				
United States	217,041	40,267,000	201,551	40,109,000
Britain	77,356	15,647,000	64,914	13,949,000
France	57,454	10,835,000	46,985	9,114,000
West Germany	50,169	10,157,000	42,371	8,196,000
Australia	33,375	5,544,000	33,297	5,822,000
Japan	19,364	3,346,000	30,267	5,209,000
Mexico	18,068	3,327,000	22,975	4,354,000
Belgium and Luxembourg	23,845	4,663,000	20,646	4,108,000
Spain	35,303	6,653,000	18,944	3,830,000
Brazil	15,724	2,969,000	18,076	3,458,000
India	14,374	2,919,000	13,096	3,019,000
Italy	12,435	2,555,000	12,023	2,407,000
Colombia	10,229	1,994,000	11,990	2,318,000
Netherlands	15,026	2,648,000	11,646	2,317,000
Other countries	132,822	24,347,000	104,499	19,360,000
Total	732,585	137,871,000	653,280	127,570,000
Shorts (groups 6,7,8 and 9)				
United States	440,075	24,639,000	406,155	22,870,000
Japan	56,030	4,903,000	76,514	6,957,000
Britain	53,655	3,023,000	45,452	2,707,000
West Germany	39,904	2,609,000	32,110	2,049,000
France	23,273	1,498,000	27,363	1,723,000
Belgium and Luxembourg	13,981	1,153,000	21,463	1,963,000
South Korea	3,500	333,000	12,412	1,213,000
Australia	9,016	636,000	8,640	574,000
Netherlands	9,358	550,000	8,352	514,000
Other countries	64,613	5,117,000	50,074	4,069,000
Total	713,405	44,461,000	688,535	44,639,000
Grand total, crude, milled fibres and shorts	1,446,162	182,483,000	1,342,044	172,398,000

Table 1 (cont'd)

	1966		1967P	
	Short Tons	$	Short Tons	$
Manufactured products				
Brake linings and clutch facings				
Cuba		156,000		231,000
Ecuador		31,000		58,000
United States		39,000		46,000
Kuwait		29,000		30,000
Australia		64,000		29,000
Lebanon		84,000		18,000
Greece		18,000		15,000
Other countries		146,000		135,000
Total		567,000		562,000
Asbestos and asbestos cement building materials				
United States		495,000		799,000
Australia		77,000		168,000
Netherlands		–		108,000
Jamaica		44,000		68,000
Japan		–		66,000
Leeward-Windward Islands		3,000		55,000
Guyana		4,000		43,000
Colombia		39,000		40,000
Other countries		275,000		30,000
Total		937,000		1,377,000
Asbestos and asbestos-cement basic products, not elsewhere specified				
United States		445,000		450,000
Switzerland		17,000		30,000
Britain		19,000		25,000
Japan		5,000		20,000
Australia		1,000		18,000
New Zealand		12,000		16,000
Guyana		2,000		13,000
Other countries		365,000		56,000
Total		866,000		628,000
Total, exports, asbestos manufactured products		2,370,000		2,567,000
Imports				
Asbestos, unmanufactured	6,560	1,274,000	7,293	1,281,000
Asbestos, manufactured cloth, dryer felts, sheets woven or felted		677,000		781,000
Packing		823,000		1,010,000
Brake linings		2,004,000		2,875,000
Clutch facings		207,000		354,000
Asbestos-cement shingles and siding		167,000		187,000
Asbestos-cement board and sheets		842,000		969,000
Asbestos and asbestos cement building material, n.e.s.		843,000		1,632,000

Table 1 (concl'd)

	1966		1967p	
	Short Tons	$	Short Tons	$
Asbestos and asbestos-cement basic products, n.e.s.		1,279,000		1,584,000
Total asbestos, manufactured		6,842,000		9,392,000
Total asbestos, unmanufactured and manufactured		8,116,000		10,673,000

Source: Dominion Bureau of Statistics.
*Does not include value of containers.
p Preliminary; – Nil; n.e.s. Not elsewhere specified.

TABLE 2

Asbestos – Production and Exports, 1958-67
(short tons)

Production*	Crude	Milled	Shorts	Total
1958	605	342,562	582,164	925,331
1959	432	404,019	645,978	1,050,429
1960	330	483,183	634,943	1,118,456
1961	163	548,230	625,302	1,173,695
1962	205	547,447	668,162	1,215,814
1963	217	579,085	696,228	1,275,530
1964	236	664,284	755,331	1,419,851
1965	163	659,598	728,451	1,388,212
1966	215	735,972	752,868	1,489,055
1967p	..	..	..	1,400,708
Exports				
1958	483	318,280	547,867	866,630
1959	416	401,583	611,923	1,013,922
1960	241	458,053	610,199	1,068,493
1961	176	527,324	589,380	1,116,880
1962	182	532,020	632,468	1,164,670
1963	195	555,419	650,811	1,206,425
1964	214	630,515	702,747	1,333,476
1965	123	630,777	688,504	1,319,404
1966	172	732,585	713,405	1,446,162
1967p	229	653,280	688,535	1,342,044

Source: Dominion Bureau of Statistics.
*Producers' shipments.
p Preliminary; .. Not available.

Although there was a moderate decline in Canadian asbestos production for 1967, the industry appears optimistic on a longer term basis. This is confirmed by the expansion programs that have taken place and are continuing.

TECHNOLOGY

Chrysotile asbestos, a hydrated magnesium silicate, is the main source of asbestos fibre in the world and is the only variety mined in Canada. The recovered fibre is graded essentially by length but other factors which determine its end-use, e.g., harshness and colour are also important.

Because of its physical characteristics, chrysotile is an important raw material in many industrial processes. When of the proper texture, the longer fibres may be processed much as the organic staple fibres. Consequently it may be carded, spun and woven into cloths of different weights, thicknesses and qualities. These cloths are used in the manufacture of heat-resistant friction materials.

The fibre is prepared from the ore by a dry milling process consisting of crushing, impact milling, fibrization and separation into different grades of fibre and tailings.

Many of the uses of chrysotile are a result of the physical characteristics, which generally vary with the mineral's occurrence. Soft or silky fibres from Quebec are used for spinning yarn and textile products, whereas harsher fibres from other sources, because of their fast filtering quality, can be used in the asbestos-cement industry. Low-magnetite fibre from British Columbia has great importance in the electrical industry where it is used because of its electrical and insulating properties.

The processed asbestos fibre groups classified as "shorts" has the greatest number of uses. These grades are used as reinforcements or fillers in floor tiling, plastics, paints and many other products. The most important single market for chrysotile is the asbestos-cement industry. Products include pipe, sheeting, shingles and millboard. Other products make use of the insulating and noncombustive properties of asbestos. It is also used in the automotive and textile industries and in specialized uses such as in space programs. In recent developments asbestos has been used for reinforcing a nylon molding compound. This compound is made with 20 per cent fibre by weight and its properties are said to approach that of glass, fibre-reinforced nylon. Low iron-content asbestos has been used as a filler in diallyl phthalate molding compounds.

Asbestos, on an overall basis, is still irreplaceable and remains as one of the more important industrial minerals which is vitally necessary in our present highly complex technological society.

WORLD REVIEW

The total world production of all types of asbestos for 1967 has been variously estimated from 3.3 million to 4.2 million tons. If we assume a world output of 3.5 million tons, Canada's production in 1967 remained at approximately 40 per cent of the world total.

In the United States production of asbestos in 1967 declined for the first time since 1960 although the value was one per cent higher than 1967. The decline is due to lower production in California, the leading United States asbestos producer. Other producers are located in Vermont, Arizona and North Carolina. Although total exports of Canadian chrysotile asbestos fibre to the United States in 1967 declined from that in 1966, the proportion (45 per cent) of the total production was similar. Demand for Canadian fibre in the United States still appears stabilized.

Southern Rhodesia discontinued publication of production and trade data on a country-wide basis in 1965 but production has been estimated at 175,000 tons, similar to that in 1964. The asbestos fibre is particularly desirable because of the low magnetite content.

South Africa is one of the largest asbestos producers in the world. In 1966, final figures show an increase in fibre production over that in 1965, 277,000 and 241,000 short tons respectively. This country was the only significant producer of amosite in the world in 1966.

TABLE 3

World Production
(short tons)

	1966	1967[e]
Canada	1,489,055	1,400,708
USSR	925,000[e]	. .
Republic of South Africa	276,597	280,000
Southern Rhodesia	175,000[e]	175,000
China	140,000	. .
United States	125,928	122,000
Italy	90,464	. .
Swaziland	36,142	. .
Other countries	101,814	. .
Total	3,360,000	3,308,000

Source: US Bureau of Mines Minerals Yearbook, 1966 and US Bureau of Mines Commodity Data Summaries, January, 1968.

[e]Estimate; . . not available.

In the USSR, according to recent statistics quoted from a Russian text publication, the 1965 production of asbestos fibre of all grades (1-7) was 1.8 million short tons. Exports of fibre were approximately 17 per cent of the total USSR fibre production. It appears that the internal consumption of a large proportion of fibre production will continue for a number of years.

TABLE 4

Consumption of asbestos fibre in the USSR
(1964 – short tons)

Asbestos cement industry	744,000
Chemical industry	79,000
Other uses	74,000
Total	897,000

Existing forecasts are generally optimistic on a long term basis, and demand for the high quality Canadian fibre is expected to remain strong. The developing countries have increased their demand for asbestos because of their high rate of growth. The United States continues to remain the largest single world market for asbestos fibre.

PRICES

A price increase of 2 per cent has been scheduled for April, 1968.

Asbestos prices quoted in Canadian funds in *Metal Week* (December 25, 1967) were as follows:

per short ton, f.o.b. mine or mill, Que.

Crude No.	1	$1,410
"	2	760
Fibre	3F	588
	3K	500
	3R	424
	3T	385
	3Z	360
	4A	335
	4K	220
	4T	198
	5D	165
	5R	140
	6D	101
	7D	85
	7M	47
	7R	46
	8S	29

per short ton North Vancouver, B.C.

Crude No.	1	$1,522
Fibre	AAA	810
	AA	843
	A	484
	AC	345
	AD	294
	AK	241
	AS	200
	AX	197
	AY	126

TARIFFS

	British Preferential (%)	Most Favoured Nation (%)	General (%)
CANADA			
Asbestos, crude	free	free	25
Asbestos in any form other than crude, and all manufactures thereof, n.o.p.	12 1/2	12 1/2	25
Asbestos in any form other than crude, and all manufactures thereof, when made from crude asbestos of British Commonwealth origin, n.o.p.	free	12 1/2	25
Yarns, wholly or in part of asbestos, for use in the manufacture of clutch facings and brake linings	7 1/2	12 1/2	25
Woven fabrics, wholly or in part of asbestos, for use in the manufacture of clutch facings and brake linings	12 1/2	12 1/2	30

UNITED STATES

Asbestos, not manufactured, crude,	free
fibres and stucco and asbestos sand and refuse containing not more than 15% by weight of foreign matter	free
Asbestos, yarn, slivers, rovings, wick, rope, cord, cloth, tape and tubing of asbestos, or of asbestos and any other spinnable fibre, with or without wire and articles of any of the foregoing	8% ad val.
Other	0.225¢ per lb

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Barite

J.E. REEVES*

Production of barite in Canada is geared closely to the demand for it in oil- and gas-well drilling. Total production in 1967 declined to 172,270 short tons, about 22 per cent lower than in 1966, because of reduced exports to the United States. Most of the barite leaving the mine sites in Nova Scotia and British Columbia is in a coarse form, having received only minimal processing before shipment. The amount of ground barite shipped from Walton, Nova Scotia, decreased to 4,708 short tons, down by more than 50 per cent from 1966 and about 75 per cent from 1965.

Exports, consisting mainly of coarse barite shipped from Nova Scotia to Gulf of Mexico ports in the United States, declined by about 27 per cent. A small amount was also sent to Venezuela, and a much smaller quantity of ground barite was exported to Trinidad.

A small but increased quantity of relatively high-priced ground barite was imported, mainly from the United States.

Incomplete statistics indicate a continued increase in world production of barite in 1967. Canada occupies a prominent position among world producers because of its ability to market a high-quality barite for use in drilling muds.

The outlook for Canadian barite is uncertain. Canada's dependence on the need for barite in the drilling for oil and gas, particularly in the United States, will continue to cause fluctuations in production. The probable new output of much higher priced filler grades will not be large enough to offset these fluctuations.

DOMESTIC PRODUCERS

Barite was produced only in Nova Scotia and British Columbia in 1967. The output from Nova Scotia is mainly exported to grinding plants in the United States. The barite from British Columbia is shipped to grinding plants in Alberta for final processing and domestic use.

Small amounts of barium metal and strontium metal are recovered by Dominion Magnesium Limited at Haley, Ontario.

NOVA SCOTIA

Dresser Minerals, Division of Dresser Industries, Inc. (which replaced by reorganization Magnet Cove Barium Corporation) mines barite from a large deposit near Walton by a modified method of block caving. During 1967, it continued to beneficiate minus two inch crushed and lump material in a heavy media installation and to truck the product to Walton for ocean shipping. Early in 1968, the barite processing plant was destroyed by fire. While a new plant was being built, production was suspended and the mine shaft was being deepened.

The company also recovers barite by flotation during the processing of argentiferous sulphides from a deposit adjacent to the barite orebody.

The operation, located near an ocean port, is dependent on exports of barite, mainly in a coarse form, to the parent company's grinding plants adjacent to the Gulf of Mexico, principally at Lake Charles, Louisiana, for ultimate use as a weighting agent in well drilling. A small amount of the barite is periodically fine-ground at a small plant near the dock in Walton. Ground barite is sold domestically for various filler uses and is exported to Trinidad for use in well drilling.

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*Mineral Processing Division, Mines Branch.

TABLE 1

Barite – Production, Trade and Consumption, 1966-67

	1966		1967	
	Short Tons	$	Short Tons	$
Production (mine shipments)				
Crushed and lump	211,657	1,982,841	167,562	1,483,685
Ground	9,719	216,213	4,708	89,685
Total	221,376	2,199,054	172,270	1,573,370
Imports				
United States	4,043	232,000	5,800	299,000
West Germany	122	5,000	94	4,000
Britain	–	–	30	2,000
Total	4,165	237,000	5,924	305,000
Exports				
United States	189,775	1,738,000	137,781	1,260,000
Venezuela	–	–	6,382	59,000
Trinidad-Tobago	9,279	172,000	1,940	36,000
Total	199,054	1,910,000	146,103	1,355,000
	1965		1966	
Consumption[1]				
Well drilling	9,436		12,223	
Paints	1,991		1,632	
Glass	860		896	
Rubber goods	62		158	
Other[2]	276		275	
Total	12,625		15,184	

Source: Dominion Bureau of Statistics.
[1] Available data reported by consumers. [2] Includes ceramic products, paper products, soaps and detergents.
– Nil.

BRITISH COLUMBIA

Mountain Minerals Limited mines barite underground from deposits near Parson and Brisco, crushes and screens it, and ships most of it to the company's grinding plant at Lethbridge, Alberta. The ground products are used mainly in well drilling.

Baroid of Canada, Ltd., recovers barite from tailings of the Giant mine, near Spillimacheen, and processes it in a grinding plant at Onoway, Alberta, for use in well drilling.

QUEBEC

Industrial Fillers Limited periodically processes barite in a grinding plant in Montreal.

OTHER DOMESTIC OCCURRENCES

Barite occurs in many other places in Canada and has been mined in a small way from several deposits. Of note are occurrences in Newfoundland, at Buchans; in Nova Scotia, east of Lake Ainslie on Cape Breton Island and near Brookfield; in northern Ontario, in Yarrow, Penhorwood and Langmuir Townships, and on McKellar Island in Lake Superior; and in northern British Columbia, at Mile 397 and north of Mile 548 on the Alaska Highway. In southeastern British Columbia, southwest of Invermere, barite constitutes about one third of the tailings of the inoperative Mineral King base-metal mine.

During the year, interest was shown in the deposits near Lake Ainslie and in Yarrow Township, and in the

TABLE 2

Barite – Production, Trade and Consumption, 1958-67
(short tons)

	Production[1]	Imports	Exports	Consumption[2]
1958	195,719	1,382	172,942	24,159
1959	238,967	1,662	221,721	22,408
1960	154,292	2,021	134,972	25,483
1961	191,404	1,889	171,696	18,723
1962	226,600	2,427	230,903	11,249
1963	173,503	3,830	159,892	11,343
1964	169,149	3,206	156,527	13,537
1965	203,025	3,686	185,032	12,625
1966	221,376	4,165	199,054	15,184
1967	172,270	5,924	146,103	. .

Source: Dominion Bureau of Statistics.
[1] Mine shipments. [2] Apparent consumption 1958 and reported consumption from 1959.
. . Not available.

TABLE 3

World Production of Barite, 1966-67
(short tons)

	1966	1967[e]
United States	1,006,965	1,010,000
West Germany	508,167	510,000
Mexico	321,306	320,000
USSR	250,000	. .
Canada	221,376	172,270
Italy	190,411	190,000
Greece	143,300	. .
Ireland	137,800	. .
China	130,000	. .
Peru	128,579	130,000
Morocco	117,126	120,000
Yugoslavia	110,231	110,000
France	110,200	110,000
Other countries	702,539	. .
Total	4,078,000	4,090,000

[e] Estimated; . . Not available.

Mineral King tailings. Extensive processing tests on samples from the Lake Ainslie deposits indicate that potentially acceptable grades of barite and fluorite can be produced. Some work was done on the deposit in Yarrow Township with a view to developing a source of barite for use in the making of various grades of filler.

An increasing interest has been shown in a deposit of celestite, strontium sulphate, near Loch Lomond on Cape Breton Island. A gently dipping bed up to 10 feet thick contains an indicated 800,000 to 1,000,000 tons of 75 per cent $SrSO_4$. Celestite from this deposit and barite from one or more sources in Nova Scotia will be used in a new plant to be built by Cape Chemical Corporation at Sydney for making strontium carbonate and barium carbonate for use in the manufacture of ferrites.

TECHNOLOGY

Barite, natural barium sulphate ($BaSO_4$), is of value mainly because of its physical properties: its high specific gravity, 4.5; its chemical inertness under normal conditions; and, from some sources, its whiteness. It is also used to a small extent as the main source of barium in the production of barium chemicals.

Barite is widely distributed and may be found in various geological environments. It occurs as the principal mineral in relatively narrow coarse-grained veins, sometimes accompanied by one or more of fluorite, calcite and quartz. It is found as the prominent gangue mineral in some lead-zinc-silver deposits. It occurs in irregular replacement deposits in sedimentary sequences, some of large size as at Walton. Because of its inertness, it is also found in some countries as residual deposits, resulting from weathering. It varies greatly in colour, from near-white to various shades of grey, brown and red. Choice white barite is relatively rare and is found most commonly in vein-type deposits.

Mining methods vary according to the type, size and attitude of the deposit. Processing methods vary with the mineral association and the required grade of products. Because of its weight, barite can be concentrated by some gravity means, but flotation is usually required to produce products that must meet strict specifications.

Witherite, natural barium carbonate ($BaCO_3$), is the only other commercial barium mineral. The only known occurrence of large size in Canada is the shallow, flat-lying replacement deposits along the Liard River in northern British Columbia, in which it occurs in association with fluorite and a small amount of barite. These deposits are too remote at present to be of economic interest. Witherite reacts readily with acids and therefore is used in the manufacture of barium chemicals. The world's principal source of witherite is in Northumberland County in England.

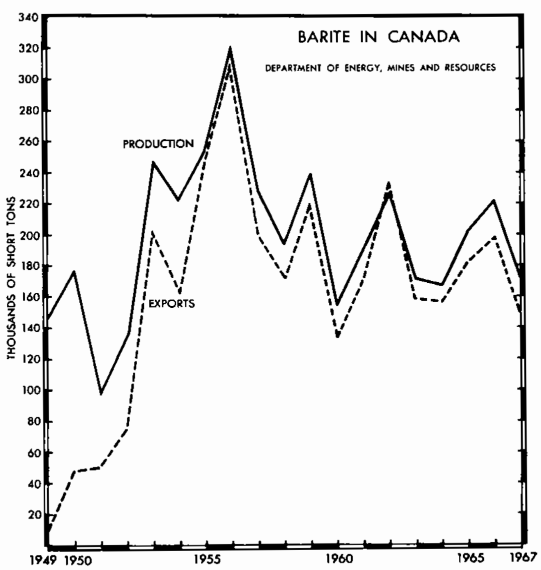
Celestite, natural strontium sulphate ($SrSO_4$), is similar to barite but not as heavy, and is used mainly in the manufacture of strontium chemicals. It occurs with fluorite in the property of Consolidated Rexspar Minerals & Chemicals Limited, at Birch Island, British Columbia, in small deposits in several places in southeastern Ontario and in Nova Scotia. The large deposit near Loch Lomond on Cape Breton Island has been known only since 1963.

TABLE 4

Barium Compounds – Imports and Consumption

	1965		1966	
	Short Tons	$	Short Tons	$
Imports				
Lithopone (70% $BaSO_4$)	218	31,000	316	44,000
Barium carbonate	3,623	321,000	3,952	361,000
	1964		1965	
	Pounds	$	Pounds	$
Consumption of some barium compounds				
Barium carbonate	1,423,534	70,000	1,530,500	88,000
Barium chloride	711,867	48,000	731,674	50,000

Source: Dominion Bureau of Statistics.



USES AND SPECIFICATIONS

The dominant use for barite is as a weighting agent in drilling muds. Its relatively high specific gravity assists in controlling abnormal fluid pressure in wells. Its relatively low cost makes it the most commonly used weighting agent. Principal specifications are usually a minimum specific gravity of 4.25 and a particle size of at least 90 per cent minus 325 mesh.

The second most important use is as a filler in paints, lacquers, and rubber and plastic compounds. In general, specifications require a minimum of 95 per cent $BaSO_4$ and a fine particle size, but vary somewhat according to end use. For some uses, barite fillers must have a high light reflectance.

Barite is used in the manufacture of glass. It acts as a flux and improves the workability of the melt, and provides added lustre. Specifications vary but usually require a minimum of 98 per cent $BaSO_4$, a maximum of 0.15 per cent iron (in terms of ferric oxide, Fe_2O_3) and a particle size of essentially minus 20 plus 200 mesh.

A minor use for barite is as a heavy aggregate in concrete for nuclear shielding and for pipeline construction.

There is as yet no barium chemicals industry in Canada. The more common barium compounds manufactured elsewhere are: lithopone, a mixture of barium and zinc sulphates, used as a white pigment in paints (lithopone has been extensively replaced by titanium dioxide); precipitated barium sulphate, or blanc fixe, used as an extender pigment in paints and as a filler in paper; precipitated barium carbonate, used for the reduction of scumming on brick and other ceramics and in the manufacture of optical glass and electronic tubes; and barium chloride used for case hardening steel. Barium oxide, hydrate, titanite, chlorate, nitrate, sulphide, ferrite and phosphate are also manufactured. Several of the barium compounds are used as a source of barium metal. The titanite is important in electronics because of its high dielectric constant and its piezoelectric and ferroelectric properties. Specifications vary for barite used in the manufacture of chemicals, but lump barite with a minimum of 94 per cent $BaSO_4$ and a maximum of 1 to 2 per cent Fe_2O_3 is usually required.

PRICES

Apart from small increases in some chemical grades of barite, prices in 1967 were much as they were in 1966. According to *Metals Week* of December 25, 1967, prices in the United States were:

Chemical grade	
Hand-picked lump, 95% $BaSO_4$, 1% Fe	\$20 - 20.50
Flotation or magnetic concentrate, 96-97½% $BaSO_4$, 0.3-0.7% Fe, in 100-lb bags, \$3 extra	\$24.50
Wet ground, 99½% $BaSO_4$, minus 325 mesh, in 50-lb bags	\$45 - 49
Drilling mud grade, 83-93% $BaSO_4$, 3-12% Fe, specific gravity 4.2 to 4.3	
Crude, in bulk	\$12 - 16
Ground	\$23 - 26
Imported, in bulk, c.i.f. Gulf ports	\$10 - 14
from Canada, long tons, in bulk, crude, f.o.b. shipping point	\$11
Ground, short tons, in 100-lb bags, f.o.b. shipping point	\$16.50

TARIFFS

Some tariffs in effect at the time of writing were:

	British Preferential	Most Favoured Nation	General
CANADA			
Crude or ground	free	20%	25%
For drilling-mud use	free	free	free
UNITED STATES			
Barite			
Crude	\$2.55 per long ton		
Ground	6.50 per long ton		
Witherite			
Crude	free		
Ground	12.5% ad val.		

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Bentonite

J.E. REEVES*

Bentonite consumption in Canada continued to grow, mainly because of its use as a binder in the increased production of pelletized iron mineral concentrates. In 1967, about 150,000 short tons were used by the iron ore industry, compared with 128,135 short tons in 1966, because of expanded output by pellet producers. The only new pellet operation in 1967, Steep Rock Iron Mines Limited, uses no bentonite because its concentrate agglomerates without the aid of a binder. The annual consumption by 1970 will probably reach 200,000 tons and possibly as high as 225,000 tons, depending on the number of proposed new plants that come into production by that time. All the bentonite used in pelletizing has come from the state of Wyoming.

Imports of bentonite from the United States increased appreciably, and a first shipment was received from Greece. Iron Ore Company of Canada and Wabush Mines, which together use nearly half the total imports of bentonite and more than two thirds of that used in pellet plants, are testing bentonite from the Grecian island of Melos. These companies import bentonite in the crude form from Wyoming and process it at Labrador City, Labrador, and Pointe Noire, Quebec, respectively.

Small but increased quantities of more expensive fuller's earth and much higher priced activated clays were also imported, principally from the United States. Small quantities of activated bentonite from Manitoba are exported to the United States.

DOMESTIC PRODUCTION

Three companies mine and process bentonite in Canada, although statistics on total production are not available for publication.

In Alberta, Dresser Minerals, Division of Dresser Industries, Inc. (which replaced by reorganization Magnet Cove Barium Corporation Ltd.) recovers swelling bentonite from the Edmonton formation, of Upper Cretaceous age, a few miles south of Rosalind, Baroid of Canada, Ltd., mines a similar bentonite from the same formation, to the northwest of Onoway. Both companies dry, pulverize and size the bentonite, for use mainly in drilling muds. Production has been declining because of strong competition from Wyoming bentonite.

In Manitoba, Pembina Mountain Clays Ltd. mines nonswelling bentonite from the Upper Cretaceous, Vermilion River formation, northwest of Morden. Some is dried and pulverized at Morden; some is activated at Winnipeg before being sold as a bleaching clay.

*Mineral Processing Division, Mines Branch.

TABLE 1

Bentonite – Trade and Consumption

	1966		1967	
	Short Tons	$	Short Tons	$
Imports				
Bentonite				
United States	192,211	1,789,000	208,998	2,045,000
Greece	–	–	10,864	109,000
Total	192,211	1,789,000	219,862	2,154,000
Activated clays and earths				
United States	4,127	575,000	6,277	838,000
France	54	17,000	218	79,000
West Germany	25	5,000	15	16,000
Total	4,206	597,000	6,510	933,000
Fuller's earth				
United States	7,621	220,000	9,079	259,000
Compounds and conditioners for use in drilling mud[1]				
United States	8,103	902,000	7,788	884,000
Britain	–	–	23	1,000
Total	8,103	902,000	7,811	885,000

	1965	1966	1967
		(short tons)	
Consumption[2] (available data)			
Pelletizing iron ore	95,108	128,135	150,300[e]
Well drilling	36,174	34,178	..
Iron and steel foundries	37,387	33,179	..
Ceramic products and refractories	626	717	..
Paper	352	387	..
Other uses[3]	6,889	4,426	..
Total	176,536	201,022	..

Source: Dominion Bureau of Statistics.

[1]Includes some bentonite not otherwise accounted for; [2]Includes fuller's earth, but not bentonite used in construction; [3]Includes the manufacturing of paints, rubber products, and cleaners and polishes; the refining of mineral and vegetable oils; and the pelletizing of stock feeds and base metal concentrates.

– Nil; [e]Estimate; .. Not available.

DOMESTIC OCCURRENCES

Bentonite deposits, some of which are thick and extensive, occur in formations of Cretaceous and Tertiary age in western Canada.

In Alberta, swelling bentonite is common in Upper Cretaceous beds. Some of the better material occurs in the Edmonton formation near Onoway, Camrose, Rosalind and Drumheller, and in the Bearpaw formation near Dorothy and Irvine.

In Manitoba, nonswelling bentonite occurs in the Vermilion River formation, and the swelling and semiswelling varieties in the Riding Mountain formation, also of Upper Cretaceous age. Both horizons outcrop at various places in the Morden-Miami area and to the northwest nearly as far as the Saskatchewan border.

In Saskatchewan, semiswelling bentonite of Tertiary age occurs in the south-central part of the province, and in the Battle formation in the southwest and the Vermilion River formation in the east, both Upper Cretaceous. Much of the bentonite in British Columbia is of Tertiary age and is found near Princeton, Merritt, Kamloops and Clinton.

TABLE 2

Bentonite – Imports and Consumption, 1958-67

	Imports		Consumption
	Short Tons	$	Bentonite[1] (short tons)
1958	..	980,585[2]	25,024
1959	..	1,082,593[2]	61,627
1960	..	1,590,441[3]	64,871
1961	..	1,528,170[3]	63,268
1962	..	1,524,080[3]	57,237
1963	..	2,005,337[3]	93,512
1964	123,533[4]	1,659,076[4]	161,695
1965	192,170[4]	2,310,566[4]	176,536
1966	204,038[4]	2,606,000[4]	201,022
1967	235,451[4]	3,346,000[4]	..

Source: Dominion Bureau of Statistics.

[1]Larger survey coverage commencing 1959; includes fuller's earth; [2]Activated clays and clay catalysts; [3]Also includes fuller's earth and clay for use in well drilling; [4]Bentonite, activated clays and earths, and fuller's earth, but not the bentonite included in materials for use in drilling mud.

.. Not available.

TECHNOLOGY

Bentonite is the name commonly applied to a clay composed essentially of minerals of the montmorillonite group, probably the species montmorillonite. Bentonite may be creamy white, grey, blue, green or brown. On a fresh surface, it appears waxy and is moist. When weathered, it generally becomes lighter in colour and forms a thin, partly dried crust with a distinctive crumbly texture. It is usually classified as swelling or nonswelling, although the terms are only relative.

Bentonite is a very soft rock that is mined with comparative ease by surface methods. Processing of swelling bentonite mainly involves only drying, pulverizing and classifying, although additives that enhance certain properties are mixed with bentonite for some uses. Some nonswelling bentonite is treated with sulphuric acid (activated) to make it more adsorptive.

Bentonite's usefulness is based on several unusual properties. Montmorillonite has a high capacity for ion exchange and normally contains sodium and calcium as exchangeable cations. If sodium is predominant, bentonite forms a gel in water and readily swells. Because of its crystallographic structure and chemical composition, montmorillonite has a negative zeta potential in water. Recent studies indicate that the ability of a bentonite to serve as a binder is related to this zeta potential. Bentonite has the property of adsorbing certain substances. Activation improves this property by leaching out various ions.

Fuller's earth is an industrial term that refers to the use of an adsorbent clay rather than its mineral composition. It is commonly composed at least partly of montmorillonite minerals.

USES

Bentonite is used in many different ways but generally constitutes only a small part of the final product.

Select swelling bentonite has found widespread and rapidly growing use as a binder in the pelletizing of iron mineral concentrates. About 15 pounds is used in every long ton of concentrate to provide the pellet with sufficient strength to withstand handling during the drying and firing stages. The amount of bentonite required varies with the mineralogy and particle size of the concentrate.

Swelling bentonite has an important function in oil and gas well drilling. A mud consisting of 8 to 10 per cent bentonite in water is used principally to prevent the loss of drilling fluid into permeable zones by coating the wall of the drill hole with a gel. It also serves as a lubricant and helps to keep the drill cuttings in suspension. The bentonite must be capable of a high yield of mud (measured in barrels per ton) with an apparent viscosity of 15 centipoises.

Swelling bentonite serves as a binder in moulding sands used by iron and steel foundries. Nonswelling bentonite is also used as a binder in some low-temperature foundries.

Swelling bentonite is used as a binder in the pelletizing of base metal concentrates and stock feeds. It is used in small quantities as a plasticizer in abrasive and ceramic mixes; as a filler in paints, paper, rubber, pesticides, cosmetics, medicinal products, and cleaning and polishing compounds; in the grouting of subsurface water-bearing zones; and in the sealing of such structures as dams and reservoirs. Bentonite slurry is effective in fighting forest fires and in retaining the walls of excavations prior to the placement of concrete or other structural materials.

Some nonswelling bentonite is used in pelletizing stock feed, as a carrier for pesticides, and as a cleaning powder for animals.

Activated bentonite is used in decolorizing mineral and vegetable oils, animal fats, waxes, beverages and syrups. It is also used as a catalyst in the refining of fluid hydrocarbons.

PRICES

There is a wide range of prices depending on the type of bentonite and the kind and degree of processing. The price varies from as little as about $5 a ton for unground swelling bentonite to many times that for special grades. *The Oil, Paint and Drug Reporter* of December 25, 1967, quoted the price of

US bentonite, minus 200 mesh, in bags and car lots, f.o.b. mines, at $14 a short ton, and the price of Italian white bentonite, with a high gel strength, in bags and 5-ton lots, at the US warehouse, at $91 a short ton.

TARIFFS

Tariffs in effect at the time of writing included:

	British Preferential (%)	Most Favoured Nation (%)	General (%)
CANADA			
Clays, not manufactured further than ground	free	free	free
Activated clays			
For refining oils	10	10	25
Not for refining oils	15	20	25

UNITED STATES

Bentonite, per long ton – 81-1/4¢
Clays, artificially activated – 1/10¢ a pound plus 12-1/2% ad val

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Bismuth

J.G. GEORGE*

In Canada, bismuth is a minor constituent of certain lead-zinc, molybdenum and copper ores, and is recovered in the processing of these ores. The more important sources are molybdenum ores mined in the Malartic district of western Quebec, lead-zinc ores produced in southeastern British Columbia, and copper ores mined near Gaspé in eastern Quebec. Minor amounts are obtained from silver-cobalt ores of the Cobalt-Gowganda area of northern Ontario.

According to preliminary figures, bismuth production in 1967 totalled 546,336 pounds compared with 525,659 pounds in 1966.

World production of bismuth in 1966, according to an estimate of the United States Bureau of Mines, was 8,800,000 pounds. The leading producer was again Peru with an output of 1,642,427 pounds, mainly from Cerro de Pasco Corporation. Japan produced an estimated 1,360,000 pounds, Mexico 1,060,000 pounds and Bolivia 822,316 pounds. The United States does not report its production.

The upward trend in demand for bismuth, which has prevailed for several years, was reversed in 1967, mainly because of decreased consumption as a catalyst, which in United States statistics is included with pharmaceuticals, and as an alloying metal.

The United States is the world's largest consumer of bismuth and a substantial portion of its requirements is imported, mainly from Peru and Mexico. Late in November 1967, the United States government authorized the release, for domestic consumption, of 1.2 million pounds of bismuth from its stockpile. A maximum of 300,000 pounds was to be offered for sale in the quarter ending March 31, 1968, and 150,000 pounds per calendar quarter thereafter. Stockpile bismuth at the end of 1967 amounted to 3,812,315 pounds of which 1,412,315 pounds were considered to be surplus to coventional war requirements. During 1967 the United States price of bismuth remained unchanged at $4 a pound, which has been in effect since June 1965.

DOMESTIC SOURCES

BRITISH COLUMBIA

Cominco Ltd. remained the only producer of bismuth in British Columbia, deriving most of its production from lead concentrate produced at its Sullivan lead-zinc mine at Kimberley. Other sources were lead concentrates from other company mines and from custom shippers. Lead bullion derived from the smelting of these concentrates contains about 0.05 per cent bismuth. Bismuth is recovered as 99.99+ per cent pure metal from the treatment of residues resulting from the electrolytic refining of the lead bullion. For use in research and in the electronics industry this bismuth is further processed to give it a purity of up to 99.9999 per cent.

*Mineral Resources Branch.

TABLE 1

Bismuth – Canadian Production and Consumption, 1966-67

	1966		1967p	
	Pounds	$	Pounds	$
Production, All forms*				
Quebec	471,912	1,757,000	517,460	1,934,000
British Columbia	47,435	199,000	24,876	107,000
Ontario	6,312	16,000	4,000	15,000
Total	525,659	1,972,000	546,336	2,056,000
Consumption, Refined metal				
Fusible alloys and solders	29,241		12,372	
Other uses**	27,187		35,522	
Total	56,428		47,894	

Source: Dominion Bureau of Statistics.
* Refined metal from Canadian ores plus bismuth content of bullion and concentrates exported.
** Includes metal used in manufacture of pharmaceuticals and fine chemicals, other alloys and malleable iron.
p Preliminary.

QUEBEC

Molybdenite Corporation of Canada Limited in its fiscal year ended September 30, 1967, treated 261,593 short tons of ore and recovered 127,590 pounds of bismuth in impure metal ingots from its operations in Lacorne township 12 miles northeast of Malartic. Three principal steps are involved in the process. A bulk concentrate containing about 8 per cent bismuth is produced by flotation. By leaching this concentrate with hydrochloric acid the bismuth is separated as bismuth oxychloride which is then smelted in electric-arc furnaces. The resulting bullion is cast into ingots containing about 96 per cent bismuth, minor amounts of lead and silver and traces of copper, iron and antimony. In October 1967, the company's mill was destroyed by fire. A new 1,200-ton-a-day concentrator is under construction and operations are expected to be resumed in November 1968.

At the molybdenum-bismuth property of Anglo-American Molybdenite Mining Corporation in the township of Preissac, 16 miles northwest of Malartic, over 400,000 tons of ore were treated in 1967. Ore reserves, at the end of the year, were estimated at 825,000 tons averaging 0.25 per cent molybdenite (MoS_2) and 0.04 per cent bismuth. Mining and milling operations continued at Preissac Molybdenite Mines Limited, in which Molybdenite Corporation of Canada Limited holds a substantial interest. This molybdenum-bismuth property is in Preissac township about 17 miles northwest of Malartic; the company produces metallic bismuth of about 95 per cent purity.

Gaspé Copper Mines, Limited, recovered 12,695 pounds of byproduct bismuth in impure metal ingots in 1967 from the treatment of flue dust derived from copper-smelting operations at Murdochville.

TABLE 2

Bismuth – Canadian Production, Exports and Consumption, 1958-67
(pounds)

	Production (all forms)[1]	Exports[2]	Consumption[3]
1958	412,792	352,000	39,800
1959	334,736	300,000	39,700
1960	423,827	286,000	44,700
1961	478,118	389,500	42,600
1962	425,102	382,182	37,200
1963	359,125	399,772	47,800
1964	399,958	300,073	53,700
1965	428,759	. .	48,300
1966	525,659	. .	56,400
1967p	546,336	. .	47,900

Source: Dominion Bureau of Statistics.
1. Refined metal from Canadian ores plus bismuth content of bullion and concentrates exported.
2. Refined and semi-refined metal. 3. Refined metal reported by consumers.
p Preliminary; . . Not available.

TABLE 3

Estimated World Production of Bismuth, 1966[p]
(pounds)

Peru	1,642,427
Japan (metal)	1,360,000[e]
Mexico	1,060,000[e]
Bolivia	822,316
Canada (metal)	525,659
Communist China (in ore)	660,000[e]
Yugoslavia (metal)	229,278
Total	8,800,000*

Source: Minerals Yearbook 1966, United States Department of the Interior, and for Canada, Dominion Bureau of Statistics.
* Includes US production, not available for publication, and estimates for several other countries.
[p] Preliminary; [e] Estimate.

TABLE 4

United States Consumption of Bismuth, by Principal Uses
(pounds)

	1966	1967[p]
Fusible alloys	913,395	805,257
Other alloys	546,637	438,502
Pharmaceuticals*	1,719,029	1,553,021
Experimental uses	9,552	6,000[e]
Other uses	10,708	8,000[e]
Total	3,199,321	2,810,780

Source: Mineral Industry Surveys, US Department of the Interior, Bureau of Mines, Bismuth Metal in fourth quarter 1967.
* Includes industrial and laboratory chemicals

[p] Preliminary; [e] Estimate.

USES

A major use of bismuth is in fusible or low-melting-point alloys for fire-protection devices, electrical fuses and solders. Many of these alloys contain 50 per cent or more bismuth, the chief additive metals being cadmium, lead and tin.

Other important outlets for bismuth are in pharmaceuticals, cosmetics, and industrial and laboratory chemicals including catalytic compounds. Various bismuth compounds, salts and mixtures are used in pharmaceuticals for indigestion remedies, antacids, burn and wound dressings. Bismuth's use as a catalyst in the production of acrylic plastics declined again in 1967 because of its replacement by a less expensive substitute.

Type metal contains bismuth because the latter expands on solidification and imparts expansion to its alloys. Bismuth is also an important additive to aluminum alloys, malleable irons and steel alloys in which it improves machinability. Tellurium is now replacing some bismuth in the alloying of malleable iron through substitution of a bismuth-tellurium combination for straight bismuth, although substitution in this application was not large in 1967.

PRICES AND TARIFFS

Canadian and United States prices of bismuth did not change during 1967. The Canadian price, quoted by Cominco Ltd., for bars 99.99+ per cent pure was $4.25 a pound in lots of one ton or more and $4.50 a pound in lots of less than one ton. The United States price, as published by *Metals Week* and expressed in United States currency, was $4.00 a pound in ton lots, delivered.

Tariffs on bismuth in 1967 were:

CANADA

Bismuth metal enters Canada duty free.

UNITED STATES

Bismuth metal, unwrought	1.875% ad val
Alloys of bismuth	
Containing not less than 30% by weight of lead	1.0625¢ per lb on lead content
Other	18% ad val.

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT) that was convened in 1964 to consider reductions in tariffs submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968 and final reductions on January 1, 1972.

Cadmium

D.B. FRASER*

Cadmium is a minor constituent of most zinc-bearing ores, occurring as the sulphide closely associated with sphalerite, the zinc sulphide. Zinc concentrates produced in Canada vary in cadmium content from a negligible amount up to 0.8 per cent, or 16 pounds of cadmium per ton of zinc concentrate. During the smelting and refining of zinc concentrates, cadmium is extracted as a residue or sponge, which is further treated to yield metallic cadmium.

Total output in 1967, expressed as the sum of refined metal and the recoverable cadmium content of concentrates exported, was 4,771,677 pounds valued at $13,385,156. Corresponding figures for 1966 were 3,236,862 pounds valued at $8,351,103. The increase of nearly 50 per cent in the volume of output was due to the start of production late in 1966 at the Kidd Creek mine, near Timmins, operated by Texas Gulf Sulphur Company. Ontario's cadmium output as a result rose from 217,237 pounds in 1966 to 1,874,980 pounds in 1967.

The chief mine producers in Canada are the companies with large zinc operations: Cominco Ltd. and Hudson Bay Mining and Smelting Co., Limited, in western Canada, and Noranda Mines Limited and some of its associated companies, and Texas Gulf Sulphur Company in eastern Canada.

Cadmium is recovered as a byproduct at the four Canadian zinc reduction plants operated by the following companies: Canadian Electrolytic Zinc Limited, at Valleyfield, Quebec; Cominco Ltd., at Trail, British Columbia; East Coast Smelting and Chemical Company Limited, at Belledune, New Brunswick; and Hudson Bay Mining and Smelting Co., Limited, at Flin Flon, Manitoba. Total output of metallic cadmium in 1967, including some cadmium in sponge, was 2,057,566 pounds.

World output of cadmium, totalling 27 million pounds in 1967, has grown proportionately with increasing zinc output. The chief producing countries are shown in an accompanying table. Canada is the fourth largest producer following the United States, the USSR and Japan in that order.

Over 90 per cent of Canada's cadmium production is exported. Refined metal exports in 1967 totalled 1,676,676 pounds, of which 48 per cent went to Britain and 47 per cent to the United States. Exports of cadmium in unrefined form are not reported separately, but are estimated at 2.8 million pounds in 1967.

Consumption in the United States declined in 1967 to 11,600,000 pounds, from 14,780,000 pounds in the previous year. Sales of cadmium from the government stockpile, authorized at a rate of 600,000 pounds a quarter, were only 812,504 during 1967, most of which was sold in the first two quarters. The government-held inventory at December 31, 1967 totalled 13,749,174 pounds, of which 5,100,000 pounds was specified as the minimum strategic requirement. Since June 1964, when 5 million pounds were authorized for release, sales from the US stockpile have been 23,400 pounds in 1964, none in 1965, 636,966 pounds in 1966, and 812,504 pounds in 1967. The 13.7 million pounds remaining in the stockpile is in ingot form and this is not readily usable for plating, where cast forms such as balls and sticks are required.

*Mineral Resources Branch.

TABLE 1

Cadmium – Production, Exports and Consumption, 1966-67

	1966		1967p	
	Pounds	$	Pounds	$
Production				
All Forms[1]				
Ontario	217,237	560,471	1,874,980	5,261,520
British Columbia	1,169,570	3,017,491	1,076,479	3,014,141
Northwest Territories	1,073,400	2,769,372	1,000,000	2,800,000
Quebec	286,302	738,659	377,280	1,069,270
Manitoba	192,863	497,586	202,821	567,898
Saskatchewan	141,171	364,221	134,032	375,290
Yukon	118,735	306,336	53,673	150,284
New Brunswick	37,584	96,967	52,412	146,753
Total	3,236,862	8,351,103	4,771,677	13,385,156
Refined	1,705,344		2,057,566[2]	
Exports				
Cadmium metal				
Britain	1,192,205	2,769,000	798,529	2,088,000
United States	765,125	1,729,000	780,020	1,967,000
India	51,912	106,000	59,541	144,000
Czechoslovakia	–	–	33,600	91,000
Other countries	3,081	7,000	4,986	12,000
Total	2,012,323	4,611,000	1,676,676	4,302,000
Consumption (cadmium metal)[3]				
Plating	134,437		121,040	
Solders	14,429		13,027	
Other products[4]	21,739		20,694	
Total	170,605		154,761	

Source: Dominion Bureau of Statistics.

[1]Production of refined cadmium from domestic ores plus cadmium content of ores and concentrates exported. [2]Includes some cadmium in sponge. [3]As reported by consumers. [4]Mainly chemicals, pigments and alloys other than solder.

p Preliminary.

DOMESTIC PRODUCTION

BRITISH COLUMBIA

The main producer was Cominco Ltd., which recovered cadmium from zinc concentrates produced at its Sullivan and Bluebell mines. Output at the Trail metallurgical works was 657 short tons, 130 tons less than in 1966. Other producers of cadmium included Canadian Exploration, Limited, and Reeves MacDonald Mines Limited, near Salmo, and Western Mines Limited, on Vancouver Island.

YUKON TERRITORY

United Keno Hill Mines Limited recovered 128,269 pounds of cadmium in zinc concentrates at Elsa, 200 miles north of Whitehorse. A total of 106,189 tons of ore was treated.

NORTHWEST TERRITORIES

Production of 1 million pounds was derived from zinc-lead ores mined by Pine Point Mines Limited. The company milled 1,521,000 tons of ore and produced 233,000 tons of zinc concentrates. In addition, 333,000 tons of direct-shipping high-grade ore were produced.

SASKATCHEWAN AND MANITOBA

Copper-zinc ores from the four mines of Hudson Bay Mining and Smelting Co., Limited, at Flin Flon and Snow Lake were the source of most of the cadmium output. The output of metallic cadmium at Flin Flon was 352,042 pounds. Share Mines & Oils Ltd. began production in June 1967 at its zinc-lead-copper mine and 350-ton-a-day mill at Hanson Lake, 65 miles west of Flin Flon, and recovered cadmium in zinc concentrates.

TABLE 2

Cadmium – Production, Exports and Consumption, 1958-67
(pounds)

	Production		Exports	
	All Forms[1]	Refined[2]	Cadmium Metal	Consumption[3]
1958	1,756,050	1,634,000	1,263,617	170,000
1959	2,160,363	2,528,000	1,979,638	226,000
1960	2,357,497	2,238,000	2,056,333	190,000
1961	1,357,874	2,234,000	1,901,962	171,000
1962	2,604,973	2,435,000	2,340,289	232,000
1963	2,475,485	2,354,000	1,939,110	209,000
1964	2,772,984	2,220,000	1,623,679	178,000
1965	1,755,925	948,000	1,364,645	172,000
1966	3,236,862	1,705,000	2,012,323	171,000
1967[p]	4,771,677	2,057,566[4]	1,676,676	155,000

Source: Dominion Bureau of Statistics.
[1]Production of refined cadmium from domestic ores plus cadmium content of ores and concentrates exported. [2]Refined cadmium from all sources including that obtained from imported lead and zinc concentrates. [3]Reported by consumers. [4]Includes some cadmium in sponge.
[p] Preliminary.

TABLE 3

World Production of Cadmium
(metric tons)

	1966	1967[p]
United States	4,745	3,902
USSR	2,032	2,032
Japan	1,760[e]	1,760[e]
Canada	773	694
Belgium	650[e]	640[e]
Australia	535	503
Poland	500[e]	500[e]
France	476	498[e]
Republic of the Congo (Kinshasa)	421	408[e]
Federal Republic of Germany	356	399
Other	1,160	1,117
Total	13,408	12,453

Source: World Bureau of Metal Statistics.
NOTE: Data are for production of cadmium as unwrought metal from domestic and imported materials. Secondary metal is included where known but the total in aggregate is less than one per cent of the world total.
[p] Preliminary; [e] Estimate.

ONTARIO

The largest producer was Texas Gulf Sulphur Company, whose zinc-copper ores at Timmins contain cadmium which is recovered in zinc concentrates. These were exported for treatment. The zinc-copper ores of the Geco mine at Manitouwadge were another source of cadmium.

QUEBEC

Cadmium was recovered in zinc concentrates produced in the Matagami district in western Quebec, and in the Eastern Townships, near Stratford Centre. At the plant of Canadian Electrolytic Zinc Limited at Valleyfield, byproduct cadmium amounting to 538,950 pounds, mostly in metallic form, and to a lesser extent as sponge, was produced in 1967. The source of a large part of this output was the Geco mine of Noranda Mines Limited in Ontario, and the Mattagami Lake mine in Quebec.

NEW BRUNSWICK

Cadmium totalling 52,412 pounds was recovered in zinc concentrates produced from zinc-lead ores of the Bathurst-Newcastle district.

USES

The chief use of cadmium is in electroplating other metals, principally iron and, to a lesser extent, copper alloys, to protect them against oxidation. A cadmium coating, like a zinc coating, protects less-active metals both by physical enclosure and by sacrificial corrosion. Cadmium is usually preferred to zinc as a coating because it is more ductile, is slightly more resistant to common atmospheric corrosion, can be applied more uniformly in recesses of intricately shaped parts, and can be electro-deposited with less electric current per unit of area covered. Because it is much more costly and much less plentiful than zinc it is not as widely used. Improvements in zinc electroplating techniques in recent years have tended to reduce the consumption of cadmium in plating.

Cadmium-plated articles are used in the manufacture of automobiles, household appliances, aircraft, radios, television sets, and electrical equipment. Plating accounts for about half the total consumption of cadmium.

The second-largest use is in the manufacture of pigments. Cadmium sulphides give yellow to orange colours and cadmium sulpho-selenides give pink to red and maroon. Cadmium stearates act as stabilizers in the production of polyvinyl chloride plastics, and cadmium phosphors are used in both black and white and colour television tubes. The use of cadmium compounds in recent years has expanded at a rate of 5 to 10 per cent annually and is now the largest potential growth area for cadmium. Expansion in this use has more than made up for reduced consumption in plating.

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. Low-cadmium copper (about 1 per cent cadmium) is used in the manufacture of trolley and telephone wires because of the improved tensile strength imparted by cadmium. Low-cadmium copper is also now employed in automobile radiator fin-stock, replacing the low-silver copper formerly used exclusively.

Another 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, higher peak power output, are smaller, and are superior in low-temperature operation. They are specially suitable for use in airplanes, satellites, missiles, and ground equipment for polar regions, as well as in small portable items such as battery-operated shavers, toothbrushes, drills and handsaws.

PRICES

The Canadian price of cadmium in sticks, bars and balls, 5,000 pounds minimum, according to *The Northern Miner*, was $2.75 a pound at the beginning of 1967. In mid-January the price rose to $2.85 a pound. This price prevailed until the middle of May when it declined to $2.60. Early in June it rose again to $2.85 and remained at this level for the balance of the year.

The United States price of cadmium during 1967, according to *Metals Week*, was:

	Jan. 1 to Jan. 12	Jan. 13 to Dec. 31
	(dollars per pound)	
One ton lots	$2.55	$2.65
Under one ton lots	2.60	2.70
General Services Administration		
ton lots	not reported	2.53
under one ton lots	" "	2.58

TARIFFS

CANADA	British Preferential %	Most Favoured Nation %	General %
Cadmium in metal, lumps, powder, ingots, blocks, etc.*	free	15	25
Cadmium, in rod, shot, or processed form	15	20	25

*If ruled as a class or kind made in Canada, this item would come under tariff class 71100-1 and carry duties as follows:

British Preferential	15%
Most Favoured Nation	20%
General	25%

UNITED STATES

Cadmium in ores and concentrates	free
Cadmium metal, unwrought	3.75¢ per lb.
Cadmium metal, wrought	18% *ad val.*
Cadmium alloys	18% *ad val.*
Cadmium flue dust	free

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in some countries with reductions beginning on January 1, 1968, and final reductions on January 1, 1972.

Calcium

W.H. JACKSON*

There are only three sources of calcium metal in the non-communist world. The Canadian producer Dominion Magnesium Limited is the leading source in international trade. Pfizer Minerals, Pigments and Metals Division in the United States and Planet-Wattholm S.A. in France are the only other sources. All use thermal reduction methods and capacity is adequate to meet the current and future needs of industry. World demand is estimated to be more than 500 tons.

DOMESTIC INDUSTRY

Dominion Magnesium Limited (Domag) produces three grades of calcium at the Haley smelter in Ontario in addition to its main product, magnesium, which is covered in another review in this series. To produce the Commercial grade, purchased high-purity powdered lime (CaO) of 200 mesh and commercial-purity aluminum of 20 mesh are briquetted and then charged into horizontal retorts made of chrome-nickel-iron alloy. Under vacuum and at temperatures of about 1,170°C the aluminum reduces the lime. The water-cooled head sections of the retorts project through the furnace wall and calcium vapour condenses as crystalline rings in a temperature range of 680°C to 740°C. Higher purities are obtained by subsequent refining operations.

The Commercial grade contains 98 to 99 per cent calcium, 0.5 to 1.5 per cent magnesium, 1 per cent maximum nitrogen and 0.35 per cent aluminum maximum. The High Purity grade contains 99.5 per cent calcium plus magnesium with 0.5 as maximum for magnesium. It is low in major impurities, the maximum being 0.004 per cent manganese, iron 0.005 per cent, nitrogen 0.025 per cent, and aluminum 0.010 per cent. Such elements as nickel, lithium, boron, sodium and cadmium are extremely minor impurities. The Chemical Standards grade is nominally 99.9 per cent pure. Minor impurities are similar to those in the High Purity grade.

Dominion Magnesium reported calcium shipments in 1967 were 543,598 pounds compared with 248,830 pounds in 1966. Most of it was marketed in the United States.

Canadian consumption is in the order of 10 tons annually but this could increase to a few hundred tons as Eldorado Mining and Refining Limited plans to construct a zirconium plant at Port Hope, Ontario, and the process to be used requires calcium.

In addition to calcium, minor quantities of other metals were produced in 1967 as follows: thorium (835 lb.), mainly for magnesium alloys; titanium (18,059 lb.), for nickel alloys and in powder form for fuses; zirconium-magnesium master alloy (8,081 lb.); barium (1,808 lb.), a getter in vacuum tubes; and strontium (53 lb.) for laboratory use.

USES

Calcium can be safely handled in air but, since it is reactive and has low strength, it has not been possible to develop structural uses.

*Mineral Resources Branch.

TABLE 1

Canadian Calcium Production and Exports, 1966-67

	1966		1967p	
	Pounds	$	Pounds	$
Production (metal)*	249,179	245,125	622,237	591,125
Exports (metal)				
United States	165,500	153,000	414,100	359,000
France	-	-	44,700	56,000
West Germany	20,000	24,000	35,400	40,000
Britain	5,700	10,000	12,000	21,000
Japan	7,000	7,000	6,600	6,000
Other countries	44,600	33,000	200	2,000
Total	242,800	227,000	513,000	484,000

Source: Dominion Bureau of Statistics.
* Smelter use and shipments.
p Preliminary. – Nil.

TABLE 2

Canadian Calcium Production and Exports, 1958-67

	Production* (pounds)	Exports (pounds)
1958	25,227	63,700e
1959	67,429	65,100e
1960	134,801	74,800e
1961	99,355	110,700
1962	123,511	124,100
1963	98,673	92,100
1964	138,357	130,800
1965	159,434	148,300
1966	249,179	242,800
1967p	622,237	513,000

Source: Dominion Bureau of Statistics.
* Production from 1958 to 1960 inclusive, shipments from 1961.
p Preliminary; e Estimated.

Commercial grade calcium is in demand for the production of calcium hydride which is a portable source of hydrogen gas, for debismuthizing lead, for deoxidation and sulphur removal in maraging and other high quality steels, for grain refining in aluminum-silicon alloys, and for selenium recovery. High Purity calcium, a reducing agent in the production of uranium and thorium, is also used to produce calcium pantothenate, an additive to animal feeds. Small quantities of the Chemical Standards grade are used for experimental or pilot plant work where pure metal is needed for chemicals and isotope separation.

PRICES

The Canadian price in 1967 quoted by Dominion Magnesium Limited, f.o.b. Haley, Ontario, ranged from 85 cents a pound for the Commercial grade to $3.50 a pound for the Chemical Standards grade.

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

TARIFFS

	British Preferential %	Most Favoured Nation %	General %
CANADA			
Calcium metal, pure, in lumps, ingot, powder*	free	15	25
Calcium metal alloys, or calcium metal in rods, sheet or any semi-processed form	15	20	25

*Must be ruled to be of a class of kind not produced in Canada, otherwise the tariff governing semiprocessed forms applies.

UNITED STATES	
Calcium metal, unwrought	-15%
Calcium metal, wrought	-18%

Cement

N. G. ZOLDNERS*

Construction value during Canada's Centennial Year, 1967, continued its upward trend, reaching a total of $11.5 billion, which is only a modest 2.7 per cent increase over the 1966 value of $11.2 billion.

The levelling-off in the construction activity had a serious impact on the entire building-materials industry. Consumption of cement decreased significantly in some regions of Canada. The total cement production in 1967 decreased to 7.7 million short tons**, a 13.5 per cent drop from the 1966 production. With its value of $146.4 million, or 3.3 per cent of the total mineral production, cement ranks ninth among Canada's leading minerals.

With the addition of one new kiln and with the replacement of another in the two cement plants in British Columbia, and with the closure of one plant in Ontario, Canada's annual rated capacity increased by 2.5 per cent over that in 1966, reaching a total capacity of 75.3 million barrels by the end of 1967. The increased capacity of the cement industry at a time of decreased production requirements resulted naturally in lower operating efficiency of cement plants. The production rate for 1967 was down to an estimated 59 per cent of total plant capacity as compared with 69 per cent for 1966.

Major expansion of an existing cement plant and construction of a new plant, both in Ontario, scheduled for completion in 1968, will add another 7 million barrels, increasing Canada's total annual rated capacity to 82.3 million barrels.

A new cement plant is under design in British Columbia. Preliminary construction work is scheduled to start late in 1968. When in production by the end of 1969 it will add another 1.2 million barrels to Canada's total annual rated capacity.

PRODUCTION

Canada produces different types of portland cement, masonry, concrete-products, and oil-well cements, as well as white cement ground from imported clinker. Most of the production is normal portland cement, although other modified types of portland cement have been produced in increasing amounts in recent years. In 1967, of the total cement produced, 97 per cent was portland and practically all the rest was masonry cement. However, the Canada Cement Company, Limited has recently signed a contract for the manufacturing rights to a patented process for white cement manufacture.

The total amount of cement shipped from all of Canada's plants during 1967 was 7,714,356 short tons, valued at $146,401,454 (Table 1). Of this volume, 64 per cent was produced in the provinces of Ontario and Quebec where 12 of the 22 operating cement plants in Canada are located. No cement is produced in Prince Edward Island, the Yukon or the Northwest Territories.

Table 2 indicates that the continuous increase in Canada's cement production during the last ten years was reversed in 1967 with a reduction in cement shipments at about 1.2 million tons. In 1967 cement clinker was produced in 22 plants operating 57 rotary kilns. Of these plants 15 employed the wet process and 7 used the dry method of cement manufacture. One more plant in Ontario will employ the dry process in its new kiln operation. The approximate capacities of Canada's cement plants at the end of 1967 are shown in Table 3; the locations of these plants are shown on the accompanying map. Production ceased at the Port Colborne plant (Nr. 14). In addition,

* Mineral Processing Division, Mines Branch.

** 1 short ton = 2,000 lb = 5.7 barrel (imperial);
1 barrel = 4 bags = 350 lb; 1 USA barrel = 376 lb.

TABLE 1

Canada – Cement – Production and Trade, 1966-67

	1966		1967p	
	Short Tons	$	Short Tons	$
Production [1]				
By province				
Ontario	3,242,591	52,680,630	2,720,929	48,122,596
Quebec	2,935,987	47,872,474	2,207,966	41,804,530
Alberta	822,360	15,685,259	880,586	17,910,266
British Columbia	707,519	15,959,443	703,942	14,279,419
Manitoba	508,152	10,221,927	406,564	8,390,839
Saskatchewan	214,145	4,963,191	280,039	6,801,520
New Brunswick	249,032	4,141,046	228,214	4,042,648
Nova Scotia	187,225	3,143,670	196,113	3,517,110
Newfoundland	63,541	1,632,982	90,003	1,532,526
Total	8,930,552	156,300,622	7,714,356	146,401,454
By type				
Portland	8,674,956	151,469,916	..	..
Masonry [2]	255,596	4,830,706	..	..
Total	8,930,552	156,300,622	7,714,356	146,401,454
Exports				
Portland cement				
United States	407,111	6,564,000	327,996	5,201,000
Other countries	284	7,000	22	2,000
Total	407,395	6,571,000	328,018	5,203,000
Cement and concrete basic products				
United States		762,000		233,000
Other countries		26,000		57,000
Total		788,000		290,000
Imports				
Portland cement, white				
United States	13,899	645,000	12,072	559,000
Japan	3,584	98,000	4,644	128,000
Belgium and Luxembourg	1,857	57,000	2,666	81,000
Britain	1,609	44,000	1,658	44,000
Denmark	1,764	55,000	1,654	51,000
Other countries	911	43,000	197	7,000
Total	23,624	942,000	22,891	870,000
Cement, n.e.s. [3]				
Britain	12,061	378,000	15,161	412,000
United States	5,309	385,000	4,044	331,000
West Germany	2,838	151,000	2,022	111,000
Other countries	6,783	122,000	–	–
Total	26,991	1,036,000	21,227	854,000
Total cement imports	50,615	1,978,000	44,118	1,724,000

TABLE 1 (cont.)

	1966		1967p	
	Short Tons	$	Short Tons	$
Refractory cement and mortars				
United States		1,385,000		1,300,000
Ireland		372,000		402,000
Other countries		177,000		9,000
Total		1,934,000		1,711,000
Cement and concrete basic products, n.e.s.				
United States		162,000		149,000
Britain		15,000		12,000
Italy		2,000		10,000
Other countries		18,000		9,000
Total		197,000		180,000
Cement Clinker				
United States (white)	17,290	454,000	14,969	386,000

Source: Dominion Bureau of Statistics.

[1] Producers' shipments plus quantities used by producers; [2] Includes small amounts of other cements;
[3] Includes grey portland, masonry, acid-proof, aluminous and other specialty types of cement.

p Preliminary; n.e.s. Not elsewhere specified; . . Not available; – Nil.

TABLE 2

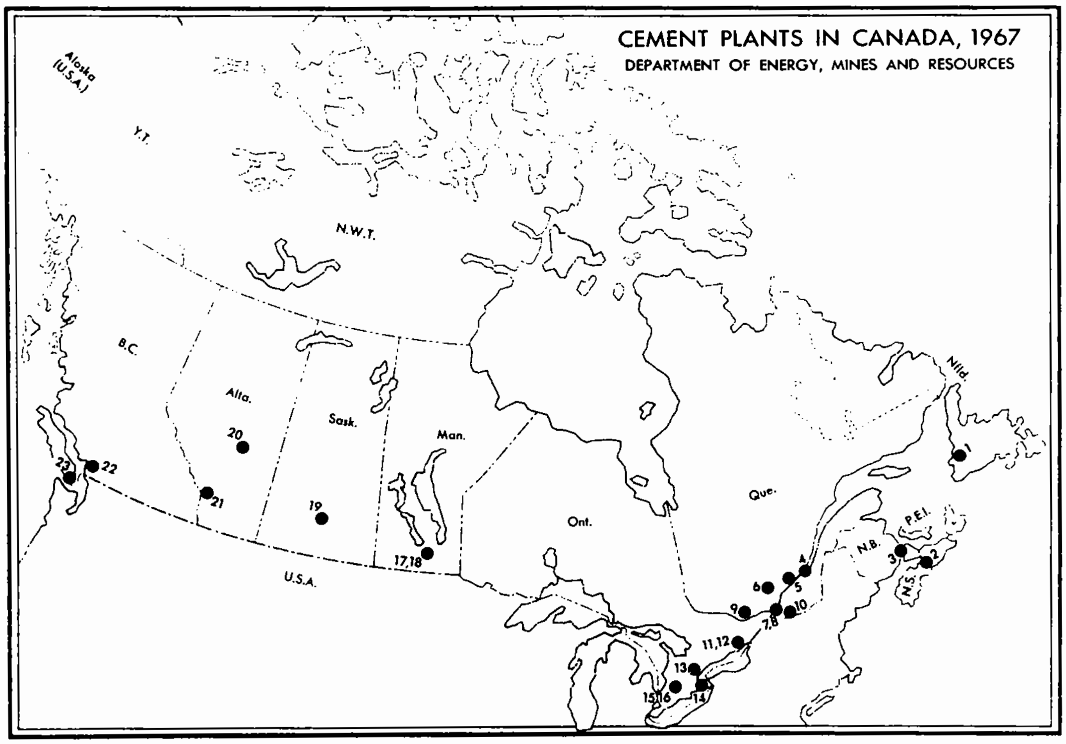
Cement – Production, Trade and Consumption, 1958-67
(short tons)

	Production[1]	Exports[2]	Imports[2]	Apparent Consumption[3]
1958	6,153,421	141,250	41,555	6,053,726
1959	6,284,486	303,126	29,256	6,010,616
1960	5,787,225	181,117	22,478	5,628,586
1961	6,205,948	249,377	29,217	5,985,788
1962	6,878,729	219,164	26,525	6,686,090
1963	7,013,662	272,803	31,579	6,772,438
1964	7,847,384	297,669	32,680	7,582,395
1965	8,427,702	334,887	37,619	8,130,434
1966	8,930,552	407,395	50,615	8,573,772
1967p	7,714,356	328,018	44,118	7,430,456

Source: Dominion Bureau of Statistics.

[1] Producers' shipments plus quantities used by producers. [2] Does not include cement clinker. [3] Production plus imports less exports.

p Preliminary.



Canada Cement Company, Limited, operated two clinker grinding plants – one in Edmonton and one at Saskatoon, each 1,900,000 barrels in capacity. Medusa Products Company of Canada, Limited, grinds imported clinker at Paris, Ontario, for the production of white cement. The Canadian cement industry now operates 31 cement storage and distribution terminals, established in strategic locations.

Table 4 summarizes changes in the production capacity of Canada's cement industry since 1957 showing that in the last 10 years the total rated production capacity of the industry has increased by 92 per cent. In this period the average plant capacity increased by 40 per cent, whereas the average kiln capacity increased by 30 per cent, indicating a trend towards larger plants and higher productivity per kiln.

In 1966*, the raw materials used in the manufacture of cement included 12,374,564 tons of limestone, 1,261,656 tons of clay, 575,122 tons of shale, 411,751 tons of gypsum, 363,213 tons of high-silica sand and 64,358 tons of iron oxide, generally produced from iron pyrites by the chemical industry.

Because cement is a relatively low-priced commodity, being sold for less than one cent per pound, the transportation of raw materials is usually one of the controlling factors affecting the total production cost. Lack of limestone deposits near cement plants in both Manitoba and Saskatchewan makes it necessary to transport raw materials long distances. Inland's cement plant in Regina hauls all its limestone about 275 miles from a deposit in Manitoba. Suitable raw material deposits within reasonable haulage distances of cement plants are constantly sought. It has been reported that an extensive deposit of calcareous shale (cement rock) has been discovered recently by a Provincial government geological team in the Pasquia Hills of northeastern Saskatchewan. The mineralogical composition of the cement rock may be of interest to the cement industry and may warrant further exploratory work and economic studies of the deposit.

Long-range planning and expansion in the cement-manufacturing industry is leading to continuous overbuilding in the cement-clinker producing facilities resulting in an increased overcapacity. The average operating efficiency of the Canadian cement industry

* 1967 figures not available at time of writing.

TABLE 3

Approximate Cement-Plant Capacities* at End of 1967
(numbers in parentheses refer to locations on the accompanying map)

Company and Location	Barrels per Year	Short Tons per Year**
Newfoundland		
North Star Cement Limited, Corner Book (1)	900,000	158,000
Nova Scotia		
Maritime Cement Company Limited, Brookfield (2)	1,400,000	245,000
New Brunswick		
Maritime Cement Company Limited, Havelock (3)	2,000,000	350,000
Quebec		
St. Lawrence Cement Company, Villeneuve (4)	4,500,000	788,000
Ciment Quebec Inc., St. Basile (5)	2,500,000	438,000
Independent Cement Inc., Joliette (6)	2,500,000	438,000
Miron Company Ltd., St. Michel (7)	6,000,000	1,050,000
Canada Cement Company, Limited, Montreal (8)	8,000,000	1,400,000
Canada Cement Company, Limited, Hull (9)	1,200,000	210,000
Lafarge Cement Quebec Ltd., St. Constant (10)	3,000,000	525,000
Ontario		
Lake Ontario Cement Limited, Picton (11)	4,500,000	788,000
Canada Cement Company, Limited, Belleville (12)	4,400,000	770,000
St. Lawrence Cement Company, Clarkson (13)	4,200,000	735,000
Canada Cement Company, Limited, Woodstock (15)	3,400,000	595,000
St. Mary's Cement Co., Limited, St. Mary's (16)	4,300,000	753,000
Medusa Products Company of Canada, Limited, Paris (grinding only)		
Manitoba		
Canada Cement Company, Limited, Fort Whyte (17)	5,270,000	922,000
Inland Cement Industries Limited, Winnipeg (18)	2,000,000	350,000
Saskatchewan		
Inland Cement Industries Limited, Regina (19)	1,300,000	227,000
Canada Cement Company, Limited, Floral (grinding only – 1.9 mill. bbl)		
Alberta		
Inland Cement Industries Limited, Edmonton (20)	3,300,000	577,000
Canada Cement Company, Limited, Exshaw (21)	3,100,000	542,000
Canada Cement Company, Limited, Edmonton (grinding only – 1.9 mill. bbl)		
British Columbia		
Lafarge Cement of North America Ltd., Lulu Island (22)	3,500,000	612,000
Ocean Cement Limited, Bamberton (23)	4,000,000	700,000
Total	75,270,000	13,173,000

Source: Published data and private correspondence.

* Not including the capacities of the separate grinding plants.

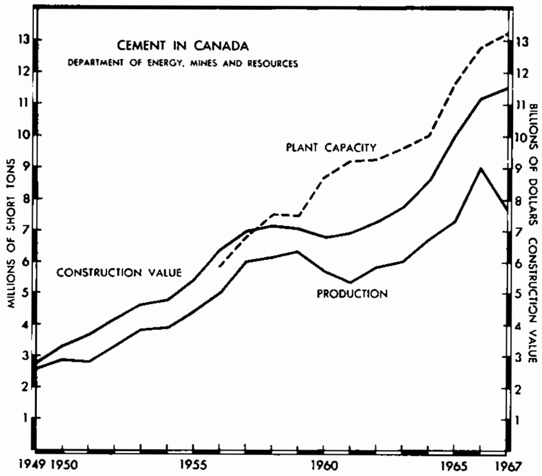
** Calculated.

TABLE 4

Cement – Rated Production Capacity*, 1957-67

			Approximate Capacity**		Average Capacity**		Production	
	No. of Plants**	No. of Kilns**	Barrels per Year	Short tons per Year	Per Plant (million bbl./year)	Per Kiln (million bbl /year)	Shipments (short tons)	As % of Year-end Capacity
1957	16	38	39,200,000	6,860,000	2.45	1.03	6,049,098	88
1958	18	41	42,800,000	7,490,000	2.38	1.04	6,153,421	82
1959	18	42	42,800,000	7,490,000	2.38	1.02	6,284,486	84
1960	19	45	50,000,000	8,750,000	2.63	1.11	5,787,225	66
1961	19	45	51,800,000	9,065,000	2.73	1.15	6,205,948	68
1962	19	45	52,450,000	9,179,000	2.76	1.17	6,878,729	75
1963	19	45	54,600,000	9,556,000	2.87	1.21	7,013,662	73
1964	19	47	57,150,000	10,001,000	3.01	1.22	7,847,384	79
1965	21	50	67,220,000	11,770,000	3.20	1.34	8,427,702	72
1966	23	54	73,470,000	12,858,000	3.20	1.36	8,930,552	69
1967	22	56	75,270,000	13,173,000	3.42	1.34	7,714,356[++]	59
1968[+]	23	57	82,270,000					
1969[+]	24	58	83,470,000					

* Clinker-producing plants. ** Year-end. [+] Scheduled to date. [++] Subject to revision.



decreased during the last 10 years from 88 per cent of the year-end annual rated capacity in 1957 to 59 per cent in 1967. With an additional new plant under construction and another expanding in Ontario, the production rate of the cement industry may improve in 1968 only if cement consumption increases considerably.

The total production capacity and the actual cement production figures are illustrated graphically in the accompanying graph "Cement in Canada", which shows also Canada's total construction values.

WORLD PRODUCTION

The pattern in world cement production has changed. For many years the United States was the world's leading cement producer, but since 1965 the lead has been taken by the USSR. The production increase in per cent during the 10-year period ending in 1966 is shown in Table 5. Canada's production during this period increased by 78 per cent to 8.9 million tons, representing twelfth place among the other countries. Particularly large increases in cement output during the 10-year period were recorded by the USSR (221 per cent) and Japan (194 per cent), indicating a construction boom in these countries. In the trend toward larger plants, USSR is leading with an average capacity of about 900,000 tons per plant as compared with the Canadian average of 560,000 tons and the USA average of 506,000 tons per plant in 1966.

The three largest cement producing countries, the USSR, USA and Japan accounted for about 44 per cent of the total world cement production in 1966.

The development of the cement industry in a country is best reflected by the cement production per capita, as illustrated in Table 6. Canada, with a production of 927 pounds of cement per capita ranks fifth in the world. Table 6 indicates also that largest per-capita production increase during the last 10 years has been shown by the USSR – 203%, followed by Japan – 163% and Spain – 144%.

TABLE 5

World Production of Cement
(thousand short tons)

Country	1956	1966	Production Increase, %
USSR	27,447	88,175	221
United States	62,693	75,556	20
Japan	14,356	42,179	194
West Germany	21,670	38,293	77
France	12,330	25,662	108
Italy	11,893	24,663	108
Britain	14,299	18,889	32
Spain	4,856	13,015	168
India	5,519	12,183	121
China	7,079	12,125	71
Poland	4,448	11,068	149
Canada	5,022	8,930	78
East Germany	3,603	7,116	98
Czechoslovakia	3,470	6,720	94
Other countries	60,274	127,300	111
Total	258,959	511,874	Avg. 110

Source: US Bureau of Mines Minerals Yearbook, 1966.

TABLE 6

World Cement Production Per Capita

	Country	Pounds of Cement 1956	Pounds of Cement 1966	Increase %
1	Belgium	1171	1362	16
2	West Germany	831	1060	27
3	Italy	495	965	95
4	Czechoslovakia	536	956	78
5	Canada	680	927	36
6	France	575	880	53
7	Japan	331	870	163
8	Spain	340	830	144
9	United States	785	787	0.25
10	USSR	256	775	203

INTERNATIONAL TRADE

A basic building material, cement is produced in more than 100 countries. Many countries are not yet self-sufficient in this commodity but more and more of them are moving in this direction, because the raw materials needed for cement manufacture are available in abundance all the world over.

Cement by its bulk nature is a "heavy freight" commodity and is rarely shipped economically for distances greater than 300 miles except by water transport. Only a minor proportion of world production is traded internationally. For instance, 1965 exports and imports for Canada were 4.5 and 0.6 per cent in 1966 and 4.3 and 0.6 per cent, respectively, in 1967. For the United States these proportions for 1966 were 0.3 and 1.8 per cent, respectively.

Data compiled in Table 2 indicate that both export and import of cement have shown a small but continuous increase the last six years, except in 1967, when a curtailment of the domestic cement markets influenced international trade. Practically all of the Canadian cement exported is shipped to the United States. In 1967 Canada supplied about 30 per cent of the US cement imports, shipped mainly to New York State.

The cement imported by Canada in 1967 was, by volume, about 13 per cent of the amount exported. However, the imports, being mostly white cement and other expensive, special cements from the US, Europe and Japan, had a value of $1,724,000 or 33 per cent of the value of exported cement which was $5,203,000. About half of the imported cement was white cement, which is not manufactured in Canada. Most of the white cement was imported from the United States and Japan. Most of the imported grey cement comes from Britain.

In addition, Canada imported refractory cements and mortars valued at $1,711,000, and 14,969 tons of white cement clinker from the US valued at $386,000.

DEVELOPMENTS

Despite a significant decrease in cement consumption in some areas in 1967, the cement industry in Canada continued to expand. The expansion of production capacity is based on long-range planning by the industry and is expected to continue at least into 1969.

In 1967 major expansions were completed at two plants and continued at another; construction was well underway on one new plant and design work was started on a second one.

A new cement kiln was put on the production line at the Lafarge Cement of North America Ltd. plant at Richmond on Lulu Island, British Columbia, doubling plant capacity to 3.5 million barrels per annum. Ocean Cement Limited raised the yearly capacity of its Bamberton plant to 4.0 million barrels by replacing one of the smaller original kilns with a new one with a capacity over 1000 tons per day. On the other hand, for economic reasons, the Port Colborne plant of Canada Cement Company, Limited, ceased production in April, 1967. These changes raised the total rated annual capacity of the Canadian cement industry by the end of 1967 to 75.27 million barrels, an increase of about 2.5 per cent over 1966.

The expansion of the St. Lawrence Cement Company's plant at Clarkson, Ont., by addition of a dual-stage suspension-preheater kiln and a new dry-milling system, was scheduled for completion in April 1968. The production of the original plant, operating with two wet-process kilns of 2100 tpd combined capacity, will be boosted by the more efficient, new 2500 tpd kiln and the new high-capacity Aerofall raw mill. This $15 million expansion program will increase the annual capacity of this plant to 10 million barrels, making it Canada's largest single plant and North America's second largest. Construction of the new cement plant of St. Mary's Cement Co., Limited, at Bowmanville, Ontario, about 40 miles east of Toronto, is well underway and is scheduled to start production

TABLE 7

Cement-plant Expansion

Company and Location	Capacity Increase (million bbl /year)	Year Started	Year Scheduled for Completion	Approximate Cost ($ million)
Ontario				
St. Mary's Cement Co., Limited, Bowmanville	2.0*	1966	1968	22
St. Lawrence Cement Company, Clarkson	5.0**	1965	1968	1.5
British Columbia				
Lafarge Cement of North America Ltd., Kamloops	1.2*	1968	1969	12

Source: Data obtained from publications and private correspondence.

* New plant. ** Expansion.

late in 1968. This will be a highly-automated, single-kiln plant with a production capacity of 2 million barrels per year. Thus by the end of 1968 the annual rated capacity of Canada's cement industry may be expected to be well over 82 million barrels.

A new plant by Lafarge Cement of North America Ltd., is currently under design. Quarry and soils investigations have already been done. The site preparation at the location about 10 miles east of Kamloops, British Columbia, and some preliminary construction work is planned to start in the late summer and fall of 1968. It is expected to have the new 1.2-million-barrel plant ready for production late in 1969.

A summary of cement-plant expansions is given in Table 7.

CONSUMPTION AND USE

With increased application of concrete as a building material in all types of construction, the consumption of cement in Canada has shown a continuous increase since 1960, except in 1967 when consumption dropped by more than 13 per cent from the year before. With an apparent consumption of cement in 1967 of about 7.43 million tons (see Table 2) the amount of concrete produced in Canada was about 3 tons per capita, placing Canada fifth in the world in this respect. The graph on page 6 indicates that the volume of cement production generally varies directly with the total cost of the construction, though this may not be a true indication of changes in construction volume. Because of continuous increases in the costs of materials and labour the value of construction in 1967 increased by 2.7 per cent, but if expressed in constant 1957 dollars the value actually decreased by 3.2 per cent from that in 1966. The cement market in various provinces depends on regional construction activity. Although market development in general depends on the overall trend in construction, cement requirements vary greatly with the type of construction and the amount of concrete being used in it. For example, the cost of concrete used in reinforced concrete frame buildings ranges from 20 to 30 per cent of the total cost, whereas in buildings with structural steel frame the value of concrete accounts for only 5 to 10 per cent of the total cost of the buildings. On the other hand, each dollar spent on concrete roads, bridges and tunnels accounts for the use of almost four times as much cement as a dollar spent on residential housing. It seems that total consumption of cement is mostly affected by the volume of heavy-engineering and industrial construction. The destination of domestic cement shipments in 1967 is shown in Table 8. Ontario and Quebec are by far the largest cement-consuming provinces, absorbing about two thirds of all cement consumed in Canada. Though total sales volume in 1967 decreased by about 11.2 per cent as compared with 1966, the market trend was different in various provinces. While cement sales in Quebec, the Maritime provinces and Ontario decreased by 26.1, 10.6 and 9.2 per cent, respectively, those to the Western provinces increased by 4.2 per cent. The amount of cement consumed by the Yukon and Northwest Territories was nearly two and one-half times larger than that used in 1966.

TABLE 8

Destination of Domestic Cement Shipments* 1967
(short tons)

Ontario	2,801,457
Quebec	2,021,549
Manitoba, Saskatchewan, Alberta and British Columbia	2,221,165
Newfoundland, Prince Edward Island, Nova Scotia and New Brunswick	540,072
Yukon and Northwest Territories	10,202
Canada total	7,594,445
Exports	319,701
Total shipments	7,914,146

Source: Dominion Bureau of Statistics.
* Only direct sales from producing plants.

In Quebec the construction boom, which started in 1965 continued in 1966. Most of this activity was evident in the greater Montreal area and at the dam-building sites of the huge Manicouagan-Outardes hydroelectric power development in northern Quebec. Large quantities of cement were used also for the construction of roads, bridges and tunnels in connection with the Trans-Canada Highway, new expressway and subway on Montreal Island, and for numerous structures of EXPO '67. After the vast EXPO '67 construction program came to an end, the heavy-engineering, industrial and commercial construction in Quebec decreased in 1967 by about 25 per cent in value. This resulted in a decrease in cement consumption of 26.1 per cent from the amount sold in 1966.

In the Maritimes the increase in engineering construction was offset greatly by the decrease of industrial construction, thus affecting cement sales, which decreased by a total of 10.6 per cent as compared with 1966.

In Ontario industrial construction decreased by about 20 per cent, thus affecting cement sales, which was reduced by a total of 9.2 per cent from the amount sold in 1966.

Significant increases in construction contracts achieved in the Western provinces resulted in a 4.2 per cent increase in cement sales there. The reasons for this growth are the hydroelectric power projects in British Columbia and the expansion of the potash and oil industries in the Prairies.

Though no overall statistics are available to provide a reliable breakdown of cement consumption by types of construction, it is obvious that expenditures for non-residential and governmental construction have a more dynamic effect on cement consumption than residential construction. Consequently, although the level of investment in construction influences the demand for cement, of more importance is the structural make-up of the construction program. Canada Cement Company provided some data on cement usage in Canada for 1966. It shows that residential and rural construction used about 22 per cent of the cement consumed. Roughly about 65 barrels of cement are being used per each house unit started. The industrial and commercial construction used about 44 per cent and the governmental construction about 34 per cent of all cement sold. In the latter group are included also highways, subways, bridges, overpasses and power dams.

An increasing amount of cement is being used by the mining industry in some form of back-fill in mines, rock support and other concrete work. A rough estimate of this application may account for about 0.4 million tons of cement, or about 5 per cent of sales in 1967.

The proportions of the total consumption of cement used for ready-mixed concrete and concrete products industry has been increasing steadily during the last few years. However, preliminary figures provided by the Dominion Bureau of Statistics indicate that the output of ready-mixed concrete in 1967 was, by volume, about 16 per cent below that of 1966, consuming about 45 per cent of the total cement shipments. Over 80 per cent of all cement delivered to concrete products and ready-mix plants was in bulk shipments. Production figures for concrete products given in Table 9 show significant decreases in 1967 from the volume produced in 1966.

Portland cement is the most widely used of all modern engineering construction materials. With most of it being used in concrete and different concrete products, cement is used also in mortar, stucco, grout, soil-cement and asbestos-cement products.

Versatility and reliability of concrete, its use as precast and prestressed structural members almost completely frees our architectural and artistic imagination for innumerable applications.

One new and revolutionary application is the use of a ferro-cement method in the boat building industry. Though discovered by Luigi Nervi about 20 years ago in Rome, Italy, this method was not widely used until recently. There are now ferro-cement boat builders in New Zealand, Australia, Britain, and quite recently the method has been adopted in Canada by boat builders in Vancouver and Richmond, B.C., and Fort Erie, Ont. Under the trade name of Seacrete, ferro-cement with lightweight aggregates is being used to build sail- and power-boats, barges and floating docks.

SPECIFICATIONS

Portland cement produced in Canada conforms to the specifications of the CSA Standard A5-1961, published by the Canadian Standards Association. This standard covers the three main types of portland cement as follows: Normal, High Early Strength, and Sulphate-Resisting Portland Cements. Many changes have been made in this standard over the years. For the last (fifth) edition of A5, issued in 1961, already 17 revisions have been published. The CSA Committee on Hydraulic Cements is presently considering publishing a revised and updated edition of the Standard which may include a new specification for a modified portland cement with a low heat of hydration and moderate sulphate resistance. This type of cement

TABLE 9

Manufacturing of Concrete Products

		1966	1967[p]
Concrete bricks	(no.)	128,002,000	85,403,244
Concrete blocks (except chimney blocks)			
Gravel	(no.)	161,883,796	145,241,368
Cinder	(no.)	4,449,782	5,809,095
Other	(no.)	45,551,033	42,567,818
Concrete drain pipe, sewer pipe, water pipe and culvert tile	(tons)	1,303,047	1,180,218
Concrete, ready mix	(cu. yd.)	17,617,624	12,473,796

Source: Dominion Bureau of Statistics (Annual Cat. Nos. 44-205 & 211).

[p] Preliminary (DBS Monthly Cat. No. 44-002).

already is being manufactured by several cement companies in Quebec according to specifications supplied by Hydro-Quebec and designed for mass concrete used in dam construction. Though the tensile strength requirement was dropped from the Standard, there is a good possibility that the present compressive strength requirements will be increased in the near future.

Masonry cement produced in Canada conforms to the CSA Standard A8-1956. This type of cement is also sold under other names–Mortar Cement, Mortar Mix, Mason's Cement, Brick Cement, etc. It is produced by intimately intergrinding portland cement clinker with high calcium limestone and an air-entraining plasticizer to a fineness greater than normal portland cement. Today's masonry cements meet CSA specification A8 Type H and L.

The cement types manufactured in Canada and not covered by CSA standards generally meet the appropriate specifications of the American Society for Testing and Materials.

PRICES

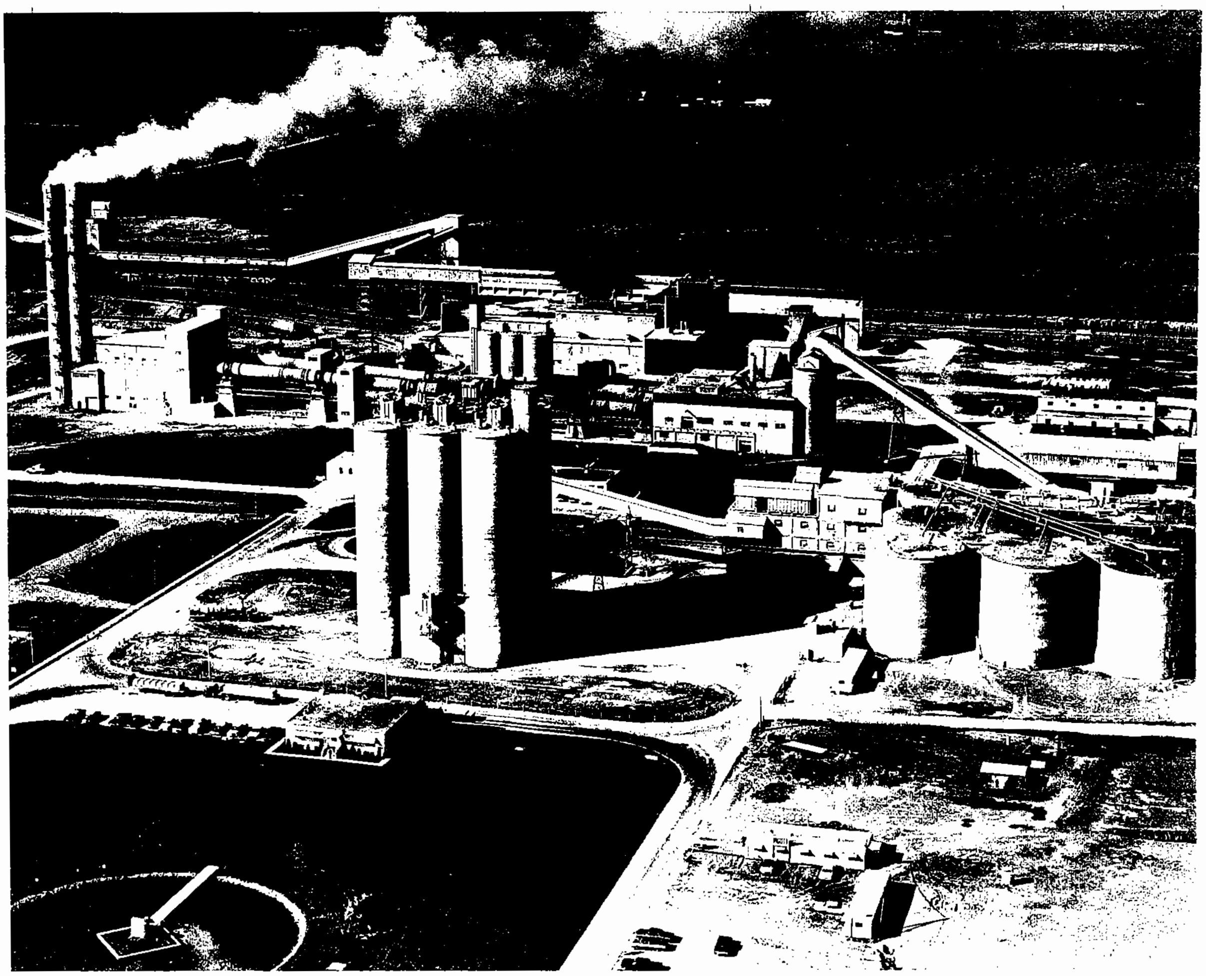
Prices of cement vary depending on supply and demand, quantity of shipment, location of the point of delivery and type of cement.

The average value of all Canadian shipments in 1966 amounted to $17.50 per ton. This increased to $18.98 in 1967 and ranged from a high of $24.29 for Saskatchewan shipments to a low of $17.03 per ton for Newfoundland shipments. There is only one cement plant in Saskatchewan and all its limestone is transported about 275 rail-miles from Manitoba.

TARIFFS

	British Preferential (¢)	Most Favoured Nation (¢)	General (¢)
CANADA			
Portland cement, hydraulic or water lime, in bulk or barrels, bags, or casks, the weight of the barrel, bag or cask to be included in the weight for duty, per 100 lb	5	8	8
White portland cement clinker for use in the manufacture of white portland cement, per 100 lb	2	3½	6
UNITED STATES			
White, nonstaining, portland cement		3¢ per 100 lb incl. weight of container	
Other cement		2.25¢ per 100 lb incl. weight of container	
Concrete mixes			
Hydraulic cement concrete		5%	
Other		15%	

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.



ONE OF A FAMILY OF EIGHT: Canada Cement's Woodstock plant in southern Ontario is one of several company operations from coast to coast. Total rated cement capacity of the company was 26.6 million barrels in 1967, compared to an industry total of 77.2

Chromium

G.P. WIGLE*

Canada is not a producer of chromite. During periods of emergency, chromite, the principal ore of chromium, has been mined in the Eastern Townships of Quebec, where many occurrences are found. Other discoveries are located in Manitoba, Newfoundland and British Columbia. The Bird River deposits in the Lac du Bonnet district of Manitoba are large low-grade occurrences averaging about 26 per cent Cr_2O_3 and 12 per cent iron with a chromium-to-iron ratio of about 1.4 to 1.

Imports of chromium in ores and concentrates in 1967 totalled 34,485 tons valued at $2.5 million compared with 20,880 tons valued at $1.6 million in 1966. Imports of ferrochromium were 21,740 tons valued at $5.5 million compared with 12,536 tons valued at $3.6 million in 1966.

The principal producer of ferroalloys and only producer of ferrochromium in Canada is Union Carbide Canada Limited. In addition to its wide range of ferroalloys it produced high-carbon ferrochromium, charge chrome, and ferrochrome silicon. The iron, steel and non-ferrous melting industries, the major customers for ferroalloys, reduced production marginally in 1967, resulting in a similar decrease in the demand for ferroalloys. Foreign suppliers of ferrochromium, including chromite-producing countries that have become producers and exporters of ferrochromium, gained a greater share of the Canadian market for low-carbon ferrochromium. The Republic of South Africa was by far the principal supplier of ferrochromium to Canada and the United States.

Suppliers of chromite and chromium additives, other than Union Carbide, include Chromium Mining & Smelting Corporation, Limited; Philipp Brothers (Canada) Ltd.; Metallurg (Canada) Ltd.; Continental Ore Co. (Canada) Limited and Engelhard Industries of Canada Limited.

Consumers of chromium in Canada include Atlas Steels Division of Rio Algom Mines Limited; Crucible Steel of Canada Ltd.; Fahralloy Canada Limited; The Steel Company of Canada, Limited; Canadian Refractories Limited and General Refractories Company of Canada Limited.

WORLD PRODUCTION AND TRADE

Estimated world mine production of chromite was 5.40 million tons in 1967, the same as in 1966. The USSR, the Republic of South Africa, the Philippines, Turkey and Rhodesia supplied nearly 90 per cent of the world's chromite requirements. The United Nations embargo on chromium ores from Rhodesia diverted that supply from its previous principal markets and obscured its volume and destination.

*Mineral Resources Branch.

TABLE 1

Canada, Chromium Trade and Consumption, 1966-67

	1966		1967[p]	
	Short Tons	$	Short Tons	$
Imports				
Chromium in ore and concentrates				
United States	8,448	843,000	18,799	1,395,000
Philippines	6,445	442,000	7,691	539,000
Cyprus	–	–	2,951	191,000
Greece	–	–	1,651	113,000
Turkey	–	–	1,613	121,000
Ireland	526	66,000	1,312	150,000
Other countries	5,461	247,000	468	17,000
Total	20,880	1,598,000	34,485	2,526,000
Ferrochromium				
Republic of South Africa	5,033	1,251,000	13,592	3,225,000
France	4,174	1,340,000	4,596	1,417,000
Sweden	70	26,000	1,605	314,000
United States	2,514	805,000	1,476	466,000
Norway	399	96,000	263	65,000
Other countries	346	96,000	208	47,000
Total	12,536	3,614,000	21,740	5,534,000
Chromic acid (chromium trioxide)				
United States	426	256,000	143	92,000
Mainland China	–	–	32	12,000
Britain	434	258,000	31	19,000
Japan	–	–	16	8,000
Other countries	83	44,000	–	–
Total	943	558,000	222	131,000
Chromium sulphates, basic, for tanning				
United States	805	192,000	725	167,000
Britain	379	76,000	341	69,000
Other countries	17	3,000	27	4,000
Total	1,201	271,000	1,093	240,000
Chrome dyestuffs				
West Germany	45	101,000	38	96,000
United States	42	87,000	32	73,000
Britain	21	47,000	18	36,000
Switzerland	10	45,000	13	45,000
France	9	25,000	8	23,000
Other countries	21	22,000	10	16,000
Total	148	327,000	119	289,000
Exports				
Ferrochromium				
Britain	34	8,000	–	–
Other countries	1	1,000	–	–
Total	35	9,000	–	–
Consumption				
Chromite	64,550			

Source: Dominion Bureau of Statistics.
[p] Preliminary; – Nil.

TABLE 2

Canada, Chromium Trade and Consumption, 1958-67
(short tons)

	Imports		Exports	Consumption[2]	
	Chromite[1]	Ferro-chro-mium[2]	Ferro-chro-mium[2]	Chro-mite	Ferro-chro-mium
1958	38,136	. .	10,460	36,297	4,714
1959	48,678	. .	7,514	58,532	8,150
1960	59,023	. .	4,611	54,331	8,827
1961	71,268	. .	1,642	52,134	8,046
1962	71,969	. .	6,602	70,342	9,452
1963	49,654	. .	2,910	56,016	9,662
1964	20,794	10,482	172	57,734	11,212
1965	35,408	15,336	205	69,105	12,903
1966	20,880	12,536	35	64,550	17,200
1967[p]	34,485	21,740	–	. .	. .

Source: Dominion Bureau of Statistics.
[1] To 1963, gross weight; from 1964, chromium content; [2] Gross weight.
[p] Preliminary; . . Not available; – Nil.

TABLE 3

World Production of Chromium Ore, 1965-67
(thousands of short tons)

	1965	1966	1967[e]
USSR	1,565	1,600	1,800
Republic of South Africa	1,038	1,169	1,200
Philippines	611	617	600
Turkey	625	583	550
Rhodesia	624	550	400
Albania	347	350	350
Iran	165	193	180
Other countries	365	338	320
Total	5,340	5,400	5,400

Source: US Bureau of Mines, Minerals Yearbook 1966; World Mining, June 1967; and Trade Publications.
[e] Estimates.

Chromite production in the Republic of South Africa was 942,312 tons during the period January to September 1967 compared with 863,016 tons in the same period of 1966; exports were 535,723 tons and 700,713 tons in the comparable periods. Domestic sales of chromite in South Africa during the period January to September 1967 were 198,874 tons compared with 135,731 tons in the first nine months of 1966. Local consumption of some 200,000 tons was principally to supply the growing South African ferrochromium industry.

The Republic of the Philippines is the major supplier of refractory-grade chromium ore to the United States. The Philippines production in 1966 was 502,000 tons of refractory ore and 115,000 tons of metallurgical ore.

The United States is the largest importer and consumer of chromite. US imports of chromite in 1967 were 1,240,761 tons and consumption was 1,348,193 tons compared with 1,864,400 tons imported and 1,461,017 tons consumed in 1966. The metallurgical industry used 64 per cent of 1967 United States consumption, the refractories industry 23 per cent, and the chemical industry 13 per cent. The largest supplier to the United States was the Republic of South Africa followed by the USSR, the Philippines, Rhodesia and Turkey. The USSR supplied 299,000 tons of chromium ore grading 55 per cent Cr_2O_3.

CHROMIUM ORE AND ITS USES

The only commercially important ore-mineral of chromium (Cr) is chromite ($FeO.Cr_2O_3$) which has a theoretical chromic oxide (Cr_2O_3) content of 68 per cent. Chromite is a combination of oxides of chromium and iron with varying amounts of alumina, magnesia and silica. The better grades of chrome ore vary between 40 and 56 per cent Cr_2O_3 and 10 to 26 per cent iron oxide (FeO). Chromium ores rarely contain more than 50 per cent chromic oxide but Russia does, however, produce high-grade chromite concentrate containing 54 to 56 per cent Cr_2O_3. Representative analyses of chromium ores are listed in an accompanying table.

Variations in chemical and physical properties are the basis for grading the ores into three main groups: metallurgical, refractory and chemical grades. The metallurgical industry of the United States, in recent years, used about 56 per cent of domestic consumption; the refractory industry about 31 per cent and the chemical industry approximately 13 per cent.

METALLURGICAL CHROMITE

Metallurgical-grade chromite ore, usually over 46 per cent Cr_2O_3, is used to make the additive alloys of chromium supplied to the iron and steel industry. Ninety per cent of the 891,000 tons of metallurgical chromite consumed in the United States in 1965 contained 50 per cent Cr_2O_3 and 88 per cent had a chromium to iron ratio of 3:1 or more.

Ferrochromium is an additive alloy of chromium and iron, 50 to 73 per cent Cr, used to add chromium to iron and steel. Chromium promotes hardenability and improves corrosion and wear resistance of iron and steel. It is an essential constituent of stainless steels; additions of 12 per cent or more give outstanding resistance to corrosion. High-carbon ferrochromium is most commonly made by reducing chromite in an open-top submerged arc electric furnace. Coke is usually used as the reducing agent. Low-carbon ferrochromium is produced by reducing the high carbon product with a ferro-silicon-chromium. This process depends on the greater affinity of chromium for silicon than for carbon and produces low-carbon ferrochromium with a silicon content of 0.2 to 0.8 per cent. Low-carbon ferrochromium, 50 to 73 per cent Cr, containing .010 to 2 per cent carbon is used in heat and corrosion resistant stainless steels with low-carbon specifications. Medium (2 to 3 per cent C) and high-carbon (3 to 6 per cent C) ferrochromiums are suitable for additions of chromium to low-alloy engineering steels in which both chromium and carbon are required.

Chromium content ranging from 16 to 26 per cent is used in the chromium-nickel and chromium-nickel-manganese types of stainless steel. Nickel-base chromium alloys are used in jet engines, turbine blades, heating elements and in handling-equipment for hot or corrosive chemicals. Chromium is used in a variety of alloy steels ranging from less than one per cent to as much as 35 per cent chromium.

REFRACTORY-GRADE CHROMITE

The refractory industry uses chromite averaging about 35 per cent Cr_2O_3. Specifications for refractory-grade chromite are not as rigid as for metallurgical but mineral constituents are important in the making of good quality refractory brick. The silica and iron content should not be over 10 and 5 per cent respectively. Chromic oxide (Cr_2O_3) and alumina (Al_2O_3) combined should not be less than 57 per cent. The ore should be hard and lumpy and above 10-mesh in size. Chromite fines are suitable for the manufacture of brick cement and chrome-magnesite brick. Chromite refractories have a chemically neutral character and are used extensively for furnace linings.

CHEMICAL-GRADE CHROMITE

The chemical industry in the United States uses chromite averaging 45 per cent Cr_2O_3. Specifications are less rigid than for other grades. Suitable ores should be as high in Cr_2O_3 and as low in silica and alumina as possible. Friable ores and fines are acceptable and the chromium to iron ratio is usually about 1.6 to 1.

Many chromium chemicals are derived from sodium dichromate manufactured from chromite for the chemical industry. Chromium chemicals are used in pigments, dyes, leather tanning, electroplating, fungicides and in a variety of chemical processes as catalysts and oxidants. Chromium plating of plastic parts for automobiles, appliances and home furnishings is a growing industrial use.

TABLE 4

Representative Analyses of Chromium Ores

Country and Type	Per Cent						Cr: Fe Ratio
	Cr_2O_3	Total Fe	Al_2O_3	MgO	CaO	SiO_2	
Rhodesia							
(Selukwe)							
Metallurgical	47.	9.34	12.64	15.50	1.80	5.70	3.4 :1
Refractory	42.6	12.2	13.80	15.80	.32	8.60	2.4 :1
(Dyke)							
Refractory	50.70	12.75	13.00	13.20	.75	4.33	2.7 :1
Metallurgical	48.50	14.2	11.50	13.40	.08	5.6	2.4 :1
Russia							
Metallurgical	53.90	9.80	9.60	13.30	1.1	5.80	3.76:1
Refractory	39.10	10.90	17.4	16.10	.7	9.4	2.5 :1
Turkey							
Metallurgical	48.30	10.95	13.00	16.84	.95	5.07	3.01:1
Refractory	37.00	11.80	24.34	17.73	.22	4.33	2.36:1
S. Africa							
Chemical	44.50	19.20	15.02	10.04	.31	3.86	1.57:1
Philippines							
(Masinloc)							
Refractory	33.35	10.30	28.23	19.56	.45	4.58	2.2 :1

Source: *E & MJ Metal and Mineral Markets,* Market Guide, Chrome, May 30, 1966.

PRICES

Chrome prices in United States as quoted by *Metals Week,* December 25, 1967 were:

Chromium Metal	
electrolytic, 99.8%, f.o.b. shipping point, per lb.	96¢
Vacuum melting	99¢
9% C	136.5 ¢
aluminothermic, per lb., delivered	
98.5%	96¢
99.25%	99¢
Chrome Ore	
per long ton, dry basis, subject to penalties if guarantees not met, f.o.b. cars Atlantic ports, term contracts (subject to negotiation) are generally lower.	
Rhodesia (nominal)	
48-50% Cr_2O_3, 3 1/2 to 1 ratio, lump	\$31–\$35
53% Cr_2O_3, 2.4 to 1 ratio, concentrate	\$28–\$29
Transvaal	
44% Cr_2O_3, no ratio	\$19–\$21.50
Turkish (nominal)	
48% Cr_2O_3, 3 to 1 ratio	\$34.50–\$35.50
Russian (nominal)	
54-56% Cr_2O_3, 4 to 1 ratio	\$36.50–\$40
Ferrochrome	
per lb. chrome content, f.o.b. shipping point, freight equalized to nearest main producer, carload lots, lump, bulk	
High carbon 67-71% Cr, 4 to 6% C or 6 to 8% C	19¢ (nominal)
Low carbon, 67 to 73% Cr	
0.025% C	25.5¢
0.05% C	24.5¢
Simplex low carbon,	
No. 2, 0.01% C	26.5¢
No. 1, 0.025% C	24.5¢
36/40 ferrochrome silicon	11.0¢
40/43 ferrochrome silicon	11.9¢
Charge chrome	
63-71% Cr, 3% Si, 0.04% S, 4.5-6% C	15.3¢
Blocking chrome, 10-14% Si	17.9¢
14-17% Si	18.9¢

TARIFFS

	British Preferential	Most Favoured Nation	General
CANADA			
Chrome ore	free	free	free
Chrome metal in lumps, powder, ingots, blocks or bars and scrap of alloy metal containing chromium for use in alloying	free	free	free
Ferrochromium	free	5%	5%
Chromium trioxide for use in manufacture of tin plate	free	free	25%
UNITED STATES			
Chrome ore		free	
Chromium metal		10 1/2%	
Ferrochromium			
less than 3% C		8 1/2%	
3% or more C		5/8¢ per lb on Cr. content	
Chromic Acid		10 1/2%	
Chromium carbide		12 1/2%	
Chrome brick		25%	
Chrome colours		10%	
Chromate and dichromate		2.25¢ per lb	

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions on January 1, 1972.

Clays and Clay Products

J. G. BRADY*

Deposits of high-quality argillaceous materials such as china clays, very refractory fireclays and ball clays are scarce in Canada. Raw materials of this type are imported for use as fillers and coaters, in refractories, or in whitewares and pottery. The search for new deposits and the re-examination of deposits known to be suitable for some of the above products continued because of the possibility of replacing the large volume of imported clay with domestic supplies. To date, efforts at development of some deposits have been unsuccessful because of uneconomic situations or beneficiation difficulties. As a result, common clays and shales are the principal domestic materials available and they are used mainly for manufacturing brick and tile.

The term 'clay products' applies to such materials as fireclay refractories, common and facing brick, structural tile, partition tile, drain tile, quarry tile, sewer pipe, conduit and flue lining, which have clay as their principal ingredient; and wall tile, floor tile, electrical porcelain, sanitaryware, dinnerware and pottery, which are prepared bodies of the whiteware type and which, in addition to high-quality clay such as kaolin and ball clay, may contain ground silica, feldspar, nepheline syenite, talc and various other components. A list of ceramic plants is shown in Operators List 6, Ceramic Plants in Canada, published by the Mineral Resources Division and Mines Branch, Department of Energy, Mines and Resources, Ottawa.

PRODUCTION, TRADE AND CONSUMPTION

Tables 1 to 6 contain statistics on production, trade and consumption of clay and clay products. The items in Table 1 are made almost entirely from domestic clay or shale. The whitewares and refractories products that are produced in Canada and listed in Tables 3 and 4 respectively generally contain clay as one of several major ingredients, although basic refractories, which are included in Table 4, contain no clay. The products listed as exports or imports in Table 2 generally contain clay as a major ingredient although there are such items as chrome magnesite and silica firebrick, and some ceramic tableware that contain no clay. The most recent figures on production of whitewares and refractories are for 1965 and consequently figures for 1967 are not shown in Tables 3 and 4.

The 1967 preliminary figures for production of clay and clay products from domestic sources (Table 1) indicate that their value is slightly higher than in 1966 and at an all time high of $43.5 million. Shipments of clay products from imported clays (Tables 3 and 5) for 1965 have risen to approximately $31.4 million, a slight increase over 1964. At approximately $70.7 million, the value of imports of clay and clay products (Table 2) remained much higher than exports ($13.7) million).

One hundred and eleven plants manufactured clay products using domestic or imported clays (these are

*Mineral Processing Division, Mines Branch.

in addition to numerous art pottery and ceramic souvenir plants). Brick and tile plants make up the largest group, where 66 manufactured such clay products as facing brick (glazed and unglazed), common brick, structural tile, drain tile and quarry tile, primarily from local common clays and shales.

Six plants manufactured such products as clay sewer pipe, flue liners, conduits and wall coping. Their raw materials were mainly domestic low-grade fireclay, stoneware clay, common clay and plastic shale. Two plants in Ontario imported low-grade fireclay from the United States for production of these products; one of them mixed local clay with the imported fireclays to form a suitable production mix.

Most of the eighteen plants manufacturing refractories used clay as the principal ingredient in many of their products. Only four, all in western Canada, used domestic clays.

Six whiteware-sanitaryware plants, eight electrical porcelain plants, three wall tile plants, four dinnerware plants and numerous souvenir and art potteries were the principal users of ceramic-grade china clay and ball clay, which are imported mainly from the United States and Britain.

TABLE 1

Canada, Production of Clay and Clay Products from Domestic Sources 1966-67

		1966		1967p	
		Quantities	$	Quantities	$
Production, shipments from domestic sources					
By main classes					
Clays, including bentonite			907,242		*
Clay products from					
Common clay			32,558,882		34,488,146
Stoneware clay			6,782,800		6,273,648
Fireclay			767,194		*
Other			1,939,967		2,787,625
Total			42,956,085		43,549,419
By Products					
Clay					
Fireclay	s.t.	6,441	99,787		
Other clay, including bentonite		..	807,455		
Fireclay blocks and shapes		..	98,183		
Firebrick	No.	4,836,163	669,011		
Brick					
Soft mud process					
Face	No.	5,107,000	299,814		
Common	No.	–	–		
Stiff mud process					
Face	No.	388,083,008	19,749,534		
Common	No.	34,993,051	860,656		
Dry process					
Face	No.	61,276,590	3,276,974		
Common	No.	3,430,154	127,738		
Fancy or ornamental	No.	21,657,391	1,566,661		
Sewer brick	No.	2,393,199	90,515		
Paving brick	No.	787,856	82,968		
Structural tile	s.t.	57,973	1,259,435		
Floor tile	sq.ft.	295,750	130,786		
Drain tile	No.	71,734,061	5,113,801		
Sewer pipe	ft.	8,517,656	4,231,677		
Flue linings	ft.	1,928,362	1,174,031		
Pottery		..	1,377,092		
Other products		..	1,939,967		
Total			42,956,085		43,549,419

Source: Dominion Bureau of Statistics.
* Included under Other.
p Preliminary: – Nil; . . Not available.

TABLE 2

Canada, Imports and Exports of Clay, Clay Products and Refractories

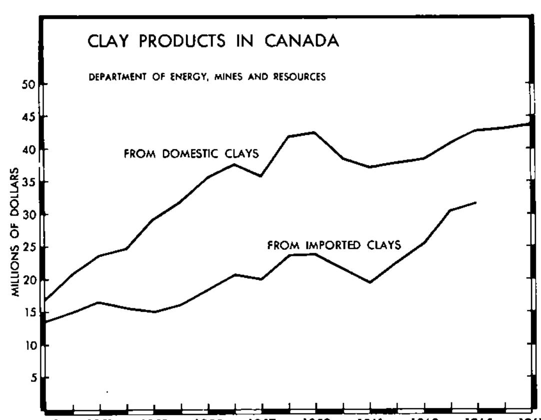
		1966		1967	
		Quantity	$	Quantity	$
Imports					
Clay, clay products and refractories					
Bentonite	s.t.	192,211	1,789,000	219,862	2,154,000
Drilling mud	s.t.	8,103	902,000	7,811	885,000
China clay, ground or unground	s.t.	196,777	4,483,000	190,311	4,549,000
Fireclay, ground or unground	s.t.	52,556	730,000	40,508	602,000
Clays, ground or unground	s.t.	82,975	1,123,000	89,335	1,255,000
Clays and earth, activated	s.t.	4,206	597,000	6,510	933,000
Brick, building					
Glazed	M	2,744	221,000	3,026	208,000
n.e.s.	M	18,414	1,150,000	17,272	1,027,000
Building blocks	M	..	526,000	..	473,000
Earthenware tiles					
Under 2½ x 2½"	sq.ft.	9,256,206	1,936,000	11,645,282	2,407,000
Over 2½ x 2½"	sq.ft.	12,606,408	2,473,000	12,008,639	2,281,000
Claybricks, blocks, tiles n.e.s.		..	143,000	..	129,000
Firebricks					
Alumina	M	2,988	4,009,000	3,482	4,472,000
Chrome	M	579	689,000	732	1,139,000
Magnesia	M	725	1,646,000	462	1,379,000
Silica	M	5,307	3,773,000	1,941	1,606,000
n.e.s.	M	45,595	13,759,000	45,556	11,644,000
Refractory cements and mortars		..	1,934,000	..	1,711,000
Pottery settings and firing supplies		..	213,000	..	273,000
Crude refractory materials	s.t.	6,126	356,000	5,689	437,000
Grog (refractory scrap)	s.t.	18,955	697,000	16,386	576,000
Refractories, n.e.s.		..	2,641,000	..	1,994,000
Acid-proof brick		..	432,000	..	272,000
Tableware, ceramic			21,934,000		25,251,000
Porcelain insulating fittings			3,590,000		3,073,000
Total, clay, clay products and refractories			71,746,000		70,730,000
By main countries					
United States			39,255,000		37,314,000
Britain			20,327,000		21,073,000
Japan			6,687,000		7,272,000
West Germany			2,083,000		1,355,000
France			864,000		836,000
Ireland			514,000		605,000
Hong Kong			323,000		605,000
Italy			246,000		350,000
Czechoslovakia			78,000		236,000
Denmark			293,000		225,000
East Germany			95,000		173,000
Other countries			981,000		686,000
Total			71,746,000		70,730,000

TABLE 2 (cont'd)

		1966		1967	
		Quantity	$	Quantity	$
Exports					
Clays, clay products and refractories					
Clays, ground and unground	s.t.	2,703	78,000	277	27,000
Crude refractory materials	"	1,302,361	2,690,000	1,114,162	2,605,000
Building brick, clay	M	11,238	901,000	13,181	1,049,000
Clay bricks, blocks, tiles n.e.s.		..	234,000	..	413,000
Firebrick and similar shapes		..	5,389,000	..	6,215,000
Refractories n.e.s.		..	703,000	..	384,000
High tension insulators and fittings		..	1,941,000	..	1,985,000
Tableware, n.e.s.		..	636,000	..	1,062,000
Stone, clay and concrete end products		..	7,000	..	*
Total clays, clay products and refractories			12,579,000		13,740,000
By main countries					
United States			9,319,000		10,202,000
Republic of South Africa			100,000		623,000
Puerto Rico			329,000		284,000
Chile			273,000		203,000
Bahamas			198,000		151,000
New Zealand			132,000		134,000
Ireland			100,000		134,000
Pakistan			188,000		132,000
Sweden			58,000		127,000
Greece			155,000		125,000
Tanzania			–		117,000
Other countries			1,727,000		1,508,000
Total			12,579,000		13,740,000

Source: Dominion Bureau of Statistics.
*Not available as a separate class after 1966
..Not available; – Nil; n.e.s. Not elsewhere specified.

The quantity of china clay used in Canada continued to rise (Table 6). No statistics on the quantity of fireclay and ball clay consumed are available. About 2.5 million tons of domestic clay are consumed in the products included in Table 1.



USES, NATURE AND LOCATION OF CLAY AND SHALE DEPOSITS

CHINA CLAY (KAOLIN)

China clay, frequently referred to as kaolin, is a high-quality material used as a filler and coater in the paper industry, a raw material in ceramic products and a filler for rubber and other products. The properties needed in the paper industry are intense whiteness, freedom from abrasive grit and high coating retention. In the ceramic industry it is used as a refractory raw

TABLE 3

Shipments of Clay Products Manufactured in Canada from Imported Clays*

	1963		1964		1965	
	Quantity	$	Quantity	$	Quantity	$
Glazed floor and wall tile, sq.ft.	14,587,214	5,100,000	18,448,215	6,176,000	15,545,578	5,882,000
Electrical porcelains	..	6,279,000	..	7,918,000	..	10,068,000
Pottery, art and decorative ware	..	806,000	..	1,053,000	..	1,246,000
Pottery tableware	..	1,563,000	..	1,806,000	..	1,859,000
All other products (sanitaryware, etc.)	..	12,016,000	..	14,289,000	..	13,030,000

Source: Dominion Bureau of Statistics.
*Does not include refractories.
..Not available.

TABLE 4

Shipments of Refractories Manufactured in Canada

		1963		1964		1965	
		Quantity	$	Quantity	$	Quantity	$
Fireclay blocks and shapes	s.t.	..	47,621	..	73,674	..	69,465
Firebrick	M	4,775	636,112	3,807	598,897	4,970	665,748
Other firebrick and shapes	s.t.	..	12,257,000	..	14,715,000		
Refractory cements, mortars castables and other refractory materials	s.t.	71,724	8,350,000	66,079	7,677,000	54,732	7,493,000

Source: Dominion Bureau of Statistics.
*Includes rigid firebrick, stove linings and other shapes made from imported clays, chrome ore, magnesite, etc.
..Not available.

material. In prepared whiteware bodies it is used along with such materials as nepheline syenite, silica, feldspar and talc, for the manufacture of such products as wall tile, floor tile, sanitaryware, dinnerware, pottery and electrical porcelain. China clay is used as a source of alumina and silica in the whiteware industries. It also imparts a degree of plasticity to the unfired body and helps to maintain a white fired colour.

Because of the problems of beneficiation and the small size of some deposits, none of the crude kaolins known to exist in Canada have been developed. Most occurrences contain a high proportion of quartz, whose particles vary in size from coarse to very fine, and such substances as mica, feldspar, magnetite, pyrite and colloidal iron. In the crude material the percentage of clay, which is principally koalinite, is frequently small. Attempts to remove impurities from Canadian kaolins have so far not been successful. However, new and improved methods of beneficiation may be effective.

Extensive deposits of sandy kaolin occur near Wood Mountain, Fir Mountain, Knollys, Flintoft and other localities in southern Saskatchewan. Considerable work had been carried out by the Government of Canada, the University of Saskatchewan and Government of Saskatchewan, but so far beneficiation has not been successful.

A deposit of refractory clay similar to a secondary china clay occurs along the Fraser River near Prince George, British Columbia. The material varies from very plastic to very sandy. The upper beds are considerably iron-stained. This material has been investigated as a source of kaolin, as a fireclay and as a raw material for facing brick.

TABLE 5

Clays and Clay Products Production, and Trade, 1958-67

($ millions)

	Production				
	Domestic Clays[1]	Imported Clays[2]	Total	Imports	Exports[3]
1958	41.7	23.7	65.4	44.8	4.2
1959	42.5	23.9	66.4	48.1	5.1
1960	38.2	21.5	59.7	46.7	5.3
1961	37.0	19.4	56.4	47.1	5.8
1962	37.8	22.5	60.3	48.3	5.4
1963	38.2	25.2	63.4	43.9	7.6
1964	40.8	30.2	71.0	54.7	8.9
1965	42.8	31.4	74.2	59.4	10.3
1966	43.0	..	..	71.7	12.6
1967p	43.5	..	..	70.7	13.7

Source: Dominion Bureau of Statistics.
[1] Production (shipments) of clay and clay products from domestic material.
[2] Production (shipments) of clay products from imported clay, from 1961 does not include refractories.
[3] From 1964 includes additional categories of refractories.
pPreliminary; ..Not available.

TABLE 6

Consumption (available data) of China Clay by Industries 1965-66
(short tons)

	1965	1966
Ceramic products	12,719	11,423
Paint and varnish	2,298	2,610
Paper and paper products	112,881	122,519
Rubber and linoleum	12,919	10,959
Other products*	13,880	14,126
Total	154,697	161,637

Source: Dominion Bureau of Statistics.
*Includes miscellaneous chemicals, cleansers, detergents, soaps, medicinals and pharmaceuticals and other miscellaneous products.

A clay deposit at Arborg, Manitoba, contains colloidal iron, a considerable quantity of quartz and some other impurities in addition to kaolinite. An interesting deposit has been reported at the lower end of Lake Winnipeg but its extent is not known to the writer.

Kaolin-bearing rock occurs in Quebec at St. Remi d'Amherst, Papineau County; Brebeuf, Terrebonne County; Point Comfort, on Thirtyone Mile Lake, Gatineau County; and Chateau Richer, Montmorency County. The Quebec deposits, in general, contain an excessive amount of quartz and iron minerals. The kaolinite content is variable but is usually less than 50 per cent. The Chateau Richer material is mainly feldspar with about 25 per cent kaolinite. In recent years, various companies have shown considerable interest in Quebec's kaolin-bearing deposits because of their kaolinite content and because of the possible uses of the unbeneficiated material for the facing-brick and other industries.

Kaolinized deposits occur extensively in northern Ontario. To date certain difficulties with quality and exploration have not been overcome. Work on these deposits continued during the year in several laboratories, particularly on the removal of very fine silica.

BALL CLAY

Ball clays are used in whitewares, where they impart plasticity and a high green strength to the bodies. They fire white or light cream, which does not interfere with the fired colour of the whiteware products. Being extremely refractory, they are used as a plastic bond clay in various types of refractory products.

Ball clays obtained in Canada are mineralogically similar to high-grade plastic fireclays. They are made up principally of fine-particle kaolinite and quartz.

In Canada, ball clays are known to occur only in the Whitemud formation of southern Saskatchewan. Good-quality deposits are known to exist at Willows, Readlyn, Big Muddy Valley, Blue Hills, Willow Bunch, Flintoft and in other areas. Clay from the Willows area has been used for many years in the potteries at Medicine Hat and in Vancouver. It has been tested in the United States. The lack of proper quality control, the distance from large markets and lack of reserves have been the principal disadvantages affecting the use of this material. Some ball clay from the Flintoft area is being used for white-to-buff facing brick and for household pottery and crocks.

FIRECLAY

Canadian fireclays are used principally for the manufacture of medium- and high-duty firebrick and refractory specialties. High-duty refractories require raw materials having a PCE (pyrometric cone equivalent) of about 31 1/2 to 32 1/2 (approximately 1,699 to 1,724°C). Intermediate-duty refractories require raw materials having a PCE of about 29 (approximately 1,659°C) or higher. Clays having a PCE of less than 29 but greater than 15 (approximately 1,430°C) may be suitable for low-duty refractories or ladle brick as well as for other clay products. No known Canadian fireclays are sufficiently refractory for the manufacture of superduty refractories without the addition of some very refractory material such as alumina. However, in 1967 a sample from northern Ontario having a PCE of cone 33 was examined at the Mines Branch, Ottawa.

Various grades of good-quality fireclays occur in the Whitemud formation in Saskatchewan. At a large plant at Claybank, fireclays from nearby pits are used for the manufacture of medium- and high-duty refractories and refractory specialties. Good-quality fireclays occur on Sumas Mountain in British Columbia. At a large plant there the better grades are used in the manufacture of products similar to those produced at the Saskatchewan plant. Some fireclay from the Sumas deposit is exported to the United States, and a small quantity is used at plants in Vancouver.

Fireclay and kaolin occur in the James Bay watershed of northern Ontario along the Missinabi, Abitibi, Moose and Mattagami rivers. Adverse terrain and climate have made exploration difficult, but considerable exploration has been carried out in this area in recent years. Some seams of clay in the deposit at Shubenacadie, Nova Scotia, are sufficiently refractory for medium-duty refractories. Preliminary work has been done on their use for the production of ladle brick. Clay from Musquodoboit, Nova Scotia, has been used by a few foundries in the Atlantic Provinces.

Ontario and Quebec have no producing domestic sources of fireclay. These industrial provinces import most of their requirements from the United States.

STONEWARE CLAY

Stoneware clays are similar to low-grade plastic fireclays. They are used extensively in sewer pipe, flue liners, facing brick, pottery, stoneware crocks and jugs and chemical stoneware. As in fireclays the principal clay mineral is kaolinite or a similar clay mineral.

The principal source of stoneware clay in Canada is the Whitemud formation of southern Saskatchewan and southeastern Alberta .The Eastend, Saskatchewan, area was formerly the source of much of the clay used at Medicine Hat. Stoneware clay pits are now located in the Alberta Cypress Hills, southeast of Medicine Hat, and at Avonlea, Saskatchewan.

Stoneware or low-grade fireclays occur on Sumas Mountain, near Abbotsford, British Columbia. They are used in the manufacture of sewer pipe, flue lining, facing brick and tile. Similar types of materials occur at Shubenacadie and Musquodoboit in Nova Scotia. The Shubenacadie clays are used principally for the manufacture of buff facing brick. Other similar deposits occur at Swan River, Manitoba, where some buff brick has been manufactured, and in British Columbia at Chimney Creek Bridge, Williams Lake, Quesnel and close to the Alaska Highway. Quebec and Ontario import stoneware clay from the United States for the manufacture of facing brick and sewer pipe.

COMMON CLAY AND SHALE

Common clays and shales are the principal raw materials available in Canada for the manufacture of clay products. They are used mainly for the manufacture of common and facing brick, structural tile, partition tile, conduit, quarry tile and drain tile. Some common Canadian clays are mixed with stoneware clay for the manufacture of such products as facing brick, sewer pipe and flue lining.

Because of the presence of iron, common clays and shales usually fire salmon or red. Their fusion points are low – usually well below cone 15 (approximately 1,430°C), which is considered to be the lower limit of the softening point for fireclays. Ordinarily, they are a heterogeneous mixture including clay minerals and various other minerals such as quartz, feldspar, mica, goethite, siderite, pyrite, carbonaceous material, gypsum, calcite, dolomite, hornblende and many others. The clay minerals are chiefly illitic, chloritic or illitic-chloritic, although frequently a member of the montmorillonite or kaolin group, vermiculite or various mixed layer clay minerals are found in them.

Clays and shales suitable for the manufacture of clay products usually contain 15 to 35 per cent small-particle quartz. If the quartz exceeds this proportion and there are other non-plastic materials, the plasticity of the clay is reduced and quality of the ware is lowered. Many clays and shales contain calcite or dolomite or both. If present in sufficient quantities, these cause the clay to fire buff and adversely affect the fired strength and density. Common clays and shales are usually higher in alkalis, alkaline materials and iron-bearing minerals and much lower in alumina than the high-quality stoneware clays, fireclays and ball clays. Since shales are less plastic than clays, they must be finely ground when used for extruded ware so that plasticity may be developed if possible, or they must be combined with a plastic clay or some plasticizer.

Common clays and shales are found in all parts of Canada, but deposits having excellent drying and firing properties are generally scarce and new deposits are continually being sought. Most of the common surface clays are the result of severe glaciation which has influenced the nature of deposits that cover the bedrock. These Pleistocene deposits are of interest to the ceramic industry and include stoneless marine and nonmarine sediments, re-worked glacial till, interglacial clays, and flood plain clays. Some Tertiary and Cretaceous deposits that are useful to the ceramic industry occur close to the surface. The Pleistocene clays melt at a low temperature, while those of the Cretaceous and Tertiary vary widely in their refractoriness, depending on the locality and formation.

It has been found that, in general, the common shales (as opposed to the common surface clays) provide the best source of raw material for brickmaking. The principal shales useful to the ceramic industry are found in Cambrian, Ordovician and Carboniferous rocks in eastern Canada, and Jurassic, Cretaceous and Tertiary rocks in western Canada. In many instances these shales are more refractory than the Pleistocene clays; in some areas, particularly in the west, they are very refractory.

BENTONITE

Bentonite is the subject of another review in the present series.

PRICES

Prices are not available for all types of clays. China clay generally commands the highest prices because of the cost of its beneficiation and the special processes necessary to produce it for various industries. For example, the paper industry's specifications and requirements for china clay are different from those of the ceramic industry. The prices of ball clays and high-quality fireclays are about the same as those of most unprocessed china clays. Low-grade fireclays and stoneware clays generally sell for less than ball clays but are priced higher than common clays and shales. Ball clays and kaolins are sold in bags or in bulk; low-grade fireclays, stoneware clays and common clays and shales are usually sold in bulk.

According to *Oil, Paint and Drug Reporter* of December 25, 1967 clay prices in the United States were as follows:

Ball clay	
Domestic, air floated, bags, car lots, f.o.b. Tennessee, per short ton	\$18.00 to \$22.00
Domestic, crushed, moisture repellent, bulk, car lots, f.o.b. Tennessee, per short ton	\$ 8.00 to \$11.25
China clay	
Water, washed, calcined, bulk, car lots, f.o.b. Georgia, per short ton	\$54.00 to \$55.50
Dry-ground, air floated, soft, same basis, per short ton	\$12.50

TARIFFS

	British Preferential	Most Favoured Nation	General
CANADA			
Clays, including china clay, fireclay, and pipe clay not further manufactured than ground	free	free	free
Activated clay, when imported for use in refining of oils	10%	10%	25%
Varying tariffs are in effect for clay products glazed and unglazed and clay building materials			
UNITED STATES			
Clays, whether or not washed, ground, or otherwise beneficiated, per long ton			
China clay or kaolin	67¢		
Fuller's earth			
Not beneficiated	50¢		
Wholly or partly beneficiated	\$1		
Bentonite	81.25¢		
Common blue clay and other ball clays			
Not beneficiated	62¢		
Wholly or partly beneficiated	1.21		

TARIFFS (cont'd)

	British Preferential	Most Favoured Nation	General
Other clays			
Not beneficiated	50¢		
Wholly or partly beneficiated	$1		
Any of the foregoing clays artificially activated with acid or other material	0.1 per lb plus 12.5% ad val		
Varying tariffs exist on clay products.			

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Coal and Coke

Coal

T.E. TIBBETTS*

There was a significant increase in total exports of coal to Japan in 1967 while imports and consumption in Canada declined. A small increase in production of subbituminous coals was registered but production of bituminous and lignite coals was down.

The overall value of bituminous coal was significantly higher than that of 1966 with increases registered in all production regions, reflecting the continued rise in production costs of these coals. Government subvention assistance was continued and expanded to help offset rising production and transportation costs. Consumption of coal by thermal electric generating stations increased sharply in 1967 and at year end increasing demands for coal in the energy sector and metallurgical industry were predicted.

*Fuels Research Centre, Mines Branch.

COAL AREAS AND PRINCIPAL PRODUCERS

(with approximate production in thousands of short tons)

(area numbers refer to numbers on map)

Nova Scotia

1. Sydney and Inverness areas (high-volatile bituminous)	
Bras d'Or Coal Company, Limited (Four Star mine)	111
Dominion Coal Company, Limited	2,680
Dominion Steel and Coal Corporation, Limited, Old Sydney Collieries Division	520
Evans Coal Mines Limited	40
2. Pictou area (high-volatile bituminous)	
Dominion Steel and Coal Corporation, Limited, Acadia Coal Company Division	189
Drummond Coal Company Limited	53
3. Springhill and Joggins areas (high-volatile bituminous)	
River Hebert Coal Company Limited	61
Springhill Coal Mines Limited	85

New Brunswick

4. Minto Area (high-volatile bituminous)	
Avon Coal Company, Limited	223
D.W. & R.A. Mills Limited	246
Dufferin Mining Limited	19
Midland Mining Co. Ltd.	45
Miramichi Lumber Company (Limited)	210
C.H. Nichols Co. Ltd.	41
Norman I. Swift, Ltd.	5
V.C. McMann, Ltd.	48

Saskatchewan

5. Souris Valley area (lignite)	
Battle River Coal Company Limited	634
Manitoba and Saskatchewan Coal Company Limited	340
Utility Coals Ltd.	1,034

Alberta

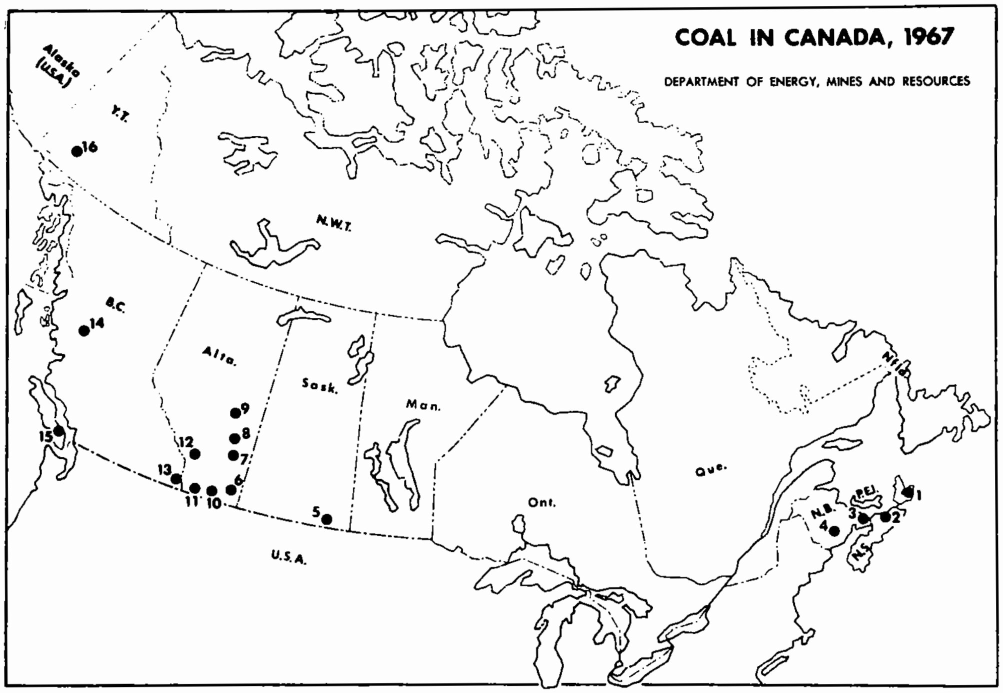
6. Brooks and Taber areas (subbituminous)	
Henry Miller (Taber Ajax)	10
The Kleenbirn Collieries, Limited	5
7. Drumheller, Sheerness and Carbon areas (subbituminous)	
Century Coals Limited	128
Fox Coulee Coals Ltd.	48
Battle River Coal Company Limited	260
New Ghost Pine Coal Company Ltd.	7
Subway Coal Limited	12
8. Castor, Ardley and Camrose Areas (subbituminous)	
Battle River Coal Company Limited	259
Burnstad Coal Ltd.	17
Forestburg Collieries Limited	593
Lynass, John	3
Sissons, R.C.	22
Stettler Coal Company Limited	7
9. Edmonton, Tofield, Westlock and Pembina Areas (subbituminous)	
Alberta Coal Ltd. (mines Nos. 419 and 1757)	1,178
Egg Lake Coal Company Limited	11
Jet Construction Ltd.	12
North Point Coal Company, Limited	17
Ostertag, Charles	9
Star-Key Mines Ltd.	41
Warburg Coal Co. Ltd.	10
Whitemud Creek Coal Co. Ltd.	11
10. Lethbridge area (high-volatile bituminous)	
Silkstone Resources Ltd.	3
11. Crowsnest Area (medium-volatile bituminous)	
Coleman Collieries Limited	621
12. Cascade Area (low-volatile bituminous and semianthracite)	
The Canmore Mines, Limited	289

British Columbia

13. East Kootenay (Crowsnest) Area (medium-volatile bituminous)	
Crows Nest Industries Limited	1,191
14. Northern Area (high-volatile bituminous)	
Bulkley Valley Collieries, Limited	16
15. Vancouver Island Area (high-volatile bituminous)	
Comox Mining Company Limited	

Yukon Territory

16. Carmacks (high-volatile bituminous)	
Yukon Coal Company Limited	2



PRODUCTION

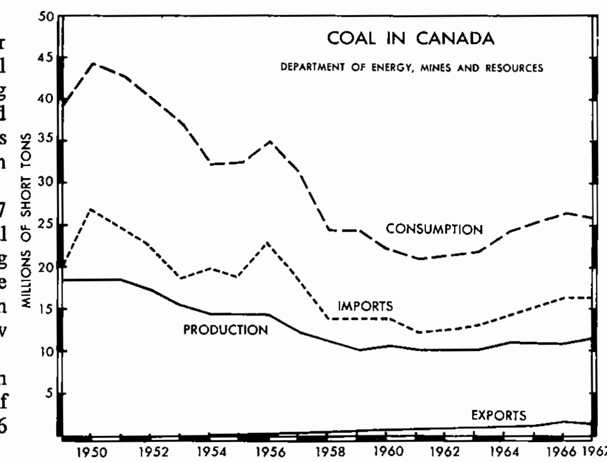
At 11.4 million tons there was little change in total coal production in 1967. This production was valued at $82.8 million. Production of bituminous coal remained about the same as for 1966. Production of subbituminous coal increased 2.9 per cent and production of lignite decreased 3.4 per cent.

Nova Scotia's coal production decreased 3.0 per cent and amounted to 32.8 per cent of the total coal production in Canada. High volatile bituminous coking coal was produced in the Sydney, Cumberland and Pictou areas and noncoking high-volatile bituminous coal was produced in the Inverness area, all from underground mines.

New Brunswick, where production decreased 6.7 per cent, produced 7.4 per cent of Canada's total coal production. This was high-volatile bituminous coking coal mainly from underground and strip mines in the Minto area but also from strip mines in the Chipman and Coal Creek areas. More than 85 per cent of New Brunswick's coal is from strip mines.

All of Saskatchewan's production was lignite from strip mines located in the Bienfait and Estevan areas of the Souris Valley and the production in 1967 was 17.6 per cent of the national output.

In Alberta where coals ranging from semianthracite to subbituminous were mined, production amounted to 31.6 per cent of total production for all of Canada. The largest output was from the subbituminous mines and twenty-nine such mines operating in 1967 produced almost 74 per cent of Alberta's coal. Six mines



in the Pembina, Castor, Drumheller, Sheerness and Taber areas produced more than 90 per cent of the subbituminous coal. Total production of coal in Alberta increased 3.9 per cent in 1967; there was an increase of 6.6 per cent in the production of bituminous coal and an increase of 2.9 per cent in the production of subbituminous coal. About 72 per cent of Alberta's production was from strip mines.

In British Columbia coal production in 1967 increased about 11.0 per cent and represented about 10.6 per cent of the nation's coal output. All of British Columbia's coal production is bituminous and the Crowsnest area (East Kootenay district on the mainland) accounted for all but a small quantity of the production. Underground mines produced 50.9 per cent of the total output in the province.

The Yukon Territory produced about 1,900 tons of coal from a single underground mine.

The weighted average output per man-day for all coal mines in Canada increased 4.078 tons to 22.089 tons. For strip mines, which accounted for 51.9 per cent of the coal production, the output per man-day increased 5.367 tons and the output from underground mines decreased by 0.239 ton per man-day.

Coal produced in Canada in 1967 had an average value of $7.26 a ton, or 32.12 cents per million BTU. Bituminous coal, which accounted for 89.0 per cent of the total value, averaged $10.95 a ton; this is an increase of about $0.25 a ton from 1966. Lignite increased only one cent a ton in value; subbituminous coals decreased 22 cents a ton. Nova Scotia coal is by far the most expensive at 51.56 cents per million BTU, with Saskatchewan lignite valued at 12.16 cents per million BTU, and the Alberta subbituminous coal at 11.57 cents per million BTU.

TRADE

In 1967 all coal imports came from the United States. Imports of bituminous coal decreased 1.5 per cent and the imports of anthracite decreased 11.5 per cent resulting in an overall decrease of 1.9 per cent. More than one-third of the bituminous coal imported was high grade coking coal used in the metallurgical industry in Ontario and Nova Scotia.

Shipments of coal from mines and destined for export increased almost 8 per cent in 1967 to a total of more than 1.2 million tons. This was mainly metallurgical grade coal destined for Japan.

Nova Scotia shipped about 58.4 per cent of its output to other parts of the country; 88.8 per cent of this went to Quebec and Ontario. A small amount of Nova Scotia coal was exported to the Island of St. Pierre. New Brunswick shipped about 8.6 per cent of its output to Quebec.

More than 30 per cent of Saskatchewan's coal production was shipped to Manitoba and Ontario.

Alberta shipped 21.8 per cent of its coal production to other provinces, Saskatchewan and British Columbia taking, respectively, 14.0 and 4.6 per cent. About 2.6 per cent went to Manitoba and 0.6 per cent to Ontario. About 89 per cent of the bituminous coking coals produced in the Crowsnest area of Alberta was exported to Japan to upgrade the Japanese coal blends for metallurgical use.

CONSUMPTION

Consumption of coal in Canada decreased 2.5 per cent in 1967 to 25.9 million tons. More than 62 per cent of the coal consumed was imported.

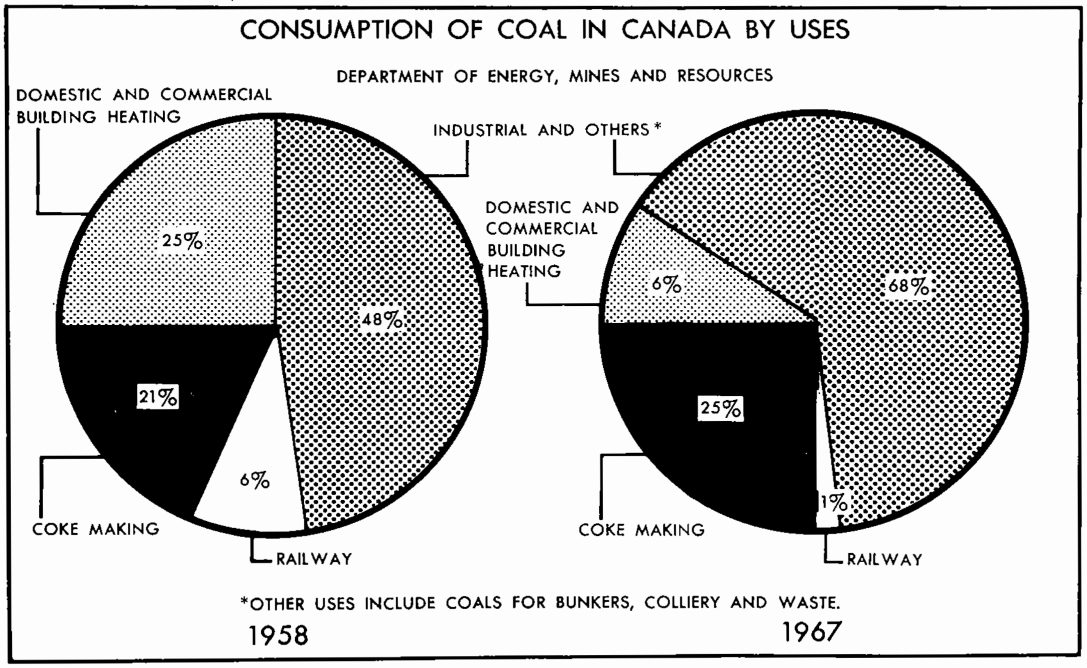
A large part of the output of Nova Scotia and New Brunswick coal mines is used locally for industrial steam-raising (including that in thermal electric plants) and household and commercial heating. The greatest single use of Nova Scotia coal is for the generation of electric energy. Its use in the manufacture of metallurgical coke for the steel industry at Sydney declined again in 1967. Increasing quantities of Alberta's subbituminous coals are being employed industrially, particularly for thermal electric power generation. A large part of the bituminous coals produced in the Crowsnest areas of Alberta and British Columbia are exported for metallurgical purposes. Lignite from Saskatchewan was used for fuel for thermal electric generating stations and for commercial and household heating and industrial purposes.

In 1967 coal used in the household and commercial building heating market decreased 22.2 per cent. Total industrial consumption of coal, including that used by thermal electric generating stations, increased 4.6 per cent. The proportion of Canadian coal used industrially was about 46.9 per cent, the remainder being mainly bituminous coal from the United States. The use of coal in thermal electric generating stations in 1967 is estimated at 9.1 million tons, an increase of about 15.6 per cent from 1966 and representing about 35.2 per cent of the total coal consumed in Canada.

There was a small decrease to just over 5.8 million tons in the use of coal to manufacture coke, although consumption of imported coal for coke making increased 1.3 per cent. The use of Canadian coal for this purpose decreased more than 25 per cent mainly as a result of substitution of Canadian coal for higher quality, imported coal at the Sydney steel works.

BRIQUETTES

There was a decrease of almost 28 per cent in the production of coal briquettes in 1967. Lignite briquette production was down about 32 per cent and production of bituminous coal briquettes was down more than 22 per cent. The apparent consumption of briquettes was about 39.1 per cent less than in 1966.



SUBVENTION ASSISTANCE

Payments by the Federal Government through the Dominion Coal Board to assist the movement of coal to markets increased by $2.75 million in 1967. Subvention assistance amounting to about $3.5 million was applied to the export of more than 1.2 million tons of coal from the Crowsnest area of Alberta and British Columbia.

Subventions earned during the calendar year of 1967 under the Atlantic Provinces Power Development Act, 1958 totalled almost $2.6 million.

TABLE 1

Coal – Production, Trade and Consumption, 1966-67
(short tons)

	1966		1967p	
	Short Tons	$	Short Tons	$
Production				
All Classes				
Nova Scotia	3,854,534	51,518,674	3,738,487	51,681,004
New Brunswick	898,315	7,892,427	837,963	7,489,617
Saskatchewan	2,078,165	3,717,586	2,008,147	3,620,962
Alberta	3,467,254	11,947,258	3,601,559	12,418,414
British Columbia and Yukon	1,093,301	6,483,849	1,209,598	7,549,919
Total	11,391,569	81,559,794	11,395,754	82,759,916
Exports				
Bituminous				
Bolivia	–	–	4	..
West Germany	–	–	4	..
Bermuda	15	–	–	–
Britain	58	6,000	–	–
St. Pierre	2,097	29,000	1,929	31,000
United States	167,148	1,754,000	169,361	1,727,000
Japan	1,059,502	11,413,000	1,167,055	13,333,000
Total	1,228,820	13,202,000	1,338,353	15,091,000
Briquettes				
United States	24,659	373,000	26,914	419,000
Imports (for consumption)				
Anthracite				
United States	594,193	6,747,000	525,645	6,094,000
Britain	–	–	–	–
Total	594,193	6,747,000	525,645	6,094,000
Bituminous				
United States	15,842,562	134,063,000	15,588,545	139,064,000
Briquettes				
United States	6,583	228,000	8,489	386,000
Consumption				
Domestic	10,117,756		9,764,754	
Imported	16,435,111		16,113,329	
Total	26,552,867		25,878,083	

pPreliminary; – Nil; .. Not available.

TABLE 2

Coal – Production, Imports, Exports and Consumption, 1957-67
(short tons)

	Production	Imports[1]	Exports	Domestic[2]	Consumption Imported[3]	Total
1957	13,189,155	19,476,249	396,311	12,478,626	19,041,030	31,519,656
1958	11,687,110	14,491,315	338,544	11,054,757	14,154,121	25,208,878
1959	10,626,722	14,236,118	473,768	10,589,263	13,958,996	24,548,259
1960	11,011,138	13,564,836	852,921	9,973,308	13,276,599	23,249,907
1961	10,397,704	12,306,498	939,336	9,572,805	12,057,086	21,629,891
1962	10,284,769	12,614,189	893,919	9,510,293	12,377,965	21,888,258
1963	10,575,694	13,370,406	1,054,367	9,504,903	13,105,686	22,610,589
1964	11,319,323	14,989,114	1,291,664	10,080,243	14,987,656	25,067,899
1965	11,588,616	16,595,393	1,225,994	10,181,171	16,593,547	26,774,718
1966	11,391,569	16,436,755	1,228,820	10,117,756	16,435,111	26,552,867
1967[p]	11,395,754	16,114,190	1,338,353	9,764,754	16,113,329	25,878,083

[1]Imported coal referred to by DBS as 'Entered for Consumption' represents amounts cleared from customs ports, duty paid. Before 1962, 'Landed Imports' were shown; these were the amounts which actually entered the country, recorded before customs clearance. [2]Sum of sales at Canadian coal mines, colliery consumption, coal supplied to employees and coal used in making coke and briquettes, less coal exported. [3]Deductions have been made to account for foreign coal re-exported from Canada and bituminous coal removed from warehouse for ships' stores. Imports of briquettes not included.
[p] Preliminary.

TABLE 3

Coal Production, by Types, Provinces and Territories, 1966-67

	1966		1967[p]	
	Short Tons	$	Short Tons	$
Bituminous*				
Nova Scotia	3,854,534	51,518,674	3,738,487	51,681,004
New Brunswick	898,315	7,892,427	837,963	7,489,617
Alberta	879,569	6,047,369	937,836	6,938,387
British Columbia and Yukon Territory	1,093,301	6,483,849	1,209,598	7,549,919
Total	6,725,719	71,942,319	6,723,884	73,658,927
Subbituminous*				
Alberta	2,587,685	5,899,889	2,663,723	5,480,027
Lignite*				
Saskatchewan	2,078,165	3,717,586	2,008,147	3,620,962
All types				
Canada total	11,391,569	81,559,794	11,395,754	82,759,916

Source: Dominion Bureau of Statistics.
* Coal classification of the American Society for Testing and Materials as in ASTM Standards on Coal and Coke, 'Classification of Coals by Rank' (ASTM Designation: D-388-64T)
[p] Preliminary.

TABLE 4

Coal Production, by Type of Mining and Average Output per Man-day, 1967
(short tons)

	Production		Average Output per Man-day^p	
	Underground	Strip	Underground	Strip
Nova Scotia	3,738,487	–	2.744	–
New Brunswick	121,423	716,540	1.845	5.475
Saskatchewan	–	2,008,147	–	50.605
Alberta	1,007,904	2,593,655	5.141	37.674
British Columbia	614,590	593,096	5.858	49.228
Yukon	1,912	–	2.888	–
Canada 1967^p	5,484,316	5,911,438	3.514*	39.323*
1966	6,013,977	5,377,592	3.753*	33.956*
Total, all mines 1967^p	11,395,754		22.089*	
1966	11,391,569		18.011*	

Source: Dominion Bureau of Statistics.
* Weighted average.
^{p} Preliminary; – Nil.

TABLE 5

Comparison of Average Values of Canadian Coals, 1967^p

	Average Btu/lb*	Average Value per Short ton**	Average Value per Million Btu
		$	¢
Nova Scotia, bituminous	13,400	13.82	51.56
New Brunswick, bituminous	12,000	8.94	37.25
Saskatchewan, lignite	7,400	1.80	12.16
Alberta			
Bituminous	13,700	7.40	27.00
Subbituminous	8,900	2.06	11.57
British Columbia, bituminous	13,700	6.24	22.77
Yukon Territory, bituminous	11,900	8.26	34.70
Total			
Bituminous	13,300	10.95	41.16
Subbituminous	8,900	2.06	11.57
Lignite	7,400	1.80	12.16
Average, Canada	11,300	7.26	32.12

*Fuels Research Centre, Department of Energy, Mines and Resources, commercial coal survey reports of analyses.
**Dominion Bureau of Statistics.
^{p}Preliminary.

TABLE 6

Interprovincial Shipments of Coal, 1967
(short tons)

Destination	Originating Province: Nova Scotia	New Brunswick	Sask.	Alberta	British Columbia
Newfoundland	39,782	–	–	–	–
Prince Edward Island	22,432	–	–	–	–
Nova Scotia	–	–	–	–	–
New Brunswick	182,229	–	–	–	–
Quebec	887,466	72,137	–	–	–
Ontario	1,051,510	–	242,596	21,217	46,660
Manitoba	–	–	376,463	93,759	130,546
Saskatchewan	–	–	–	504,606	179
Alberta	–	–	–	–	116
British Columbia and Yukon	–	–	–	165,413	–
Total	2,183,419	72,137	619,059	784,995	177,501

Source: Dominion Bureau of Statistics.
– Nil.

TABLE 7

Exports of Coal, 1967
(short tons)

Destination	Shipments from Mines by Provinces*: Nova Scotia	New Brunswick	Sask.	Alberta	British Columbia	All
Norway	–	–	–	–	–	–
St. Pierre	317	–	–	–	–	317
United States	–	–	10,735	9,816	10,266	30,817
Japan	–	–	–	773,505	407,201	1,180,706
Total	317	–	10,735	783,321	417,467	1,211,840

Source: Dominion Bureau of Statistics.
*Destined for Export.
– Nil.

TABLE 8

Imports of Coal for Consumption, 1966-67
(short tons)

Country of Origin		Anthracite	Bituminous*	Total
United States	1967p	525,645	15,597,034	16,122,679
	1966	594,193	15,842,562	16,436,755
Britain	1967p	–	–	–
	1966	–	–	
Total	1967p	525,645	15,597,034	16,122,679
	1966	594,193	15,842,562	16,436,755
Value	1967p	6,094,000	139,450,000	145,544,000
	1966	6,747,000	134,063,000	140,810,000

Source: Dominion Bureau of Statistics, Trade of Canada.
*Includes coal dust and coal not otherwise provided for and coal exwarehoused for ships' stores.
pPreliminary; – Nil.

TABLE 9

Consumption of Canadian and Imported Coal, 1957-67

	Canadian		Imported		Total
	short tons*	% of Consumption	short tons**	% of Consumption	short tons
1957	12,478,626	39.6	19,041,030	60.4	31,519,656
1958	11,054,757	43.9	14,154,121	56.1	25,208,878
1959	10,589,263	43.1	13,958,996	56.9	24,548,259
1960	9,973,308	42.9	13,276,599	57.1	23,249,907
1961	9,572,805	44.3	12,057,086	55.7	21,629,891
1962	9,510,293	43.4	12,377,965	56.6	21,888,258
1963	9,504,903	42.0	13,105,686	58.0	22,610,589
1964	10,080,243	40.2	14,987,656	59.8	25,067,899
1965	10,181,171	38.0	16,593,547	62.0	26,774,718
1966	10,117,756	38.1	16,435,111	61.9	26,552,867
1967p	9,764,754	37.7	16,113,329	62.3	25,878,083

Source: Dominion Bureau of Statistics.
*Sum of Canadian coal-mines sales, colliery consumption, coal supplied to employees, and coal used in making coke and briquettes, less tonnage of coal exported. **Deductions have been made to account for foreign coal re-exported from Canada and bituminous coal removed from warehouse for ships' stores. Imports of briquettes not included.
pPreliminary.

TABLE 10

Consumption of Coal – Major Uses, 1966-67
(short tons)

	1966	1967p
Household and Commercial Building Heating		
Canadian		
Bituminous	381,917	331,379
Subbituminous	307,339	236,535
Lignite	121,998	84,658
Briquettes	18,464	15,574
Total	829,718	668,146
Imported		
Anthracite	147,998	123,177
Bituminous	750,867	555,872
Briquettes	5,149	2,066
Total	904,014	681,115
Total, all types	1,733,732	1,349,261
Industrial*		
Canadian		
Bituminous	3,736,017	3,830,846
Subbituminous	1,719,666	1,950,328
Lignite	1,608,171	1,644,569
Total	7,063,854	7,425,743
Imported		
Anthracite	304,916	305,079
Bituminous	7,779,533	8,114,749
Total	8,084,449	8,419,828
Total, all types	15,148,303	15,845,571
Coke Making		
Canadian		
Bituminous	413,976	309,782
Imported		
Bituminous	5,476,601	5,546,274
Total	5,890,577	5,856,056

Source: Dominion Bureau of Statistics.
* Does not include firms using less than 500 tons of coal per annum nor coal used to make coke.
p Preliminary.

TABLE 11

Coal Used by Thermal Electric Generating Stations, by Provinces, 1966-67
(thousand short tons)

	1966	1967p
Nova Scotia	884	838
New Brunswick	324	305
Ontario	3,857	4,880
Manitoba	89	41
Saskatchewan	1,232	1,479
Alberta	1,501	1,573
Canada, Total	7,887	9,116

Source: Dominion Coal Board.
p Preliminary.

TABLE 12

Briquettes – Production and Consumption, 1966-67
(short tons)

	1966	1967p
Production		
Saskatchewan	29,636	20,000e
Alberta* and British Columbia	27,904	21,503
Total, Canada	57,540	41,503e
Consumption (briquettes available for consumption)**	37,926	23,078

Source: Provincial government reports, and Fuels Research Centre, Mines Branch, Survey of Carbonization Plants in Canada.
e Estimated from published report on plant capacity and domestic heating product distribution.
* Alberta production excludes 11,387 tons of char in 1966, and 7,430 tons in 1967. (Carbonized briquettes previously known as 'char' are now defined as 'coke'.)
** Production (excluding char) plus landed imports less exports.
p Preliminary.

TABLE 13

Coal Moved Under Subvention, 1966-67

Origin of Coal	1966		1967	
	Short tons	Value	Short tons	Value
Nova Socita	3,647,386	$27,610,279	3,415,230	$29,583,325
New Brunswick	767,899	1,925,500	687,125	2,421,328
Saskatchewan	200,273	135,562	269,695	186,132
Alberta and British Columbia	1,167,295	3,296,819	1,256,068	3,531,747
Total	5,782,853	$32,968,260	5,628,118	$35,722,532

Source: Dominion Coal Board.

Coke

J.C. BOTHAM*

Of the 25.9 million tons of coal consumed in Canada in 1967 about 5.9 million tons were carbonized to to produce coke. The coke was used mainly in the making of primary iron and, to a lesser extent, in foundry practice, base-metal recovery, chemical processes and domestic heating.

Canadian-produced byproduct coke is manufactured mainly at five plants in batteries of standard slot-type ovens, the plants in operation varying in annual coal capacity from 600,000 to two million tons. With the exception of one coke oven plant built primarily for the production of domestic coke, they are owned and operated by the steel companies. Apart from the conventional slot-type byproduct coke ovens, Canada has a Curran-Knowles carbonization plant at Kaiser Coal Ltd., formerly Crows Nest Industries Limited's collieries, in Michel, British Columbia. About 95% of the coal used in the production of coke is processed at these six plants.

Three of the four integrated steel plants expanded their coke plant capacity during the year. Two of these plants have followed the current trend in byproduct slot-type coke oven construction, namely towards higher ovens of greater capacity. The new battery of ovens for one plant was the first so-called "high oven" battery to be contracted for on the North American continent.

There is also interest in North America toward a return of the use of non-recovery ovens stemming primarily from the loss of markets for coke oven byproducts to the petrochemical industry. Some incentives for their use are low capital and labour costs and their ability to be shut down if not needed. Three Mitchell ovens have been built in the Crowsnest area of British Columbia on an experimental basis to explore the market for foundry coke in western Canada and western United States. The operation of a 26-foot diameter rotary carbonizer by Lethbridge Collieries Ltd., Lethbridge Alberta has been discontinued.

In the Cascade area of Alberta a carbonizing retort began operation on a commercial scale early in 1963. A coke product is made by carbonizing briquettes prepared from low-volatile and semianthracite coals; a form-coke could be produced if desired. The product is used primarily for the electric smelting process used in the manufacture of elemental phosphorus.

Other nonconventional carbonization processes include the Lurgi carbonization retorts which carbonize and briquette a Saskatchewan lignite coal to produce a high fixed-carbon product for domestic fuel and for use in barbecues. A distinctive stoker-type coking plant is operated by the Shawinigan Chemicals Limited, Shawinigan, Quebec.

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

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*Fuels Research Centre, Mines Branch.

TABLE 1

Standard Slot-Type Byproduct Coke Oven Plants in Canada

Coke Plant	Battery	Type of Oven	No. of Ovens	Year Built	Byproduct Recovered	Plant Capacity	Coke Distribution
The Algoma Steel Corporation, Limited Sault Ste. Marie Ontario	No. 5	Koppers-Becker Underjet	86	1943	Napthalene, light oil, gas, tar	4 batteries of 260 ovens with an annual rated capacity of 2,700,000 tons of coal	Blast furnace use – 3 1/2 × 3/4 inch; base metal industry 3/4 × 3/8 inch and 3/8 × 3/6 inch; sintering 3/16 × 0 inch
	No. 6	Koppers-Becker Underjet	57	1953			
	No. 7	Wilputte Underjet	57	1958			
	No. 8	Wilputte Underjet	60	1967			
The Steel Company of Canada, Limited, Hamilton, Ontario	No. 3	Wilputte Underjet	61	1947	Tar, sulphate of ammonia, sodium phenolate, gas	4 batteries of 264 ovens with an annual rated capacity of 2,670,000 tons of coal	Blast furnace use plus 5/8 inch; sintering – minus 1/4 inch; other uses 5/8 × 1/4
	No. 4	Wilputte Underjet	83	1952			
	No. 5	Wilputte Underjet	47	1953			
	No. 6	Otto Underjet	73	1967			
Dominion Foundries and Steel, Limited, Hamilton, Ontario.	No. 1	Koppers-Becker Gun Type Comb.	25	1956	Tar, light, oil, gas, ammonium sulphate, sulphur	4 batteries of 158 ovens with an annual capacity of 1,400,000 tons of coal	Blast furnace use – plus 3/4 inch; sintering 1/8 × 0 inch; other uses – 3/4 × 1/8 inch
	No. 2	Koppers-Becker Gun Type Comb.	35	1951			
	No. 3	Koppers-Becker Gun Type Comb.	45	1958			

TABLE 1 (cont'd)

Standard Slot-Type Byproduct Coke Oven Plants in Canada

Coke Plant	Battery	Type of Oven	No. of Ovens	Year Built	Byproduct Recovered	Plant Capacity	Coke Distribution
	No. 4	Koppers-Becker Gun Type Comb.	53	1967			
Dominion Steel and Coal Corporation, Limited, Sydney Works, Sydney, N.S.	No. 5	Koppers-Becker Underjet	53	1949	Tar, crude oil, gas	2 batteries of 114 ovens with an annual rated capacity of 900,000 tons of coal	Blast furnace use – 3 1/2 × 1 1/2 inch, 2 1/2 × 1 1/2 inch domestic heating – 2 1/2 × 1 1/2 inch 1 1/2 × 3/4 inch 3/4 × 1/4 inch sintering – 1/2 × 0 inch
	No. 6	Koppers-Becker Underjet	61	1953			
Quebec Natural Gas Corporation, Ville LaSalle, Que.	No. 1	Koppers-Becker	59	1928	Tar, sulphate of ammonia light oil, gas	2 batteries of 74 ovens with an annual rated capacity of 626,300 tons of coal	Foundry coke, domestic heating, chemical industry, blast furnace use, base metal industry, rockwool producers
	No. 2	Koppers-Becker	15	1947			

TABLE 2

Other Carbonization Plants in Canada

	Type of Unit	No. of Units	Year Built	Coal Capacity of each unit (tons/day)	Byproducts Recovered	Plant Capacity (annual rated capacity in tons of coal)	Product Distribution (sizes in inches)
Husky Oil (Alberta) Ltd. *Bienfait, Sask.	Lurgi carbonizing retort	2	1925	150–175	Creosote, lignite tar, lignite pitch	2 units: 110,000	Domestic heating – 30,000 tons char; other – 1,900 tons
Shawinigan Chemicals Limited, Shawinigan, Que.	Travelling grate coking stoker	8	1939	70	Low-grade producer gas	8 units: 200,000	Manufacture of calcium carbide in electric furnaces
The Canmore Mines, Limited, Canmore, Alberta	Vertical retort	1	1963	100	Crude tar, gas	1 unit: 30,000 (agglomerated)	Chemical Industries
Kaiser Coal Ltd.** Fernie, B.C.	Mitchell	3	1963	7	No byproducts	The 3 ovens are being used mainly to evaluate the foundry coke market	Foundry Market
	Curran-Knowles	10	1939	5.5	Crude tar, gas	4 batteries of 52 Curran-Knowles ovens: 243,000	Base metal industry – 7 × 3; beet sugar industry – 7 × 3; iron reduction in electric furnaces – 7 × 3 and 3 × 1; sintering – minus 1/4
		10	1943	5.5			
		16	1949	7.5			
		16	1952	7.5			

*Formerly Dominion Briquettes & Chemicals Ltd.
**Formerly Crows Nest Industries Limited.

TABLE 3

Coke – Production and Trade

	1966		1967p	
	Short Tons	$	Short Tons	$
Production*				
Coal Coke				
Ontario	3,537,891		3,653,694	
Other provinces	888,160		776,605	
Total	4,426,051		4,430,299	
Pitch Coke	–		–	
Petroleum Coke**	230,119		262,312e	
Total	4,656,170		4,692,611	
Imports (all types)				
United States	1,084,119	21,000,000	935,091	18,656,000
West Germany	–	–	17,794	293,000
Total	1,084,119	21,000,000	952,885	18,949,000
Exports (all types)				
United States	87,615	1,421,000	83,933	1,266,000
Britain	–	–	–	–
Other countries	–	–	–	–
Total	87,615	1,421,000	83,933	1,266,000

Source: Dominion Bureau of Statistics.
* Value of coke production and selling price of coke are not available. Practically all coke output is that produced in the primary iron and steel industry as material used in process.
** Includes quantities of catalytic carbon.
p Preliminary; eEstimated; – Nil.

TABLE 4

Coke – Production and Trade, 1957-67
(short tons)

	Production				Imports			Exports
	Coal	Pitch	Petroleum	Total	Coal	Petroleum	Total	Total
1957	4,117,623	5,395	273,296	4,396,314	650,540	426,849	1,077,389	158,298
1958	3,474,985	8,155	462,797	3,945,937	305,330	300,366	605,696	145,202
1959	4,094,882	3,463	529,580	4,627,925	382,683	314,732	697,415	176,020
1960	3,872,802	3,414	534,979	4,411,195	297,707	403,391	701,098	161,190
1961	3,899,545	4,466	964,494	4,868,505	288,815	365,744	654,559	226,703
1962	4,021,774	1,899	201,985	4,225,658	247,304	338,068	585,372	157,882
1963	4,280,797	–	199,636	4,480,433	234,610	369,037	603,647	154,332
1964	4,342,982	–	206,815	4,549,797	315,763	440,607	756,370	120,740
1965	4,368,791	–	242,813	4,611,604	569,905	413,047	982,952	88,632
1966	4,426,051	–	230,119	4,656,170	584,965	499,154	1,084,119	87,615
1967p	4,430,299	–	262,312	4,692,611	387,049	565,836	952,885	83,933

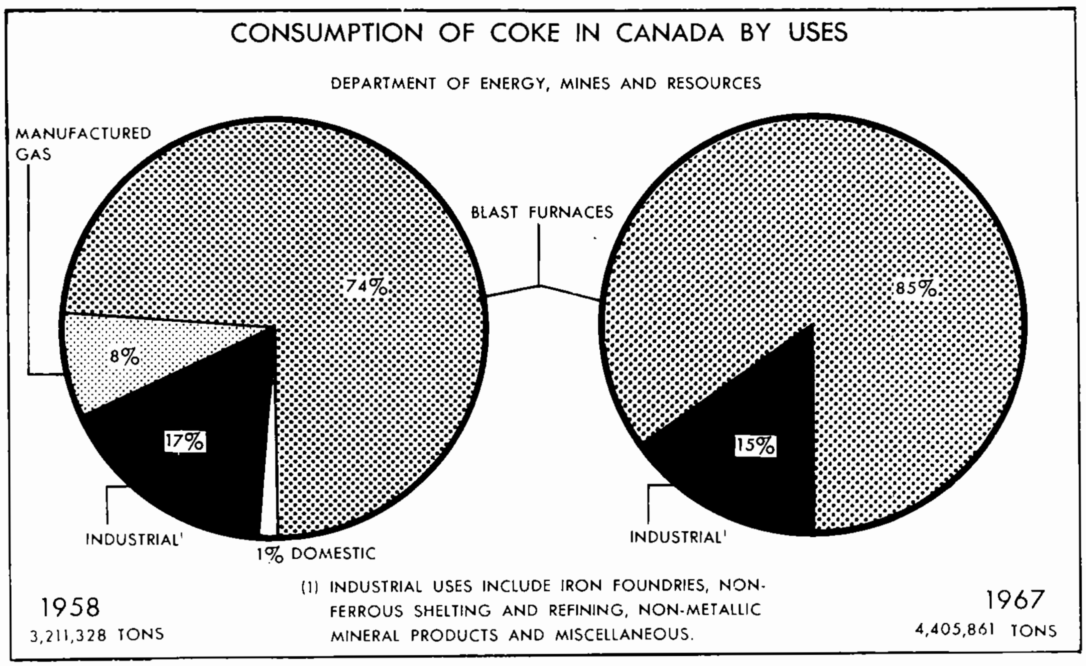
Source: Dominion Bureau of Statistics.
p Preliminary; – Nil.

In Canada, petroleum coke is used mainly in the production of electrodes for the aluminum industry; pitch coke is obtained only from surplus coal-tar pitch that is not required for such other industrial uses as the production of electrodes or briquettes.

For many years gas-retort plants operated in Canada producing manufactured gas and domestic coke for space-heating, and other domestic and commercial uses. These plants are now practically non-existent and the markets are largely supplied by natural gas, liquid petroleum gases and oil.

Recently the uses of metallurgical coke have changed because of alterations in the methods of producing pig iron and steel. An increase in the use of agglomerated ores in the iron blast furnace has resulted in an increase in the demand for small sizes of coke and coke breeze. This has made possible, to a greater extent than was previously considered practical, the preparation of sized coke for iron blast furnaces.

Continuing developments in the use of supplementary liquid and gaseous fuels in iron blast furnaces by introduction through the tuyeres have led to an increase in the throughput of standard furnaces with a corresponding reduction in the quantity of coke used for each ton of pig iron produced. However, blast furnace coke has maintained its level of consumption through an increase in pig-iron production. These changes have contributed materially to a more efficient production of pig iron in the standard blast furnaces.



Cobalt

G.P. WIGLE*

Canadian cobalt production in 1967 was 3.7 million pounds valued at $7.4 million which compares with 3.5 million pounds valued at $7.1 million in 1966.

Non-communist world production of cobalt declined in 1967 to an estimated 17,800 tons which compares with the record high of 20,200 tons produced in 1966.

The United States General Services Administration supplied about 50 per cent of US consumption, estimated at 6,250 tons, through the sale of 3,000 tons of cobalt from stockpile surplus in 1967.

CANADIAN PRODUCTION

ONTARIO

The International Nickel Company of Canada, Limited (Inco) produces cobalt oxide and electrolytic cobalt at its refining operations at Port Colborne. Cobalt oxide and cobalt salts are produced at Inco's refinery at Clydach, Wales, from cobalt oxide shipped from Canada. Shipments of 2.2 million pounds of cobalt from all Inco operations, including the production at Clydach, was reported for 1967.

Falconbridge Nickel Mines, Limited produces cobalt at its refinery at Kristiansand, Norway, from nickel-copper matte shipped from Canada.

Cobalt Refinery Division of Kam-Kotia Mines Limited produces cobalt oxide and speiss as byproducts of smelting and refining complex silver-cobalt concentrates from mines in the Cobalt and Gowganda areas. Black cobalt oxide is sold to manufacturers of ground-coat frit in Canada, United States, Mexico and Europe. The intermediate product, speiss, is sold in Europe.

MANITOBA AND ALBERTA

International Nickel produces cobalt oxide at its Thompson, Manitoba, nickel refinery.

Sherritt Gordon Mines, Limited,produced 764,073 pounds of cobalt in 1967 compared with 790,597 pounds in 1966. Cobalt is recovered as a byproduct of its nickel-refining operations at Fort Saskatchewan, Alberta. The refinery treats nickel-copper concentrates from the company's Lynn Lake mine in Manitoba, nickel and cobalt-bearing materials on a toll basis, and alloy grindings containing cobalt.

*Mineral Resources Branch.

TABLE 1

Canada, Cobalt Production, Trade and Consumption, 1966-67

	1966		1967P	
	Pounds	$	Pounds	$
Production,[1] all forms	3,511,169	7,107,963	3,724,355	7,398,675
Exports				
Cobalt metal				
Belgium and Luxembourg	–	–	695,360	761,000
United States	599,575	1,095,000	673,961	1,359,000
Britain	11,418	23,000	27,410	61,000
France	–	–	22,009	51,000
Republic of South Africa	8,435	75,000	17,400	89,000
West Germany	429	1,000	12,628	31,000
Austria	–	–	11,200	26,000
Mexico	–	–	10,800	23,000
Argentina	–	–	10,667	23,000
Spain	–	–	6,600	16,000
India	–	–	5,673	11,000
Other countries	8,133	8,000	4,851	11,000
Total	627,990	1,202,000	1,498,559	2,462,000
Cobalt oxides and salts[2]				
Britain	1,265,400	2,153,000	1,918,400	3,250,000
United States	42,900	56,000	16,100	30,000
Total	1,308,300	2,209,000	1,934,500	3,280,000
Consumption[3]				
Cobalt metal and cobalt contained in oxides and salts	392,177	. .	293,086	. .

Source: Dominion Bureau of Statistics.

[1] Production (cobalt content) from domestic ores of cobalt metal and cobalt in alloys, oxides and salts. 1967 production includes the estimated cobalt content of Inco and Falconbridge shipments to overseas refineries but 1966 figures exclude Inco shipments to Britain.
[2] Gross weight. [3] As reported by consumers.
P Preliminary; – nil; . . not available.

TABLE 2

Canadian Cobalt Production, Trade and Consumption, 1958-67
(pounds)

		Exports			Imports		
	Production[1] (all forms)	Cobalt Metal	Cobalt Alloys[3]	Cobalt Oxide and Salts[3]	Cobalt Ores	Cobalt Oxides[3]	Consumption[2]
1958	2,710,429	1,024,667	9,712	522,144	–	16,230	303,433
1959	3,150,027	680,323	3,280	1,100,734	–	24,716	250,046
1960	3,568,811	844,293	1,938	1,175,206	–	20,227	252,050
1961	3,182,897	603,931	. .	1,521,000	–	28,364	390,091
1962	3,481,922	542,565	. .	1,629,900	–	40,936	383,442
1963	3,024,965	739,227	. .	1,098,300	2,500	28,291	364,594
1964	3,184,983	593,607	. .	1,654,900	. .	. .	365,851
1965	3,648,332	292,191	. .	1,414,200	. .	. .	366,036
1966	3,511,169	627,990	. .	1,308,300	. .	. .	392,177
1967P	3,724,675	1,498,559	. .	1,934,500	. .	. .	293,086

Source: Dominion Bureau of Statistics.

[1] Production from domestic ores of cobalt metal and cobalt contained in alloys, oxides and salts. 1967 production includes the estimated cobalt content of Inco and Falconbridge shipments to overseas refineries but prior years exclude Inco shipments to Britain.
[2] Total consumption, cobalt content, metal, oxides and salts. [3] Gross weight.
PPreliminary; – nil; . . not available.

TABLE 3

Non-Communist World Production of Cobalt
(short tons)

	1965	1966	1967
Congo (Kinshasa)	9,246	12,453	10,695
Morocco	2,092	2,238	2,220
Canada	1,824	1,756	1,862[p]
Zambia	1,595	1,618	1,595
Germany	1,385	1,152	903
Other countries[e]	908	983	525
Total	17,050	20,200	17,800

Source: Dominion Bureau of Statistics; Cobalt Information Center, Brussels, Belgium.
[p] Preliminary; [e] Estimate.

WORLD PRODUCTION

Non-communist world production of cobalt in 1967 was 17,800 tons compared with 20,200 tons in 1966.

The Democratic Republic of the Congo (Kinshasa) is the world's largest producer of cobalt. Its production in 1967 was 10,695 tons, recovered as a by-product of copper refining operations. Morocco, Canada, Zambia and Germany each produce about 1,000 to 2,200 tons a year.

In the United States, cobalt is recovered, in small quantities, as a byproduct of a magnetite ore that contains a cobalt-bearing pyrite, and from some zinc plant residues. United States refiners and processors produce a range of cobalt products from duty-free imported ores, concentrates, cobalt metal, and cobalt oxide.

CONSUMPTION AND USES

Canadian consumption of cobalt in 1967 was 293,086 pounds, 78 per cent of it as cobalt metal, 17 per cent in cobalt oxide, and 5 per cent in cobalt salts.

United States imports and consumption of cobalt declined sharply in 1967. The cobalt content of US imports of cobalt was estimated at 4,000 tons compared with 9,412 tons in 1966. Consumption in the US was 6,250 tons in 1967 compared with 7,102 tons in 1966. Domestic supply was supplemented by the sale of 6 million pounds of cobalt by the US General Services Administration from stockpile supplies.

TABLE 4

United States Consumption of Cobalt, by Use, 1966-67

	1966		1967	
	Short Tons	Per Cent	Short Tons	Per Cent
Metallic:				
High speed steel	411	2.9	375	3.1
Other tool and alloy steel	1,022	7.2	772	6.5
Permanent-magnet alloys	2,698	19.0	2,276	19.0
Cutting and wear resisting materials	360	2.5	305	2.6
High-temperature high-strength materials	3,641	25.6	2,586	21.6
Alloy hard-facing rods and materials	991	7.0	791	6.6
Cemented carbides	543	3.8	459	3.9
Nonferrous alloys and other metallic uses	1,698	12.0	1,917	16.0
Total	11,364	80.0	9,481	79.3
Nonmetallic, exclusive of salts and driers:				
Ground-coat frit	456	3.2	253	2.1
Pigments	185	1.3	161	1.4
Other materials	579	4.1	471	3.9
Total	1,220	8.6	885	7.4
Salts and driers: lacquers, varnishes, paints, inks, pigments, enamels, feeds, electroplating etc.	1,621	11.4	1,592	13.3
Grand total	14,205	100.0	11,958	100.0

Sources: US Bureau of Mines Minerals Yearbook, 1966, and US Mineral Industry Surveys, "Cobalt in December, 1967"

The more important uses of cobalt are in high-temperature high-strength alloys, magnet alloys, high-speed and tool steels, hard-facing rod, cemented carbides, and other ferrous and nonferrous alloys. The metallic uses account for about 75 per cent of cobalt consumption. Non-metallic uses include organic and inorganic cobalt salts used as driers in paints, varnishes and enamels, ground-coat frit, pigments, dyes, catalysts and in animal feeds. The radioactive isotope, cobalt 60, is used for therapeutic purposes and in the examination of metal castings and forgings for flaws.

TABLE 5

Cobalt Consumption in Canada, 1966-67
(pounds of contained cobalt)

	1966	1967
Cobalt metal	284,629	229,091
Cobalt oxide	93,696	49,275
Cobalt salt	13,852	14,720
Total	392,177	293,086

Source: Dominion Bureau of Statistics, Ottawa.

PRICES

Prices in the United States according to *Metals Week*, December 25, 1967 were:

Cobalt Metal, per lb f.o.b. New York	
Shot – 99%+	
less than 100-lb lots	$1.92
100-lb lots	1.87
500-lb lots	1.85
Powder – 99%+	
300 mesh, 100-lb lots	2.39
extra fine, 125 kilo drums	2.89
Briquettes, 10-ton lots	2.03

TARIFFS

	British Preferential (%)	Most Favoured Nation (%)	General (%)
CANADA			
Ore	free	free	free
Cobalt metal: lumps, powder, ingots, blocks	free	10	25
Cobalt oxide	free	10	10
UNITED STATES			
Cobalt ore	free		
Metal	free		
Cobalt oxide	1.5¢ per lb		

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Columbium (Niobium) and Tantalum

G.P. WIGLE*

St. Lawrence Columbium and Metals Corporation continued as Canada's only producer of columbium. Production in 1967 was 2.2 million pounds of columbium pentoxide (Cb_2O_5) in pyrochlore concentrates. St. Lawrence Columbium operates one of two mines in the world that produce columbium concentrates as a primary product, the other is in Brazil.

Canada's commercial production of columbium dates from 1961 when St. Lawrence Columbium began mining pyrochlore at its properties near Oka, Quebec. Tantalum is not produced in Canada but exploration and development of promising occurrences of columbium and/or tantalum was carried on during 1967.

TABLE 1

Canada, Columbium (Niobium) and Tantalum Production, Trade and Consumption, 1966–67

	1966		1967p	
	Pounds	$	Pounds	$
Production (Cb_2O_5 content of products shipped)	2,637,997	3,182,170	2,207,000	2,627,000
Imports[1] from United States				
Columbium and columbium alloys, wrought and unwrought, waste and scrap	–	–	185	21,024
Tantalum and tantalum alloys, wrought and unwrought, waste and scrap	1,533	180,326	1,245	195,086
Tantalum and tantalum alloy powder	2,730	99,939	1,155	33,527
Exports[2] to United States				
Columbium ore and concentrates	1,524,279	869,678	890,884	481,792
Consumption by steel industry				
Ferrocolumbium and ferrotantalum-columbium (Cb and Ta-Cb content)	40,000	. .	. .	. .

Source: Dominion Bureau of Statistics.

1. From US Department of Commerce, Exports of Domestic and Foreign Merchandise, Report Ft 410. Values in US Currency. 2. From United States Department of Commerce, Imports of Merchandise for Consumption, Report FT 125. Values in US currency.

pPreliminary; – Nil; . . Not available.

*Mineral Resources Branch.

The Brazilian producer of columbium concentrates and ferrocolumbium, Companhia Brasileira de Metalurgia e Mineraçâo, maintained a high rate of production at its high-grade pyrochlore deposits near Araxa, Minas Gerais. Production in 1966 was 10.5 million pounds of concentrates, of which 893 tons were used in the production of 506 tons of ferrocolumbium. Production in 1967 was about 3.4 million pounds of columbium contained in pyrochlore concentrates and ferrocolumbium.

Production of columbium in Canada and Brazil was lower in 1967 than in 1966. Prices for Cb_2O_5 in Canadian pyrochlore, for long-term contracts, declined from a range of $1.12 to $1.15 a pound of contained Cb_2O_5 to 95 cents a pound. Trade publications reported sales of large lots of tantalite (Ta_2O_5) at about $10 a pound of Ta_2O_5 in the latter part of 1967. Buyers had paid as high as $13.75 a pound of Ta_2O_5 during the first half of the year.

PRINCIPAL MINERALS

The principal commercial minerals of columbium and tantalum have been columbite and tantalite from pegmatities, and from residual and placer deposits. Both are recovered as a co-product of tin, notably in Nigeria. Major sources of columbium are now the pyrochlore deposits in Brazil and Canada.

Columbite and tantalite have the theoretical compositions (FeMn)O Cb_2O_5 and (FeMn)O Ta_2O_5. They are closely related minerals and frequently associated in ore occurrences. The two minerals vary in composition from the nearly pure columbite containing 82.7 per cent Cb_2O_5, to nearly pure tantalite, containing 86.1 per cent Ta_2O_5. The iron and manganese content varies widely and tin and tungsten may be present.

Pyrochlore is the columbium-rich member of the pyrochlore-microlite series of minerals which also contain oxides of other elements including the rare earths (e.g. cerium) and radioactive elements (e.g. uranium, thorium). Microlite is the tantalum-rich mineral.

CANADIAN PRODUCTION

St. Lawrence Columbium and Metals Corporation has made four successive increases in milling capacity from the initial 500 tons a day at the start of production in October 1961. Present mill capacity is rated at 1,500 tons a day. The change-over from open pit to underground mining was completed in 1967. In 1967, the mill treated 362,040 tons of ore and recovered 2,236,245 pounds of Cb_2O_5 compared with 406,090 tons and 2,639,689 pounds of Cb_2O_5 in 1966. Production of ferrocolumbium was started by St. Lawrence Columbium in 1967. The company's revenue from sales of columbium products was $2.8 million in 1967.

Masterloy Products Limited, near Ottawa, Ontario, produced 148 tons of ferrocolumbium on a 60 per cent Cb-content basis.

Suppliers of ferrocolumbium noted that the market for this material was influenced by a slackening in steel production and an accumulation of ferrocolumbium inventory at reduced prices pertaining in the latter part of the year.

CANADIAN DEVELOPMENTS

Production of tantalite was planned and plant construction started at the Bernic Lake, Manitoba, area property of Chemalloy Minerals Limited under an agreement with The Goldfield Corporation of New York. A new company, Tantalum Mining Corporation of Canada Limited, was formed in which Chemalloy retains a 40 per cent interest and Goldfield holds 60 per cent. Chemalloy reported drill-indicated reserves of about two million tons grading 0.24 per cent tantalum pentoxide (Ta_2O_5).

Imperial Oil Enterprises Ltd., Consolidated Morrison Explorations Limited, and associated companies undertook a program of shaft sinking and crosscutting to provide bulk samples for large-scale metallurgical testing on their columbium-pyrochlore property in the James Bay Lowlands area south of Moosonee, Ontario. Previous drilling was reported to have indicated a possible 80,000 tons per vertical foot averaging 0.52 per cent columbium pentoxide.

TABLE 2

Production of Columbium in Pyrochlore Concentrates by St. Lawrence Columbium and Metals Corporation 1964–67
(pounds)

	1964	1965	1966	1967
Concentrates	4,150,388	4,541,745	5,147,529	4,408,000
Contained Cb_2O_5	2,163,135	2,333,967	2,639,689	2,236,245
Concentrates shipped	4,222,424	4,510,182	5,114,801	4,278,846[1]
Per cent Cb_2O_5 in concentrates	52.1	51.4	51.5	50.75

Source: Company report.
[1] Includes concentrates converted to ferrocolumbium.

Other occurrences of columbium minerals in Ontario include the columbium-uranium deposits of Nova Beaucage Mines Limited, near North Bay, and two areas in Chewett township explored by Dominion Gulf Company. These properties and creek placer deposits, 45 miles southeast of Golden, British Columbia, were examined and explored during 1956 to 1958. Many occurrences of columbite-tantalite have been noted in pegmatite dykes in the Yellowknife area of Great Slave Lake.

WORLD PRODUCTION

Non-communist world production of columbium and tantalum concentrates in 1967 amounted to some 11,300 tons of which 10,550 were columbium concentrates (columbite or pyrochlore) and 750 tons were tantalum concentrate (tantalite).

Brazil became the leading producer of columbium concentrates in 1966 and maintained that position in 1967 with an estimated production of 5,000 tons of concentrate. Production of ferrocolumbium began in Brazil in 1964 and increased to 514 tons in 1966 from 309 tons in 1965. Brazil supplied 50 per cent of United States 1967 imports of columbium concentrates.

TABLE 3

Non-Communist World Production of Columbium-Tantalum Concentrates
(short tons)

	1966		1967[e]	
	Columbium	Tantalum	Columbium	Tantalum
Brazil	5,348[1]	144	5,000	150
Nigeria	2,493	13	2,500	15
Canada	2,574	–	2,204	–
Mozambique	. .	87	10	95
Republic of the Congo (Kinshasa)	64	476	70	480
Malaysia	76	–	80	–
Other Countries	470	12	690	10
Total	11,025	732	10,554	750

Source: US Bureau of Mines Commodity Data Summaries, January 1968; and company reports.
[1] U.S. Bureau of Mines Mineral Trade Notes, Vol. 65, No. 1, January 1968.
[e]Estimated; . . Not available; – Nil.

Nigeria had been the perennial leader in the production of columbium which began there about 1933. In contrast to the more recent producers of columbium-bearing pyrochlore, its columbite concentrates are a co-product of tin mining.

Columbium and/or tantalum concentrates are also produced in eight or more countries other than the three principal producers, but their combined annual production is less than 10 per cent of the world total.

CONSUMPTION AND USE

The United States imported an estimated 6,000 tons of columbium and tantalum concentrates compared with 5,710 tons in 1966*. Brazil, Nigeria and Canada were the principal suppliers.

Canada's consumption in 1966, of columbium and tantalum in the form of ferroalloy additives was 40,000 pounds of the combined elements (Cb, Ta). The market for this material in Canada remains small but is growing in some applications such as in the manufacture of oil and gas transmission pipe.

The United States is the largest consumer of columbium and tantalum with the major part of its wholly-imported supply being used to make ferrocolumbium and ferrotantalum-columbium. Columbium is used as ferrocolumbium in alloy and stainless steels, high-temperature alloys, nickel-base alloys and carbon steels. A primary reason for its addition to steel is to control and refine grain size. The improved strength-to-weight ratio, due to the use of columbium in steel, gives weight savings in the manufacture of oil and gas transmission piping. Both metals are finding increasing use through nuclear research and in high-temperature alloys for jet engines, turbines and rocket-engine parts. Tantalum is used in high-performance capacitors, and in electronic equipment, chemical equipment, alloys and carbides.

The principal Canadian suppliers of ferrocolumbium are Union Carbide Canada Limited; Metallurg (Canada) Ltd.; and Masterloy Products Limited. The Macro Division of Kennametal Inc., Port Coquitlam, B.C. makes high-purity tantalum carbides and columbium carbides.

Among the Canadian users of columbium and tantalum are Atlas Steels Division of Rio Algom Mines Limited; The Algoma Steel Corporation, Limited; Black Clawson-Kennedy Ltd.; Dominion Foundries and Steel, Limited; The Steel Company of Canada, Limited; and Crucible Steel of Canada Ltd.

* US Bureau of Mines Commodity Data Summaries, January 1968.

PRICES

The following quotations are from *E&MJ and Metals Week* of December 1967, in US currency:

	US Currency
Pyrochlore, per lb Cb_2O_5, f.o.b. mine or mill,	
Canadian spot	\$1.02 – \$1.07
long term	95¢
Brazilian, f.o.b. shipping point, spot	95.5¢

Columbium ore		
Columbite, per lb pentoxide, 65% Cb_2O_5 and Ta_2O_5, c.i.f. US ports, spot, 10–1 ratio	90¢	
Ferrocolumbium, per lb Cb, ton lots, f.o.b. shipping point,		
low alloy grades	\$2.45 – \$2.60	
standard grade	\$2.45 – \$2.60	
high purity grades	\$3.82 – \$4.50	
	Powder, roundel	**Ingot**
Columbium metal		
99.5 – 99.8%, per lb, depending on size of lot,		
Metallurgical	\$11–\$22	\$16–\$27
Reactor	\$12–\$23	\$17.50–\$28
Tantalum metal		
f.o.b. shipping point, depending on size of lot, per lb,		
powder	\$32–\$46	
sheet (depending on grade)	\$36–\$60	
rod (depending on grade)	\$40–\$52	

TARIFFS

	British Preferential	Most Favoured Nation	General
CANADA			
Columbium and tantalum ores and concentrates	free	free	free
Columbium metal or tantalum metal in pure form, in lumps, powder, block ingots	free	15%	25%
Columbium metal or tantalum metal in alloy form, in rod, sheet or any semi-processed form	15%	20%	25%
UNITED STATES			
Columbium and tantalum ores and concentrates	free		
Columbium metal			
Unwrought, other than alloys	10%		
Waste and scrap*	10%		
Unwrought alloys	15%		
Wrought metal	18%		
Tantalum metal			
Unwrought	10%		
Waste and scrap*	10%		
Wrought	18%		
Unwrought alloys	15%		

*Duty on waste and scrap suspended to June 30, 1969.

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions on January 1, 1972.

Copper

A.F. KILLIN*

The general strike in the United States dominated world copper markets in 1967. The strike started in mid-July and by year-end had idled nearly 90 per cent of the mine capacity and 80 per cent of smelter and refinery capacity in the United States. The resultant loss in the United States' production, of about 500,000 tons, affected consumption, trade patterns and prices.

Production increased in most other parts of the non-communist world and this additional supply, coupled with large inventories accumulated by United States producers prior to the strike, offset, to some extent the loss in the United States production. A further offsetting factor was a decline in demand for copper in Europe and North America. Consumption in the non-communist world decreased.

Prices on the commodity exchanges fluctuated in response to the supply-demand situation. Government controls on the export of copper in ores, concentrates and scrap were relaxed in Canada and the United States.

Production from new mines in New Brunswick, Quebec, Ontario, Saskatchewan, British Columbia and Yukon Territory plus uninterrupted production at the established mines raised Canada's output to 592,299 tons, valued at $563,513,408, an increase of 86,223 tons and $109,989,428 from 1966. Production of refined copper increased to 500,020 tons from 433,921 tons in 1966.

The export market for Canadian refined copper and for copper in ores and concentrates remained strong and exports of copper in these categories increased. Most of the ores and concentrates went to Japan, and over half of the refined copper exports went to the United States. Export demand for copper semi-fabricated products decreased although there was an upsurge in demand from the United States in the last quarter. Domestic consumption of refined copper declined to less than fifty per cent of refined production for the first time since 1965.

Exploration for and development of new properties continued in many parts of Canada, extending from Pilley's Island in Newfoundland through to British Columbia. In the latter province the emphasis was on large, low-grade, porphyry-type copper deposits. Several of these are under investigation and, granted favourable markets and prices, it is probable that copper production in British Columbia will show a marked increase by 1975.

PRODUCTION AND DEVELOPMENT

Decreased production in Quebec, Manitoba, New Brunswick, Northwest Territories and Nova Scotia was offset by sharp production increases in the Yukon Territory, British Columbia, Ontario and Saskatchewan and a small increase in Newfoundland.

Details of individual mine production and development are given in Table 3. The following résumé outlines the production and developments by provinces.

NEWFOUNDLAND

Closure of Consolidated Rambler Mines Limited's Main Zone mine and First Maritime Mining Corporation Limited's Tilt Cove mine was offset by increased production from Rambler's East Zone and a full year's production from First Maritime's Gullbridge mine. Production in Newfoundland increased 295 tons in 1967 to 19,689 tons valued at $18,732,507.

*Mineral Resources Branch.

TABLE 1

Canada, Copper Production, Trade and Consumption, 1966-67

	1966		1967p	
	Short Tons	$	Short Tons	$
Production[1]				
All Forms				
Ontario	202,976	181,375,552	269,855	256,739,969
Quebec	171,998	154,454,627	159,088	151,355,859
British Columbia	52,880	47,450,169	81,921	77,939,139
Manitoba	31,315	28,120,677	29,459	28,027,719
Saskatchewan	19,561	17,565,676	22,738	21,632,992
Newfoundland	19,394	17,415,394	19,689	18,732,507
New Brunswick	7,089	6,366,203	5,608	5,335,477
Yukon	–	–	3,675	3,496,395
Northwest Territories	748	672,065	226	215,016
Nova Scotia	115	103,617	40	38,335
Total	506,076	453,523,980	592,299	563,513,408
Refined	433,921		500,020	
Exports				
Copper in ores, concentrates and matte				
Japan	56,456	51,796,000	93,632	82,666,000
Norway	16,611	14,733,000	15,217	16,922,000
United States	9,736	7,260,000	7,168	6,070,000
Sweden	8,509	9,716,000	4,925	4,117,000
West Germany	424	225,000	3,094	2,794,000
Spain	14	15,000	2,303	2,204,000
Britain	1,342	1,124,000	1,544	1,430,000
Belgium and Luxembourg	1,227	799,000	1,093	672,000
Other countries	569	630,000	–	–
Total	94,888	86,298,000	128,976	116,875,000
Copper in slag, skimmings and sludge				
United States	216	181,000	429	385,000
Belgium and Luxembourg	167	112,000	113	40,000
Japan	–	–	2	1,000
Total	383	293,000	544	426,000
Copper scrap (gross weight)				
Japan	1,458	1,427,000	9,772	8,603,000
United States	22,795	26,832,000	9,383	8,776,000
West Germany	1,779	1,888,000	4,337	3,884,000
Spain	1,547	1,696,000	3,810	3,525,000
Belgium and Luxembourg	167	116,000	2,150	1,572,000
Netherlands	.272	301,000	561	489,000
Yugoslavia	130	112,000	367	283,000
Other countries	1,258	1,454,000	781	657,000
Total	29,406	33,826,000	31,161	27,789,000
Brass and bronze scrap (gross weight)				
Japan	3,745	2,596,000	10,894	7,303,000
United States	8,313	6,853,000	1,871	1,200,000
West Germany	251	179,000	1,405	949,000
Netherlands	155	133,000	1,007	770,000
Belgium and Luxembourg	323	252,000	792	568,000
Other countries	417	320,000	712	487,000
Total	13,204	10,333,000	16,681	11,277,000

TABLE 1 (Cont'd)

	1966		1967P	
	Short Tons	$	Short Tons	$
Copper alloy scrap, n.e.s. (gross weight)				
Japan	78	58,000	1,271	859,000
Belgium and Luxembourg	16	6,000	168	116,000
United States	120	77,000	142	56,000
Other countries	28	7,000	86	66,000
Total	242	148,000	1,667	1,097,000
Copper refinery shapes				
United States	84,980	76,761,000	147,101	139,325,000
Britain	91,881	102,187,000	94,006	100,261,000
France	9,193	9,439,000	11,059	11,462,000
West Germany	700	623,000	7,773	7,710,000
Japan	–	–	4,798	4,742,000
India	–	–	2,952	3,030,000
Switzerland	1,528	1,637,000	1,748	1,863,000
Italy	84	69,000	1,548	1,492,000
Brazil	2	3,000	1,498	1,492,000
Netherlands	809	731,000	1,257	1,247,000
Portugal	449	366,000	785	750,000
Sweden	448	381,000	785	799,000
Other countries	617	565,000	609	638,000
Total	190,691	192,762,000	275,919	274,811,000
Copper bars, rods and shapes, n.e.s.				
United States	2,946	3,275,000	2,852	3,313,000
Switzerland	1,972	1,746,000	2,831	2,901,000
Pakistan	1,505	1,274,000	2,518	2,862,000
Norway	9,944	10,175,000	1,978	2,188,000
Denmark	1,237	1,202,000	1,769	1,981,000
Britain	2,150	2,136,000	1,638	1,798,000
New Zealand	244	255,000	843	951,000
Colombia	750	870,000	684	740,000
Yugoslavia	–	–	661	653,000
Other countries	4,343	4,462,000	2,299	2,387,000
Total	25,091	25,395,000	18,073	19,774,000
Copper plates, sheet, strip and flat products				
United States	4,069	5,204,000	5,993	7,881,000
Venezuela	105	142,000	305	449,000
New Zealand	214	298,000	152	238,000
Britain	11	15,000	65	100,000
Korea	58	80,000	33	44,000
Other countries	131	172,000	60	89,000
Total	4,588	5,911,000	6,608	8,801,000
Copper pipe and tubing				
United States	11,525	18,476,000	6,118	8,392,000
New Zealand	1,562	2,462,000	1,345	2,256,000
Puerto Rico	437	629,000	734	1,097,000
Philippines	271	434,000	355	593,000
Britain	646	923,000	355	548,000
Venezuela	391	583,000	343	533,000
Other countries	1,842	2,680,000	1,149	1,807,000
Total	16,674	26,187,000	10,399	15,226,000

TABLE 1 (Cont'd)

	1966		1967P	
	Short Tons	$	Short Tons	$
Copper wire and cable, not insulated				
United States	2,826	3,552,000	1,517	1,819,000
Pakistan	36	46,000	523	616,000
Portugal	–	–	50	70,000
Bolivia	43	58,000	46	61,000
Ecuador	8	10,000	28	33,000
Other countries	164	214,000	99	138,000
Total	3,077	3,880,000	2,263	2,737,000
Copper alloy refinery shapes, section and flat products				
United States	6,050	7,001,000	8,035	9,219,000
Netherlands	35	39,000	270	265,000
Hong Kong	63	73,000	187	194,000
Venezuela	103	116,000	185	253,000
Belgium and Luxembourg	58	80,000	132	171,000
Britain	109	138,000	74	106,000
Other countries	128	171,000	204	298,000
Total	6,546	7,618,000	9,087	10,506,000
Copper alloy pipe and tubing				
United States	1,015	1,533,000	1,218	1,935,000
Spain	258	371,000	307	446,000
India	118	110,000	247	371,000
New Zealand	237	347,000	189	298,000
Philippines	–	–	133	186,000
Other countries	373	603,000	201	329,000
Total	2,001	2,964,000	2,295	3,565,000
Copper alloy wire and cable not insulated				
United States	447	719,000	335	569,000
Australia	32	57,000	13	25,000
Britain	23	44,000	7	13,000
Other countries	13	30,000	5	8,000
Total	515	850,000	360	615,000
Copper alloy fabricated materials n.e.s.				
United States	289	402,000	332	570,000
Sweden	–	–	27	40,000
Belgium and Luxembourg	–	–	13	8,000
Other countries	16	97,000	31	70,000
Total	305	499,000	403	688,000
Wire and cable insulated[2]				
United States	7,856	11,920,000	6,633	9,435,000
Philippines	2	4,000	1,765	2,776,000
Puerto Rico	217	332,000	593	1,130,000
Bahamas	557	784,000	412	527,000
Dominican Republic	75	127,000	299	419,000
Jamaica	99	142,000	295	449,000
Thailand	262	408,000	269	324,000
Peru	168	214,000	267	466,000
Nigeria	1,661	2,641,000	206	324,000
Other countries	1,600	2,207,000	1,777	2,571,000
Total	12,497	18,779,000	12,516	18,421,000

TABLE 1(Cont'd)

	1966		1967P	
	Short Tons	$	Short Tons	$
Imports				
Copper in ores, concentrates and scrap	2,199	2,385,000	24,178	20,205,000
Copper refinery shapes	10,492	10,550,000	5,310	5,225,000
Copper bars, rods and shapes (sections) n.e.s.	1,218	1,264,000	451	464,000
Copper plates, sheet, strip and flat products	481	653,000	199	297,000
Copper pipe and tubing	479	892,000	892	1,223,000
Copper wire and cable except insulated	165	286,000	214	332,000
Copper alloy scrap (gross weight)	338	254,000	10,643	7,173,000
Copper powder[3]			400	536,000
Copper alloy refinery shapes, rods and sections	1,108	1,720,000	1,941	2,468,000
Brass plates, sheet and flat products[3]			2,154	2,426,000
Copper alloy plates, sheet, strip and flat products	2,163	2,973,000	514	1,028,000
Copper alloy pipe and tubing	1,062	2,058,000	904	1,700,000
Copper alloy wire and cable, except insulated	706	1,315,000	1,032	1,922,000
Copper alloy castings[3]			264	629,000
Copper and alloy fabricated materials n.e.s.		3,936,000	629	1,455,000
Consumption [4]				
Refined	262,557		224,400	

Source: Dominion Bureau of Statistics.

[1] Blister copper plus recoverable copper in matte and concentrate exported. [2] Includes also small quantities of non-copper wire and cable, insulated. [3] Not available as a separate class prior to 1967. [4] Producers' domestic shipments. P Preliminary; – Nil; . . Less than one ton; n.e.s. – Not elsewhere specified.

A number of companies were exploring for copper deposits including Big Nama Creek Mines Limited at York Harbour and McIntyre Porcupine Mines Limited and Phelps Dodge Corporation at various locations in northwestern Newfoundland.

NOVA SCOTIA

The copper produced in Nova Scotia is contained in the lead concentrate shipped from the Walton mine of Dresser Industries, Inc. (formerly Magnet Cove Barium Corporation).

Mariner Mines Limited continued exploration by diamond drilling and geochemical surveys of its properties in the Coxheath-Frenchvale district of Cape Breton Island.

NEW BRUNSWICK

Nigadoo River Mines Limited started production in the fourth quarter of the year. The production from this new mine was offset by decreased copper output at Cominco Ltd.'s Wedge and Brunswick Mining and Smelting Corporation Limited's No. 6 and No. 12 mines. Production in 1967 at 5,608 tons was 1,481 tons less than in 1966 and value at $5,335,477 was $1,030,726 less. The loss in production from the planned closure of the Wedge mine, by mid-1968, will be compensated for by a scheduled increase in output from the Heath Steele Mines Limited property. No development was done at the mine of Key Anacon Mines Limited.

QUEBEC

Mine production of copper as reported by the companies was 165,915 tons in 1967, down 1,030 tons from 1966. Production reported by the Dominion Bureau of Statistics (DBS) was 159,088 tons valued at $151,355,859, a decrease of 12,910 tons and $3,098,768 from 1966. The DBS total is the sum of blister copper produced and recoverable copper in concentrates and matte exported. It reflects shipments from the mines and may differ from mine production because of shipments made after the end of the reporting year.

Production lost because of the closure of the East Sullivan mine of Sullico Mines Limited near Val d'Or, the Bruneau mine of Rosario Mining Explorations Ltd., near Chibougamau, and the mining of lower grade ore at several Quebec mines, was offset by increased production at Cupra Mines Ltd. at Stratford Place, Gaspé Copper Mines, Limited at Murdochville, Noranda Mines Limited at Noranda, Mines de Poirier inc. at Joutel, and the start of production at the mine of Joutel Copper Mines Limited at Joutel, and of Grandroy Mines Limited and the Icon Syndicate at Chibougamau.

Three new mines were being prepared for production.

TABLE 2

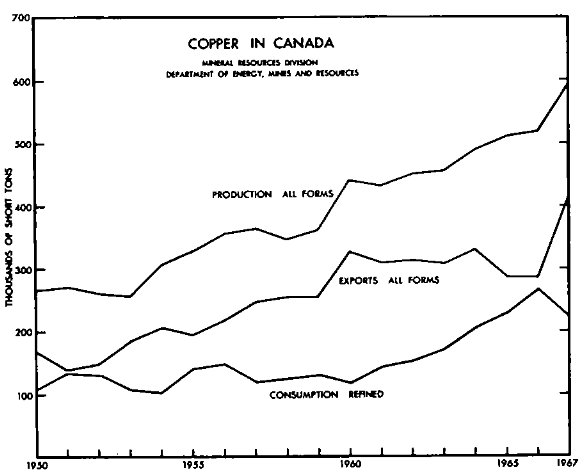
Canada, Copper Production, Trade and Consumption, 1958-67
(short tons)

	Production		Exports			Imports	Consumption**
	All Forms*	Refined	In Ore and Matte	Refined	Total	Refined	Refined
1958	345,114	329,239	30,316	224,638	254,954	1	122,893
1959	395,269	365,366	32,070	222,437	254,507	105	129,973
1960	439,262	417,029	47,633	278,066	325,699	25	117,637
1961	439,088	406,359	42,894	266,247	309,141	3	141,808
1962	457,385	382,862	89,374	223,043	312,417	147	151,525
1963	452,559	380,075	92,930	214,987	307,917	6,549	169,750
1964	436,900	407,942	104,550	224,273	328,823	6,771	202,225
1965	507,877	434,133	87,000	199,830	286,830	5,747	224,684
1966	506,076	433,921	94,888	190,691	285,579	10,492	262,557
1967P	592,299	500,020	128,976	275,919	404,895	5,310	224,400

Source: Dominion Bureau of Statistics.

* Blister copper plus recoverable copper in matte and concentrate exported. ** Producers' domestic shipments, refined copper.

P Preliminary.



ONTARIO

Production from the recently-opened Kidd Creek mine of Ecstall Mining Limited, a wholly owned subsidiary of Texas Gulf Sulphur Company, near Timmins, and greater production from the Sudbury area mines of The International Nickel Company of Canada, Limited (Inco) accounted for most of the increase of 66,879 tons in Ontario's copper output in 1967. Production was 269,855 tons valued at $256,739,969.

Ecstall Mining completed the installation of the second and third 3,000-ton-a-day circuits in its mill at Hoyle and operated the mine and plant at slightly above the rated capacity of 3 million tons of ore a year. The company shipped 205,000 tons of concentrates averaging 24 per cent copper to Noranda for smelting. Kidd Copper Mines Limited at Worthington, Munro Copper Mines Limited at Matheson, and Tribag Mining Co., Limited at Batchawana Bay started production in the year.

In the Sudbury area Inco will bring five mines into production before 1972 and Falconbridge Nickel Mines, Limited will bring two mines and a mill into production. Jameland Mines Limited at Timmins and Big Nama Creek Mines Limited at Manitouwadge are scheduled to begin production before the end of 1969.

MANITOBA

Production of copper in 1967 was 29,459 tons valued at $28,027,729, down 1,856 tons and $92,958 from 1966.

Hudson Bay Mining and Smelting Co., Limited operated the Flin Flon mine, mill and a smelter at Flin Flon, three mines at Snow Lake, and was developing the Osborne Lake and Anderson Lake mines, at Snow Lake, for production in 1968.

Sherritt Gordon Mines, Limited was preparing its Fox Lake mine, some 34 miles southwest of Lynn Lake, for production in 1970. The company plans to build a 3,000-ton-a-day mill to produce copper, zinc and possibly pyrite concentrates.

TABLE 3

Producing Companies, 1967

Company and Location	Mill or Mine Capacity (tons ore/day)	Ore Produced 1967 (1966) (short tons)	Grade (%)			Developments
			Copper	Zinc	Nickel	
Newfoundland						
American Smelting and Refining Company (Buchans Unit), Buchans	1,250	378,000 (366,000)	1.15	13.51	–	Routine exploration and development.
Atlantic Coast Copper Corporation Limited, Little Bay	1,200	341,322 (292,023)	1.12	–	–	Routine development of known ore. Extensive surface and underground exploration for new orebodies. Exploration of North zone by drifting and diamond drilling on the 1,000 level.
British Newfoundland Exploration Limited, Whalesback mine, Springdale	2,000	658,285 (644,128)	0.85	–	–	Routine development. Exploration of Little Deer Pond zone underground and on surface.
Consolidated Rambler Mines Limited, Baie Verte	1,500					
Main zone		94,611 (148,737)	0.95	2.54	–	Closed October 1967.
East zone		236,910 (34,059)	1.26	–	–	Routine development of known ore. Surface and underground exploration for new orebodies and for extensions to known ore.
First Maritime Mining Corporation Limited						
Tilt Cove mine	2,350	. .	. .	–	–	Mine closed July 1967.
Gullbridge mine	2,000	. .	. .	–	–	Operations started January 1967.
Nova Scotia						
Dresser Minerals, Division of Dresser Industries, Inc. (formerly Magnet Cove Barium Corporation), Walton	125	50,330 (50,213)	0.32	0.40	–	Routine mine development. Exploration by drifting and diamond drilling, also surface diamond drilling.
New Brunswick						
Brunswick Mining and Smelting Corporation Limited, Bathurst						
No. 12 mine	4,500	1,669,075 (1,650,120)	0.29	9.07	–	Routine mining and exploration.

TABLE 3 (Cont'd)

Company and Location	Mill or Mine Capacity (tons ore/day)	Ore Produced 1967 (1966) (short tons)	Grade (%)			Developments
			Copper	Zinc	Nickel	
No. 6 mine	2,250	867,373 (300,676)	0.40	5.96	–	Open-pit mining.
Cominco Ltd., Wedge mine, Bathurst	750 (ore to Heath Steele mill)	257,019 (269,295)	. .	–	–	Mine scheduled to close by mid-1968.
Heath Steele Mines Limited, Bathurst-Newcastle	1,500 (mills Wedge ore)	308,866 (287,515)	0.56	8.87	–	Surface and underground exploration. Shaft sinking and mine development preparatory to doubling production by mid-1968.
Nigadoo River Mines Limited, Robertville	1,000	22,630 (–)	0.43	2.06	–	Mill completed in third quarter. Mill tune-up started in fourth quarter. Underground development and exploration.
Quebec						
Campbell Chibougamau Mines Ltd. (Main, Cedar Bay and Henderson mines), Chibougamau	3,500 (mills Grandroy ore)	980,536 (966,027)	1.77	–	–	Sinking of production shafts at Henderson and Cedar Bay mines. Lateral developments on new levels from shaft extensions. Merrill Island mine purchased. Exploration and evaluation of Main mine.
Cupra Mines Ltd., Stratford Place	1,500 (ore to Solbec mill)	308,347 (158,130)	3.42	3.16	–	Routine development and mining of known reserves. Exploration for downward extension of the orebody by diamond drilling.
Gaspé Copper Mines, Limited, Murdochville	11,000	2,763,085 (2,831,800)	1.12	–	–	Installation of 8,000-ton-a-day crusher plant and 3,750-ton-a-day addition to concentrator completed. Stripping of waste and preparation for mining continued at the Copper Mountain mine.
Grandroy Mines Limited, Chibougamau	700 (ore to Campbell Chibougamau mill)	. . (–)	1.05	–	–	Open-pit mine leased and operated by Campbell Chibougamau. Extensive exploration by geophysical survey and diamond drilling.

TABLE 3 (Cont'd)

Company and Location	Mill or Mine Capacity (tons ore/day)	Ore Produced 1967 (1966) (short tons)	Grade (%)			Developments
			Copper	Zinc	Nickel	
Icon Syndicate, Chibougamau	600 (ore to Merrill Island mill)	82,129 (–)	2.65	–	–	Open-pit production started in May. Underground mining in December. Open-pit operations are scheduled for areas 2 and 3 in 1968.
Joutel Copper Mines Limited, Joutel	700 (ore to Poirier mill)	186,786 (–)	1.80	–	–	Stope development and routine mining.
Lake Dufault Mines, Limited, Noranda	1,300	492,938 (489,387)	3.96	8.51	–	Mining of the remaining reserves in Block 1, preparation for mining of low-grade ore in Block 2. Exploration of C zone by drifting and diamond drilling. Exploration on surface by diamond drilling with eight machines.
Lorraine Mining Company Limited, Belleterre	500	192,532 (186,362)	0.92	–	0.45	Mining of existing reserves. Extensive underground exploration for new orebodies.
Manitou-Barvue Mines Limited, Val d'Or	1,300	294,640 (299,875)	0.70	–	–	Routine mining of remaining ore reserves.
		181,350 (173,130)	–	2.57	–	
Mattagami Lake Mines Limited, Matagami	3,850	1,414,000 (1,411,100)	0.61	10.00	–	Routine development and mining. Stope filling with deslimed tailings. Exploration by drifting and diamond drilling.
Marbridge Mines Limited, Malartic	400 (ore to Canadian Malartic Gold Mines Limited mill)	79,201 (129,000)	. .	–	1.77	Routine mining of remaining ore reserves.
Merrill Island Mining Corporation, Ltd., Chibougamau	650 (mills ore from Icon mine)	. . (85,798)	1.80	–	–	Milling of Merrill ore stopped in June when Icon ore treated exclusively. Shaft and claims adjacent to Campbell Chibougamau sold to that company in December.

TABLE 3 (Cont'd)

Company and Location	Mill or Mine Capacity (tons ore/day)	Ore Produced 1967 (1966) (short tons)	Grade (%) Copper	Zinc	Nickel	Developments
New Hosco Mines Limited, Matagami	900 (ore to Orchan mill)	331,228 (315,083)	1.36	4.31	–	Routine mining and development. Stope preparation in B orebody. Exploration and diamond drilling for extensions to known orebodies.
Noranda Mines Limited, Noranda	3,200	855,534 (774,719)	1.97	–	–	Routine mining, exploration and development.
Normetal Mining Corporation, Limited, Normetal	1,000	348,440 (335,666)	1.50	7.13	–	Lateral development of the ore zone on the 7,355-, 7,555- and 7,755- levels. Drifting on the 7,955- level and diamond drilling to 600 feet below this level for ore extensions.
Opemiska Copper Mines (Quebec) Limited, Chapais	2,000	737,272 (766,128)	2.93	–	–	Perry shaft deepened 840 feet, Robitaille shaft deepened 1,043 feet. Lateral development and exploration by diamond drilling in Springer, Perry and Robitaille mines.
Orchan Mines Limited, Matagami	1,900 (mills ore from New Hosco)	375,135 (368,030)	1.19	11.52	–	Surface crusher installed to handle production in 1968 from Bell Allard open-pit mine. Lateral development and exploration by diamond drilling in the 1-A orebody.
The Patino Mining Corporation, Copper Rand Mines Division (Machin Point, Jaculet, Portage, Quebec Chibougamau, Copper Cliff and Bouzan mines), Chibougamau	1,875	680,379 (651,210)	1.88	–	–	Deepening shaft of Machin Point mine. Shaft sinking started at Copper Cliff mine. Ore reserves exhausted at Quebec Chibougamau mine. Exploration by lateral development and diamond drilling at all mines.
Quemont Mining Corporation, Limited, Noranda	2,300	443,774 (578,171)	0.98	2.33	–	Routine development and mining. Exploration by lateral development and diamond drilling.
Rio Algom Mines Limited, Mines de Poirier mine, Joutel	2,500 (mills Joutel ore)	631,000 (575,900)	1.25	2.72	–	Preparation for shaft deepening. Routine mining and exploration.
Rosario Mining Explorations Ltd., Bruneau Mine, Chibougamau	480 (ore to Merrill Island mill)	13,023 (44,302)	1.67	–	–	Mining operations suspended June 30, 1967. Diamond drilling below the adit level to explore for ore extensions.

TABLE 3 (Cont'd)

Company and Location	Mill or Mine Capacity (tons ore/day)	Ore Produced 1967 (1966) (short tons)	Grade (%)			Developments
			Copper	Zinc	Nickel	
Solbec Copper Mines, Ltd., Stratford Place	1,000 (mills Cupra ore)	75,310 (154,795)	1.39	4.54	–	Routine mining and stope preparation.
Ontario						
Canadian Jamieson Mines Limited, Timmins	450	. . (92,685)	2.80	5.00	–	Development of north orebody for mining. Exploration by diamond drilling below the present workings.
Consolidated Canadian Faraday Limited (formerly Metal Mines Limited) Werner Lake mine, Gordon Lake	750	214,536 (192,874)	0.58	–	1.17	Changeover to blasthole stoping method.
Copperfields Mining Corporation Limited (Temagami mine), Timagami	200	. . (. .)	. .	–	–	Shaft sinking and lateral development. Exploration by drifting and diamond drilling.
Ecstall Mining Limited (Texas Gulf Sulphur Company), Kidd Creek mine, Timmins	9,000	3,039,219 (. .)	1.90	9.00	–	Second unit of mill in production mid-January, third unit mid-February.
Falconbridge Nickel Mines, Limited (Falconbridge, East, Hardy, Fecunis, Onaping and North mines), Falconbridge	3,000 (Falconbridge) 2,400 (Fecunis) 1,500 (Hardy)	2,093,507 (1,998,860)	0.76	–	1.50	Routine mining and exploration at developed mines. Shaft sinking at the East, Longvac South and Onaping mines. Lateral development and exploration at all mines.
The International Nickel Company of Canada, Limited (Creighton, Frood-Stobie, Levack, Garson, Murray, Crean Hill, MacLennan, Totten, Copper Cliff North mines and Clarabelle open pit), Copper Cliff	30,000 (Copper Cliff) 12,000 (Creighton) 6,000 (Levack) 22,500 (Stobie)	16,953,760 (14,625,200)	. .	–	. .	Shaft sinking at the Creighton, Totten and Stobie mines. Development of the Copper Cliff South, Copper, Cliff North, Coleman, Kirkwood and Little Stobie mines. Smelter modernization.
Kam-Kotia Mines Limited, Timmins	2,000	679,677 (464,726)	1.36	1.76	–	Completion of shaft sinking program. Development on 4 new levels. Installation

TABLE 3 (Cont'd)

Company and Location	Mill or Mine Capacity (tons ore/day)	Ore Produced 1967 (1966) (short tons)	Grade (%)			Developments
			Copper	Zinc	Nickel	
						of jaw crusher below 9th level and completion of ore-pass raises. Exploration by drifting and diamond drilling.
Kidd Copper Mines Limited, Aer Nickel mine, Worthington	1,000	. . (–)	. .	–	. .	Routine mining and development. Exploration by drifting and diamond drilling. Drilling below the 950 level for extensions of known ore zones.
McIntyre Porcupine Mines Limited, Schumacher	2,000	728,590 (665,545)	0.80	–	–	Routine mining and development. Exploration for extensions to the copper zone on and below the 3875 level by diamond drilling.
Munro Copper Mines Limited, Matheson	600	. . (–)	. .	–	–	Exploration by drifting, cross-cutting and diamond drilling.
Noranda Mines Limited, Geco Division, Manitouwadge	3,700	1,461,000 (1,459,600)	2.02	3.69	–	Completion of No. 4 shaft sinking project. Development of ore zone started from the shaft.
North Canadian Enterprises Limited, Coppercorp mine, Point Mamainse	500	. . (149,691)	. .	–	–	Routine development and exploration.
North Coldstream Mines Limited, Kashabowie	1,000	198,946 (343,835)	1.51	–	–	Mine closed August 1967 on depletion of ore reserves.
Rio Algom Mines Limited, Pronto Division, Spragge	750	242,530 (240,828)	1.93	–	–	Routine mining of reserves down to the 4,000-foot level. Shaft deepening below this level not warranted by exploration results.
Tribag Mining Co., Limited, Batchawana Bay	400	100,326 (–)	1.90	–	–	Milling started in May. Routine exploration and development.
Upper Beaver Mines Limited, Dobie	150 (ore to Upper Canada Mines Ltd. mill)	61,826 (60,397)	1.22	–	–	Routine mining and exploration.
Willecho Mines Limited, Manitouwadge	1,000 (ore to Willroy mill)	338,437 (330,000)	0.58	3.52	–	Development of three new levels below the 1,000-foot level.

TABLE 3 (Cont'd)

Company and Location	Mill or Mine Capacity (tons ore/day)	Ore Produced 1967 (1966) (short tons)	Grade (%) Copper	Zinc	Nickel	Developments
Willroy Mines Limited, Manitouwadge	1,700 (mills Willecho ore)	165,053 (219,400)	0.66	3.33	–	Exploration by drifting and diamond drilling.
Zenmac Metal Mines Limited, Zenith mine, Schreiber	165	60,162 (29,839)	..	15.46	–	Increased mill tonnage by addition of flotation cells. Exploration by drifting and diamond drilling.
Manitoba						
Hudson Bay Mining and Smelting Co., Limited (Flin Flon, Schist Lake, Chisel Lake and Stall Lake mines), Flin Flon	6,000	1,588,216 (1,689,550)	2.64	4.30	–	Additions to known ore reserves by underground development and diamond drilling.
Sherritt Gordon Mines, Limited, Lynn Lake	3,500	1,071,490 (1,205,318)	..	–	..	Routine development of known ore. Exploration for new ore in the O and N zones by drifting and diamond drilling.
Saskatchewan						
Hudson Bay Mining and Smelting Co., Limited, Flin Flon mine		See Manitoba				Additions to known ore reserves by underground development and diamond drilling. Flin Flon mine straddles Manitoba-Saskatchewan boundary.
Rio Algom Mines Limited, Anglo-Rouyn mine, Waden Bay	900	309,123 (230,586)	1.88	–	–	Routine mining and exploration.
Share Mines & Oils Ltd., Hanson Lake	350	41,898 (–)	0.46	8.11	–	Mill and mining plant built. Hydraulic backfill plant added. Routine mining and exploration.
British Columbia						
The Anaconda Company (Canada) Ltd., Britannia mine, Britannia Beach	3,000	627,868 (505,433)	1.07	0.39	–	Routine development of known ore. Extensive exploration underground and on surface to establish new ore reserves.
Bethlehem Copper Corporation Ltd., Highland Valley	14,000	3,948,134 (3,027,281)	0.58	–	–	Open-pit mining of the Jersey zone. Diamond and percussion drilling of the Huestis and Iona zones. Mining operations taken over by company from a contractor.

TABLE 3 (Conc'd)

Company and Location	Mill or Mine Capacity (tons ore/day)	Ore Produced 1967 (1966) (short tons)	Grade (%)			Developments
			Copper	Zinc	Nickel	
Cominco Ltd., Coast Copper mine, Benson Lake, V.I.	750	290,524 (282,832)	..	–	–	Exploration by drifting and diamond drilling for new orebodies.
Craigmont Mines Limited, Merritt	5,000	2,010,232 (989,144)	1.71	–	–	Open pit phased out in May. Mill feed supplied from underground mining and stockpiled open-pit ore.
Falconbridge Nickel Mines, Limited, Wesfrob mine, Tasu Harbour, Q.C.I.	10,000	.. (–)	..	–	–	Production started at mid-year.
Giant Mascot Mines Limited, Hope	1,300	338,912 (331,579)	0.31	–	0.86	Exploration and development of 1500 and Brunswick zones. Exploration on 2950 level by drifting and diamond drilling. Extensive exploration of ore zone by geochemical, geophysical and geological surveying.
The Granby Mining Company Limited. Granisle Copper mine, Babine Lake	5,000	1,943,656 (–)	0.78	–	–	Routine open-pit mining.
The Granby Mining Company Limited, Phoenix Copper Division, Greenwood	2,000	713,513 (700,743)	0.84	–	–	Routine open-pit mining.
Minoca Mines Ltd., Yreka mine, Jeune Landing, V.I.	200	71,500 (73,959)	2.53	–	–	Mine closed.
Mt. Washington Copper Co. Ltd., Courtenay, V.I.	1,000	29,121 (179,502)	0.89	–	–	Mine and mill closed in March. Surface exploration continuing.
Western Mines Limited, Buttle Lake, V.I.	750	293,276 (–)	1.90	8.20	–	Routine exploration and development. Mill in production in January.
Yukon Territory						
New Imperial Mines Ltd., Whitehorse	2,500	453,056 (–)	1.17	–	–	Production started from Little Chief open pit May 1.

Source: Company reports.

.. Not available; – Nil.

Dickstone Copper Mines Limited has negotiated an agreement with Hudson Bay whereby the latter company will mine and mill ore from the Dickstone property in 1970.

SASKATCHEWAN

Anglo-Rouyn Mines Limited at Waden Bay, controlled and managed by Rio Algom Mines Limited; Share Mines & Oils Ltd. at Hanson Lake; and the Saskatchewan portion of the Flin Flon orebody of Hudson Bay accounted for the 22,738 tons of copper valued at $21,632,992 produced in 1967. Anglo-Rouyn shipped its concentrates to the smelter at Flin Flon for processing and Share shipped to the United States.

Hudson Bay was developing the Flexar mine 8½ miles southwest of Flin Flon for production in 1968. Share Mines & Oils was exploring and developing the Quandt property, nine miles north of its mill.

BRITISH COLUMBIA

Production in British Columbia increased 55 per cent in 1967 to 81,921 tons valued at $77,939,139.

Three new mines contributed most of the increased production: Western Mines Limited at Buttle Lake on Vancouver Island, The Granby Mining Company Limited's Granisle mine on Copper Island, Babine Lake and Falconbridge Nickel Mines, Limited's Wesfrob mine at Tasu Harbour, Queen Charlotte Islands, started production in 1967. Craigmont Mines Limited, at Merritt, and Bethlehem Copper Corporation Ltd., in the Highland Valley, increased production in 1967. Craigmont had been strike-bound in 1966 but operated at capacity in 1967. Bethlehem completed a program of mine and mill expansion, and by year's-end, had capacity to treat 14,000 tons of ore a day.

Brenda Mines Ltd. near Peachland was preparing its deposit for open-pit mining and plans to construct a 24,000-ton-a-day mill to produce a copper and a molybdenite concentrate. Granduc Mines, Limited, on the Unuk River north of Stewart, continued driving its 11-mile access tunnel from Tide Lake to the property. By year-end the tunnel had advanced 34,396 feet from the portal. Excavations for the surface plant at the portal were started. Development of the mine from the Leduc portal continued and the start of production has been scheduled for late 1969.

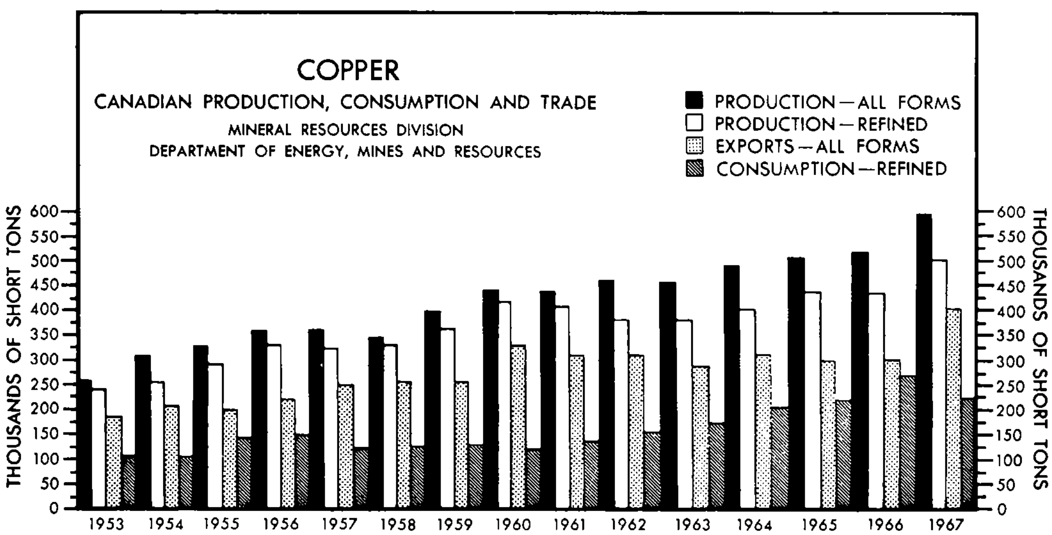
Numerous large-tonnage, low-grade deposits were being explored including the Lornex, Sheba and Highmont deposits in the Highland Valley, the Churchill Copper deposit west of Fort Nelson and the Ingerbelle-Copper Mountain deposits near Princeton.

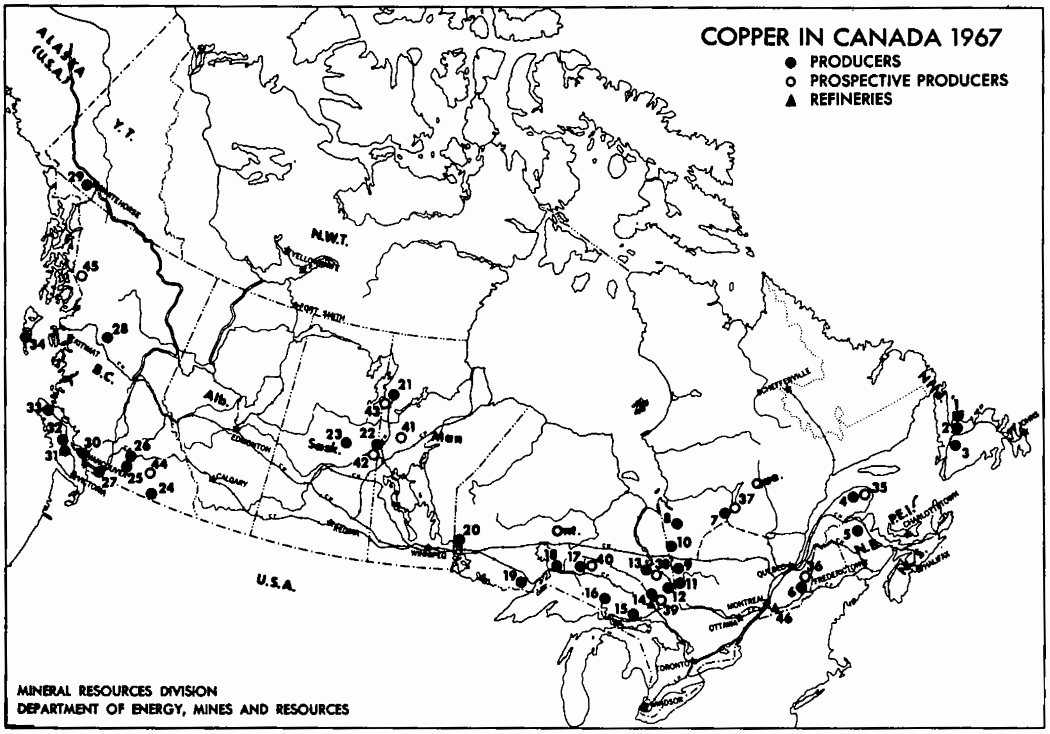
YUKON TERRITORY

New Imperial Mines Ltd. near Whitehorse produced 3,675 tons of copper valued at $3,496,395, all of the Yukon's output in 1967. The mill and mine started production in May and was operating near capacity by mid-year. Exploration below the Little Chief open pit by diamond drilling has indicated over 5 million tons of 2 per cent copper ore.

SMELTERS AND REFINERIES

Salient statistics on Canada's 6 copper smelters and 2 refineries are given in Tables 5 and 6. Modernization of Inco's Copper Cliff, Ontario, smelter continued. Noranda was constructing a pilot plant furnace at Noranda to test a new, continuous-smelting process that would bypass the conventional reverberatory furnace.





PRODUCERS

(numbers refer to numbers on map)

1. Atlantic Coast Copper Corp. Ltd.
   British Newfoundland Expl. Ltd. (Whalesback Pond)
   Consolidated Rambler Mines Ltd.
   First Maritime Mining Corp. Ltd. (Tilt Cove)
2. First Maritime Mining Corp. Ltd. (Gullbridge)
3. American Smelting and Refining Co. (Buchans unit)
4. Gaspé Copper Mines, Ltd.
5. Brunswick Mining and Smelting Corp. Ltd. (No. 6 and No. 12)
   Cominco Ltd. (Wedge)
   Heath Steele Mines Ltd.
   Nigadoo River Mines Ltd.
6. Cupra Mines Ltd.
   Solbec Copper Mines, Ltd.
7. Campbell Chibougamau Mines Ltd. (3 mines)
   Merrill Island Mining Corp. Ltd.
   Opemiska Copper Mines (Quebec) Ltd.
   The Patino Mining Corp., Copper Rand Mines Division (6 mines)
   Rosario Mining Explorations Ltd. (Bruneau)
   Grandroy Mines Ltd.
   Icon Syndicate
8. Mattagami Lake Mines Ltd.
   New Hosco Mines Ltd.
   Orchan Mines Ltd.
   Rio Algom Mines Ltd.–(Mines de Poirier)
   Joutel Copper Mines Ltd.
9. Lake Dufault Mines, Ltd.
   Manitou-Barvue Mines Ltd.
   Noranda Mines Ltd.
   Quemont Mining Corp., Ltd.
   Marbridge Mines Ltd.
10. Normetal Mining Corp., Ltd.
11. Lorraine Mining Co. Ltd.
12. Copperfields Mining Corp. Ltd. (Temagami)
13. Kam-Kotia Mines Ltd.

McIntyre Porcupine Mines Ltd.
Canadian Jamieson Mines Ltd.
Ecstall Mining Limited
Upper Beaver Mines Ltd.
Munro Copper Mines Ltd.

14. Falconbridge Nickel Mines, Ltd. (6 mines, 1 smelter)
The International Nickel Company of Canada, Ltd. (10 mines, 2 smelters, 1 refinery)
Kidd Copper Mines Ltd. (Aer nickel)
15. Rio Algom Mines Ltd. (Pronto Division)
16. North Canadian Enterprises Ltd. (Coppercorp)
Tribag Mining Co., Ltd.
17. Noranda Mines Ltd. (Geco Division)
Willecho Mines Ltd.
Willroy Mines Ltd.
18. Zenmac Metal Mines Ltd.
19. North Coldstream Mines Ltd.
20. Consolidated Canadian Faraday Ltd.
21. Sherritt Gordon Mines, Ltd.
22. Hudson Bay Mining and Smelting Co., Ltd. (4 mines, 1 smelter)
23. Anglo-Rouyn Mines Ltd.
Share Mines & Oils Ltd.
24. The Granby Mining Company Ltd. (Phoenix Division)
25. Craigmont Mines Ltd.
26. Bethlehem Copper Corp. Ltd.
27. Giant Mascot Mines Ltd.
28. The Granby Mining Co. Ltd. (Granisle)
29. New Imperial Mines Ltd.
30. The Anaconda Company (Canada) Ltd. (Britannia Division)
31. Western Mines Ltd.
32. Mt. Washington Copper Co. Ltd.
33. Cominco Ltd. (Coast Copper)
Minoca Mines Ltd.
34. Falconbridge Nickel Mines, Ltd. (Wesfrob)

PROSPECTIVE PRODUCERS

35. Wexford Mines Ltd.
36. D'Estrie Mining Company Ltd.
37. Bell Allard Mines Ltd.
38. Jameland Mines Ltd.
39. Falconbridge Nickel Mines, Ltd. (2 mines)
The International Nickel Company of Canada, Ltd. (5 mines)
40. Big Nama Creek Mines Ltd.
41. Hudson Bay Mining and Smelting Co., Ltd. (3 mines)
42. Hudson Bay Mining and Smelting Co., Ltd. (1 mine)
43. Sherritt Gordon Mines, Ltd. (Fox mine)
44. Brenda Mines Ltd.
45. Granduc Mines, Ltd.

REFINERIES

14. The International Nickel Company of Canada, Ltd.
46. Canadian Copper Refiners Ltd.

TABLE 4

Prospective Producing Companies*, 1967

Company and Location	Type of Ore	Mill or Mine Capacity (tons ore/day)	Production to Start	Destination of Concentrates
Quebec				
Bell Allard Mines Limited, Chibougamau	Zn, Cu	.. (will be milled at Orchan)	1968	Noranda
D'Estrie Mining Company Ltd., Stratford Place	Cu, Zn	.. (will be milled at Cupra)	1970	Export market
Wexford Mines Limited, Gaspé Provincial Park	Cu	2,500	1969	Not available

TABLE 4 (Conc'd)

Company and Location	Type of Ore	Mill or Mine Capacity (tons ore/day)	Production to Start	Destination of Concentrates
Ontario				
Big Nama Creek Mines Limited, Manitouwadge	Zn, Cu	.. (will be milled at Willroy)	1969	Noranda
Falconbridge Nickel Mines, Limited, Falconbridge,				
Strathcona mine	Ni,Cu	6,000	1968	Own smelter
Longvac South mine	Ni,Cu	..	1969	Own smelter
The International Nickel Company of Canada, Limited, Copper Cliff,				
Frood-Stobie expansion	Ni,Cu	22,500	1968	Own smelter
Coleman mine	Ni,Cu	..	1969	Own smelter
Kirkwood mine	Ni,Cu	..	1969	Own smelter
Little Stobie mine	Ni,Cu	6,000 (will be milled at Frood-Stobie)	1969	Own smelter
Copper Cliff North mine	Ni,Cu	..	1968	Own smelter
Copper Cliff South mine	Ni,Cu	4,000 (will be milled at Copper Cliff)	1971	Own smelter
Jameland Mines Limited, Timmins	Cu,Zn	.. (will be milled at Kam-Kotia)	1969	Not available
Manitoba-Saskatchewan				
Hudson Bay Mining and Smelting Co., Limited, Flin Flon Manitoba				
Flexar mine, Saskatchewan	Cu,Zn	.. (will be milled at Flin Flon)	1968	Own smelter
Osborne Lake mine, Man.	Cu,Zn	.. (will be milled at Flin Flon)	1968	Own smelter
Anderson Lake mine, Man.	Cu,Zn	.. (will be milled at Flin Flon)	1968	Own smelter
Dickstone mine, Man.	Cu	.. (will be milled at Flin Flon)	1970	Own smelter
Sherritt Gordon Mines, Limited, Fox mine, Manitoba	Cu,Zn	3,000	1970	Japan
British Columbia				
Brenda Mines Ltd., Peachland	Cu,Mo	24,000	1969	Japan
Granduc Mines, Limited, Unuk River	Cu	7,000	1969	Tacoma, U.S.A.

Source: Company reports.

* Includes only companies with announced production plans.

. . Not available.

TABLE 5

Canadian Copper and Copper-Nickel Smelters

Operator and Location	Product	Rated Annual Capacity (short tons)	Remarks	Ore and Concentrate Treated, 1967 (short tons)	Blister or Anode Copper Produced, 1967 (short tons)
Falconbridge Nickel Mines, Limited, Falconbridge, Ont.	Copper-nickel matte	650,000 (ores and concentrates)	Copper-nickel ore and prepared concentrate smelted in blast furnaces; converted to produce matte for shipment to company's electrolytic refinery in Norway.	..	..
Gaspé Copper Mines, Limited, Murdochville, Que.	Copper anodes, metallic bismuth	300,000 (ores and concentrates)	One reverberatory furnace for green or wet-charge concentrates, 2 Pierce-Smith converters, 1 anode furnace, 1 Walker casting wheel. Also smelts custom concentrates.	298,600 (of which 97,800 were custom concentrates)	54,717
Hudson Bay Mining and Smelting Co., Limited, Flin Flon, Man.	Blister-copper cakes	575,000 (ores and concentrates)	Roasting furnaces, 1 reverberatory furnace, 3 converters, for treating copper flotation concentrates and zinc-plant residues in conjunction with slag-fuming furnaces. Treats some concentrates on toll.	376,203 (of which 29,630 were custom concentrates)	38,989
The International Nickel Company of Canada, Limited					
Coniston, Ont.	Copper-nickel Bessemer matte	800,000 (ores and concentrates)	Sintering; blast-furnace smelting of nickel-copper ore and concentrate; converters for production of copper - nickel Bessemer matte.	..	..
Copper Cliff, Ont.	Blister copper, nickel sulphide and nickel sinter for company's refineries; nickel oxide sinter for market	4,000,000 (ores and concentrates)	Oxygen flash-smelting of copper sulphide concentrates; converters for production of blister copper. Blast furnaces, roasters, reverberatory furnaces for smelting of copper-nickel ore and concentrate; converters for production of copper-nickel	..	..

TABLE 5 (Conc'd)

Operator and Location	Product	Rated Annual Capacity (short tons)	Remarks	Ore and Concentrate Treated, 1967 (short tons)	Blister or Anode Copper Produced, 1967 (short tons)
			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.		
Noranda Mines Limited, Noranda, Que.	Copper anodes	1,700,000 (ores and concentrates and scrap)	Roasting furnaces, 2 hot-charge reverberatory furnaces, 1 green-charge reverberatory furnace, 5 converters. Also smelts custom material.	1,593,900 (of which 807,700 were custom material)	215,890

Source: Company reports.
.. Not available.

TABLE 6

Copper Refineries in Canada, 1967

Refinery	Products
Canadian Copper Refiners Limited, Montreal East, Quebec. (subsidiary of Noranda Mines Limited)	Rated annual capacity: 342,000 tons.
	Refines anode copper from Noranda and Gaspé smelters, blister copper from Flin Flon smelter and purchased scrap. Copper sulphate recovered by vacuum evaporation. Precious metals, selenium and tellurium recovered from anode slimes.
	CCR brand electrolytic copper wire bars, ingot bars, ingots, cathodes, cakes and billets.
The International Nickel Company of Canada, Limited, Copper Refining Division, Copper Cliff, Ont.	Rated annual capacity: 168,000 tons.
	Refining of blister Copper from Copper Cliff smelter. Also custom refining. Precious metals, selenium and tellurium are recovered from anode slimes.
	ORC brand electrolytic copper, cathodes, wire bars, cakes billets, ingots and ingot bars.

Source: Company reports.

WORLD MINE PRODUCTION

Non-communist world production decreased under the impact of the general strike in the United States. Estimates of the production loss in the United States vary but it appears that the loss in mine output because of the strike was about 500,000 tons of contained copper. The effects of the production loss were alleviated to some extent by the sizable inventories accumulated in the latter part of 1966 and the first half of 1967, increased production in other countries and a slackening in demand in Europe and the United States because of decreased industrial activity. Copper was available during the year if the customer was willing to pay a high price. World mine production was estimated by the United States Bureau of Mines at 5,579,000 tons, only 276,000 tons less than in 1966.

Non-communist world capacity for copper production will increase by an estimated 2 million tons by the end of 1971. Most of this increase will occur in United States (500,000 tons), Chile (800,000 tons), Zambia (300,000 tons), and Canada (100,000 tons). Other countries expected to raise production include Spain, Republic of South Africa, Philippines, Australia, India and Japan.

CONSUMPTION AND USES

There was a general decrease in world consumption in 1967. A slackening of industrial demand in the civilian sector in the United States was offset to a great extent by increased usage for defence and military needs.

Canadian consumption of refined copper decreased 38,157 tons to 224,400 tons in 1967. The decrease is largely attributed to a decline in export demand for semi-fabricated and finished products. More than fifty per cent of the copper consumed in Canada was used in the manufacture of wire and rod. The remainder was used in the manufacture of pipe, tube, sheet, strip, rolls, bars, etc. Exports of copper semi-fabricated products decreased 9,290 tons to 62,004 tons.

The principal copper and brass fabricators in Canada are: in British Columbia – Noranda Copper Mills Ltd., Western Division, Vancouver; in Ontario – Anaconda American Brass Limited, Toronto, Phillips Cables Limited, Brockville, Ratcliffs (Canada) Limited, Richmond Hill, Wolverine Tube Division of Calumet & Hecla (Canadian) Limited, London; in Quebec – Noranda Copper Mills Ltd., Eastern Division, Montreal East, Pirelli Cables Limited, St. Johns, and Northern Electric Company, Limited, Montreal.

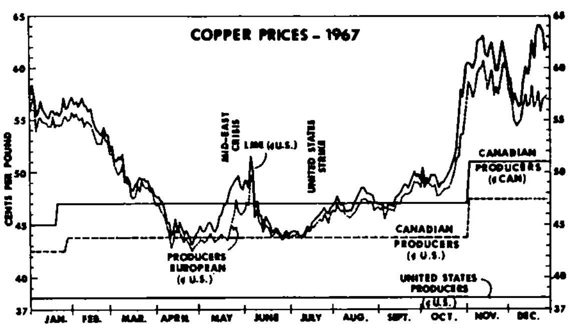
TABLE 7

Canada, Consumption of Primary Copper in Manufacture of Semi fabricated Products, 1965-66
(short tons)

	1965	1966
Copper mill products, sheet, strip, bars, rolls, pipe, tube, etc.	62,993	73,343
Brass mill products – plate sheet, strip, rods, bars, rolls, pipe, tubes, etc.	11,279	21,446
Wire and rod mill products	114,546	122,098
Miscellaneous	1,918	1,119
Total	190,736	218,006

PRICES

The accompanying graph shows the variations in copper prices in 1967. The Canadian producer price was raised from 45 cents a pound to 47.25 cents on January 20 and to 51.00 cents on December 1. The United States domestic producer price remained at 38.00 – 38.25 cents (US) a pound for the year. Producers sold copper in Europe on the basis of the morning quote* for three months' copper on the London Metal Exchange (LME). This price and the LME spot price were under pressure for the first half of the year because of excess production and inventories. The Middle East crisis involving Israel and the Arab nations caused a brief rise in prices. After the start of the general strike in the United States prices rose slowly until inventories at US fabricators were depleted. When buying on the LME by US consumers started in October there was a sharp rise in the LME prices. This rise was checked by adequate supply and the price remained relatively stable for the remainder of the year.



SOURCE: AMERICAN METAL MARKET

TARIFFS

Copper entering Canada in ores and concentrates is not subject to tariff. Various tariff rates are in effect for the copper content in bars, rods, wire, semi fabricated forms and fully processed products entering the country. Table 9 summarizes the Canadian tariff rates on copper and its products.

TABLE 8

World Copper Mine Production, 1966-67
(short tons)

	1966	1967p
United States	1,429,152	939,000
Communist countries	880,000	1,150,000
Chile	724,364	780,000
Zambia	687,226	690,000
Canada	506,076	590,000
Congo (Kinshasa)	347,960	350,000
Peru	194,441	180,000
Republic of South Africa	137,414	..
Japan	122,665	..
Australia	117,494	..
Other countries	704,208	900,000*
Total	5,851,000	5,579,000

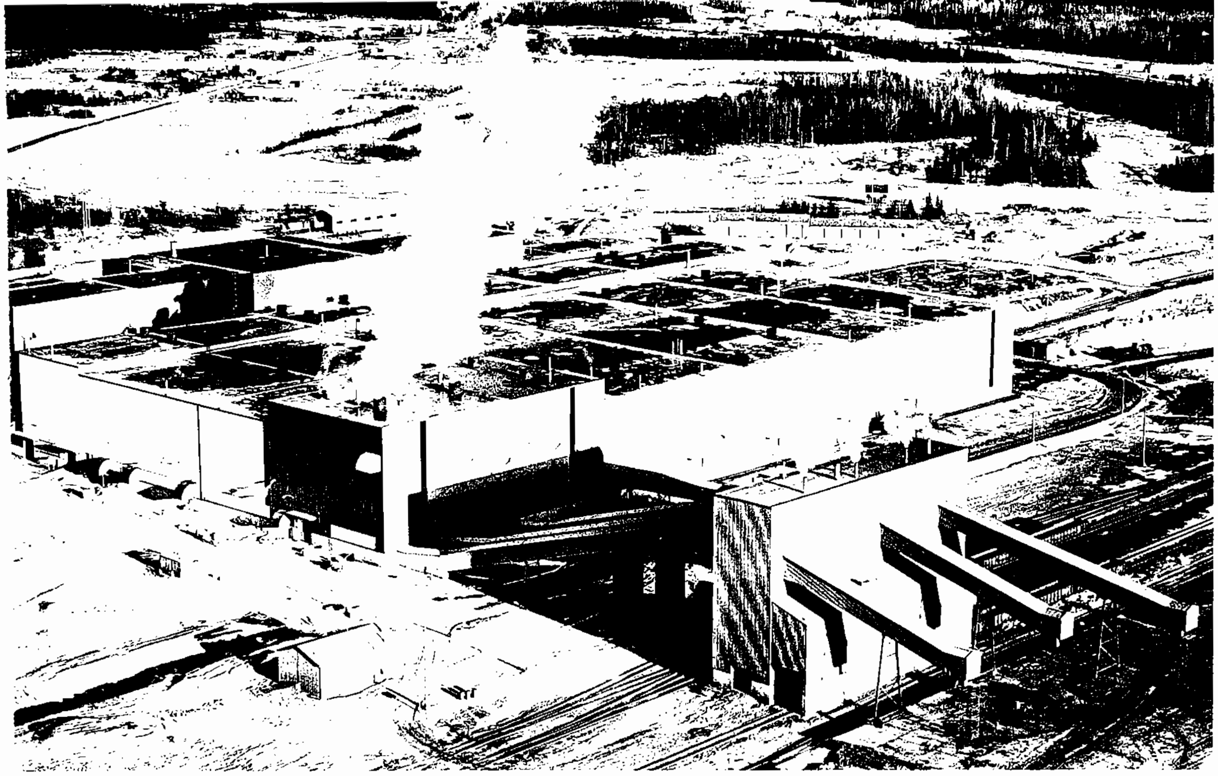
Sources: For 1966, US Bureau of Mines, Minerals Yearbook, 1966; and for 1967, US Bureau of Mines, Commodity Data Summaries, January 1968.

p Preliminary; .. Not available; * Includes Republic of South Africa, Japan, Australia.

The United States tariff on copper entering the country in ores, concentrates and primary shapes is 1.7 cents a pound on copper content**. On fabricated products an ad valorem duty that varies with the type of product is added to the tariff of 1.7 cents a pound on copper content.

*The morning closing price for copper that is sold for delivery in three months.

**Suspended from February 9, 1966 until June 30, 1968.



GOING UNDERGROUND: the Craigment copper mine, at Merritt in south-central British Columbia, phased-out its open-pit operation in May. The photograph shows the open-pit and waste dumps upper centre, the cable-belt conveyor centre, the mill buildings lower centre, and the portal to underground workings at lower left centre.

OPERATING ABOVE RATED CAPACITY IN THE FIRST FULL YEAR: Ecstall's new mill at Hoyle near Timmins, Ontario, processed the Kidd Creek zinc-copper-silver-lead ore slightly above its rated capacity of three million tons a year. Copper concentrates were sent to Noranda's smelters in the United States, Europe and Japan. Silver-lead concentrates went to smelters in the United States and Europe.

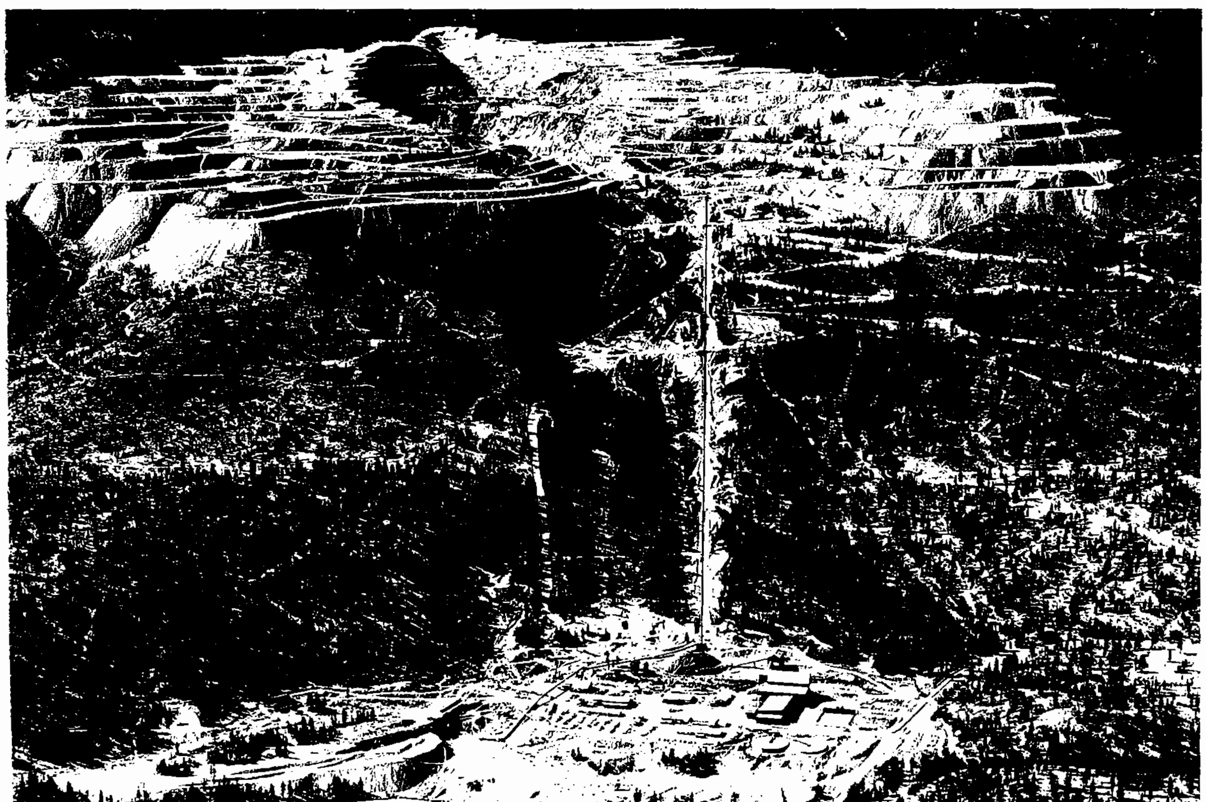


TABLE 9

Canadian Tariffs

	British Preferential	Most Favoured Nation	General
Ores, concentrates	free	free	free
Pigs, blocks, ingots, cathodes	¾¢ lb	¾¢ lb	1½¢ lb
Scrap	¾¢ lb	¾¢ lb	1½¢ lb
Anodes	5%	7.5%	10%
Oxides	free	15%	15%
Bars or rods; tubing not less than 6 ft. long, unmanufactured; copper in sheets, strips or plates, not polished, planished or coated	5%	10%	10%
Bars and rods for manufacture of wire and cable	free	10%	10%
Tubing not more than ½ in. in dia. and not less than 6 ft. long	5%	10%	10%
Alloys of copper consisting 50% or more by weight of copper in sheets, plates, bars, rods, tubes	7.5%	15%	15%

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions on January 1, 1972.

Feldspar

J.E. REEVES*

Production of feldspar in Canada during the past few years has remained steady at about 10,000 tons a year. In 1967, total shipments by International Minerals & Chemical Corporation (Canada) Limited, the only producer, were nearly the same as in 1966. The company's processing plant in Buckingham, Quebec, grinds hand-cobbed feldspar mined from a large, very coarse-grained, granitic pegmatite a few miles to the north. The principal market is the ceramic industry in southern Ontario and northwestern New York State. Statistics are no longer available on the small amount of trade in feldspar that takes place with the United States. The reporting of exports as a separate class was discontinued in 1966. Imports, from the United States to the west coast, have not been reported since 1963.

The Canadian feldspar industry declined considerably during the 1950's as a result of the widespread acceptance of nepheline syenite as a substitute. Because of its higher alumina content and consistent quality, nepheline syenite has completely replaced feldspar in the Canadian glass industry and is used extensively in the manufacture of glass in the northeastern United States. It has also become widely accepted, at the expense of feldspar, by many parts of the whitewares industry.

TECHNOLOGY

Feldspar is the general term for a group of related aluminum silicates of potassium, sodium and calcium. Feldspar containing potassium and sodium is of value to the ceramic industry as a source of alumina (Al_2O_3), potash (Ka_2O) and soda (Na_2O), and for its relatively low firing temperature; it is of some use to manufacturers of cleaning compounds because it is moderately abrasive. High-calcium feldspar, in the form of anorthosite or as pieces of labradorite, is in some demand for building and decorative purposes but is not included in Canadian feldspar statistics.

Soda and potash feldspar occur widely in many types of rock, but commercial deposits are restricted to a very few with a high content of feldspar that can be suitably extracted. Very coarse-grained granitic pegmatites, with the feldspar concentrated in zones, have been the most common sources. The feldspar from such sources is hand-cobbed to remove excess quartz and various other unwanted minerals, and is ground and sized. Nearly all the feldspar produced in Canada has come from such pegmatites, which are relatively common in southeastern Ontario and southwestern Quebec.

Elsewhere, the depletion of many of these deposits and the need for mechanized high-tonnage operations have led to the development of pegmatites or other highly feldspathic rocks in which the feldspar is finer grained and more intimately mixed with quartz and small quantities of other minerals. The feldspar is concentrated mechanically, usually by flotation.

The acceptance of feldspathic substitutes by the consumers has adversely affected the growth of the feldspar industry. Nepheline syenite from Ontario has been substituted by glass manufacturers because of its comparatively higher content of alumina; aplite, a feldspathic byproduct of titanium mineral operations

*Mineral Processing Division, Mines Branch.

TABLE 1

Feldspar – Production, Trade and Consumption, 1966-67

	1966		1967	
	Short Tons	$	Short Tons	$
Production (shipments)	10,924	254,714	10,394	241,715
Exports				
United States	3,419	78,000	. .	. .
	1965		1966	
Consumption, available data				
Whiteware	7,607		10,148	
Porcelain enamel	309		286	
Cleaning compounds	356		690	
Other	66		379	
Total	8,338		11,503	

Source: Dominion Bureau of Statistics.
. . Not available as a separate class after 1966.

TABLE 2

Feldspar, Production and Trade, 1958-67
(short tons)

	Production	Imports	Exports
1958	20,387	1,140	9,956
1959	17,953	1,161	7,552
1960	13,862	1,338	3,183
1961	10,507	1,721	2,626
1962	9,994	1,901	3,698
1963	8,608	2,600	3,282
1964	9,149	. .	3,386
1965	10,904	. .	3,746
1966	10,924	. .	3,419
1967	10,394	. .	. .

Source: Dominion Bureau of Statistics.
. . Not available.

in Virginia, is also used in some types of glass as a relatively cheap source of alumina; and controlled feldspar-silica mixtures have become acceptable in glass and certain clay ware.

USES AND SPECIFICATIONS

Feldspar is important as a flux in the firing of whiteware bodies and glazes, and is used principally in Canada in the manufacture of electric porcelain and vitreous sanitary ware. It must be essentially minus 325 mesh, have a very low quartz and iron-mineral content and, in many cases, contain a high potash-soda ratio. An iron content of less than 0.1 per cent (in terms of ferric oxide, Fe_2O_3) is specified to ensure a white fired product.

In the manufacture of porcelain enamels, feldspar is a source of alumina, potash and silica. It must be at least minus 120 mesh, have a very low iron content and fire white.

For cleaning compounds, feldspar should be white and free of quartz.

Where it can compete economically with nepheline syenite, feldspar is still used extensively as a source of alumina, soda and potash in the manufacture of glass. A relatively coarse particle size, generally with an upper limit of 20 mesh, is required. The iron content should be less than 0.1 per cent Fe_2O_3 .

PRICES

There were no reported changes in the prices of feldspar during 1967. According to *Metals Week* of December 25, 1967 some prices in the United States, per short ton, f.o.b. mine or mill, in bulk and carload lots, were:

North Carolina	
40 mesh, dry ground	$18.50 – $21.00
200 mesh, dry ground	18.50 – 21.00
20 mesh, flotation	$ 9.00
200 mesh, flotation	18.50
Connecticut	
20-30 mesh, granular	$12.00
200 mesh	19.50
325 mesh	21.50

TARIFFS

Canadian and United States feldspar tariffs in effect at the time of writing were:

	British Preferential	Most Favoured Nation	General
CANADA			
Crude only	free	free	free
Ground but not further manufactured	free	15%	30%
UNITED STATES			
Crude 12 1/2¢ per long ton			
Ground 7 1/2¢ ad val			

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Fluorspar

J.E. REEVES*

In 1967, Canada continued to import a large part of its requirements for fluorspar. Production, almost all for use in making aluminum, was a little higher than in 1966, but because of mining difficulties was lower than in previous years. There was a sharp increase in imports, a continuation of a threefold rise over the last decade. Mexico is by far the most important supplier and was the source of nearly all of the increase in 1967. Most imports are metallurgical grade.

The demand for fluorspar throughout the world has been increasing steadily, with a resulting increase in prices. This trend is expected to continue, at least for a few years, perhaps eventually providing some impetus for new fluorspar production in Canada. A recent study forecasts a tripling in world demand for hydrofluoric acid from 1965 to 1975.

THE CANADIAN INDUSTRY

By far the principal producer is Newfoundland Fluorspar Limited, a subsidiary of Alcan Aluminium Limited, which mines a fluorite-bearing vein near St. Lawrence, on the Burin Peninsula of Newfoundland, and ships a partly concentrated product to another subsidiary, Aluminum Company of Canada, Limited,at Arvida, Quebec. The latter upgrades the concentrate and uses most of it in the production of artificial cryolite (sodium aluminum fluoride) for use in reducing alumina to aluminum. The Director vein has been the only one mined in recent years, but the Tarefare vein is being developed and should be in operation by 1969.

Pacific Silica Limited recovers a small amount of metallurgical-grade fluorspar as a byproduct of its silica operation near Oliver, British Columbia.

Yale Lead & Zinc Mines Limited continued the development of barite-fluorite deposits east of Lake Ainslie on Cape Breton Island. Much work was done on processing method, mill design and market potential. Diamond drilling on two veins has indicated at least 2 1/2 million tons averaging about 46 per cent barite and 14 per cent fluorite.

Allied Chemical Canada, Ltd., imports acid-grade fluorspar and produces hydrofluoric acid at Valleyfield, Quebec, for use in making various fluorine chemicals, including the increasingly important fluorocarbons. At North Brook, Ontario, Huntingdon Fluorspar Mines Limited used imported metallurgical-grade fluorspar to make 5-pound briquettes for foundries. Some fluorine is being recovered, in part as fluosilicic acid, from the processing of phosphate rock by at least two companies, Electric Reduction Company of Canada, Ltd., at Port Maitland, Ontario, and Cominco Ltd., at Trail, British Columbia.

*Mineral Processing Division, Mines Branch.

TABLE 1

Fluorspar – Production, Trade and Consumption

	1966		1967p	
	Short Tons	$	Short Tons	$
Production (shipments)				
Newfoundland	..	1,890,768	..	2,097,390
British Columbia	..	4,986	..	2,330
Total	..	1,895,754	..	2,099,720
Exports				
Britain	12	6,000*	**	**
Imports				
Mexico	60,287	1,572,000	79,027	2,016,000
United States	11,403	412,000	10,606	400,000
Britain	3,634	159,000	4,611	193,000
	75,324	2,143,000	94,244	2,609,000
	1965		1966	
Consumption (available data)				
Metallurgical flux (steel, magnesium, foundries)	44,666		42,555	
Glass	2,751		2,761	
Enamels	291		290	
Other (including aluminum and chemicals)	119,829		120,669	
Total	167,537		166,275	

Source: Dominion Bureau of Statistics.
* Shipments of clear crystal for optical use.
** Not available as a separate class after 1966.
p Preliminary; .. Not available.

TABLE 2

Fluorspar – Production, Trade and Consumption, 1958-67
(short tons)

	Production	Exports	Imports	Consumption
1958	62,000[1]	7	30,408	89,933
1959	74,000[1]	3,774	26,588	96,016
1960	77,000[1]	10,312	59,690	111,835
1961	78,600[2]	2,048	32,769	111,542
1962	77,700[2]	4	67,847	123,694
1963	85,000[2]	4	66,798	142,840
1964	96,000[2]	..	69,986	155,828
1965	112,000[2]	..	69,848	167,537
1966	..	12	75,324	166,275
1967	..	..	94,244	..

Source: Dominion Bureau of Statistics except where otherwise indicated.
1 Estimates reported by US Bureau of Mines.
2 Shipments reported in annual reports of Aluminium Limited.
.. Not available.

TABLE 3

World Production of Fluorspar
(short tons)

	1965	1966	1967e
Mexico	810,618	799,602	825,000
USSR	385,000	385,000	..
France	215,573	265,000	..
Spain	234,109	264,004	..
United States	240,932	253,068	260,000
China, mainland	240,000	250,000	..
Italy	162,990	226,143	225,000
Britain	191,251	203,927	..
West Germany	91,402	101,912	105,000
Other Countries	538,125	531,344	..
Total	3,110,000	3,280,000	3,470,000

Source: For 1965 and 1966, US Bureau of Mines Minerals Yearbook, 1966; for 1967, US Bureau of Mines Commodity Data Summaries, Jan. 1968.
e Estimate; .. Not available.

CANADIAN RESOURCES

Fluorite deposits near St. Lawrence, Newfoundland, consisting of veins of various widths in a granitic rock, have been Canada's most important source of fluorspar, having provided a total of about 2 million tons. Newfoundland Fluorspar has operated continuously since 1940 to supply the Canadian aluminum industry. St. Lawrence Corporation of Newfoundland Limited produced metallurgical and acid grades, mainly for export to the United States, from 1933 until forced to close in 1957 because of competition from Mexican fluorspar. Newfoundland Fluorspar now has control of all the deposits in the St. Lawrence area.

Near Madoc, Ontario, veins were mined on a small scale almost continuously from 1910 to 1961, producing up to 11,000 tons a year. Total production was about 120,000 tons. The several deposits were mined to only shallow depths and probably have considerable fluorite remaining below the bottom levels.

From 1940 to 1949, about 1400 tons of fluorspar were produced from veins near Lake Ainslie on Cape Breton Island, for metallurgical use. Current development of these deposits offers the most promise of new production in Canada.

Fluorite occurs in several areas in British Columbia. The Rock Candy mine, near Grand Forks, was mined intermittently from 1918 to 1942 and is still controlled by what is now Cominco Ltd. Substantial reserves probably remain but Cominco recovers all the fluorine it requires from the processing of phosphate rock for making fertilizers. Consolidated Rexspar Minerals & Chemicals Limited* has a large medium-grade fluorite deposit adjacent to the rail line at Birch Island, about 60 miles north of Kamloops. The fluorite is fine grained and difficult to concentrate, but higher prices and the greater use of pelletized metallurgical-grade fluorspar may result in production at some future time. Shallow flat-lying deposits along the Liard River in northern British Columbia apparently contain large quantities of fluorite, barite and witherite, but without higher prices and a much improved means of transportation the deposits are uneconomic.

WORLD REVIEW

The demand for fluorspar has been increasing steadily, with an attendant increase in prices. Despite growing production in most producing countries, some grades in some places have been periodically in short supply. This has resulted in several developments. In Mexico, a large new flotation plant for recovering fluorite from tailings from a lead-zinc operation in the southern part of the state of Chihuahua is being planned. Capacity will reportedly be 80,000 tons of acid-grade fluorspar a year. In Tunisia, a fluorspar-barite mine, which will have a reported output of 25,000 to 30,000 tons of fluorspar a year, will be reopened. In India, new production facilities for acid and metallurgical grades are being built. In the United States, production and consumption both rose. Production began in Arizona in late 1967, and dormant plants elsewhere were reopened. Briquetting and pelletizing plants were operating at capacity. Consumption in 1967 may have increased to nearly 1.2 million tons, from 1,065,000 tons in 1966.

TECHNOLOGY

"Fluorspar" is an archaic mineralogical term that is still the common commercial term for the mineral fluorite (calcium fluoride, CaF_2). Fluorite is widely distributed, occurring in a variety of colours in many different geological environments. It is important commercially because it is an active flux and the principal source of fluorine.

Processing methods vary considerably. Hand cobbing is still common in some countries for producing metallurgical-grade lump. For producing higher grades and for processing fine-grained ores, flotation is used. The pelletizing of fine fluorspar is providing the steel industry with an acceptable alternative to lump fluorspar, although at a higher price, and may lead to the development of deposits not currently of commercial value because the fluorite is too fine grained to yield metallurgical lump or is not amenable to concentration to higher grades. Newfoundland Fluorspar upgrades its ore with a heavy media process; the product is further concentrated by flotation at Arvida before being converted to hydrofluoric acid.

Phosphate rock normally contains 2 to 4 per cent fluorine and is being processed widely and in large quantity by the fertilizer manufacturers. The recovery of byproduct fluorine has long been recognized as a possibility, but thus far is only being done by a few companies for captive use or to make water fluoridating chemicals.

USES AND SPECIFICATIONS

Metallurgical-grade fluorspar is used as a flux in the steelmaking process, to assist the melting of the furnace charge and to improve the separation of metal and slag. With the increasing use of the basic oxygen furnace process, the proportion of fluorspar required per ton of steel has increased. Steel manufacturers specify fluorspar on the basis of a minimum of about 75 to 80 per cent effective CaF_2 (which is computed by subtracting 2 1/2 times the silica content from the total CaF_2 content), – a maximum of about 5 per cent silica (SiO_2), a very small content of sulphur and lead, and in lumps essentially between 2 inches and 3/8 inch, with no more than about 15 per cent finer. Metallurgical-grade fluorspar is also used as a flux in

*Company name was changed in June 1967 from Rexspar Minerals & Chemicals Limited.

foundries and in the reduction of dolomite to magnesium.

In the absence of abundant natural cryolite (Na_3AlF_6), acid-grade fluorspar is converted to hydrofluoric acid, which is used to make artificial cryolite. Molten artificial cryolite forms the electrolyte in the Hall process for converting alumina to aluminum. A small amount of fluorspar is also added to the melt as a flux.

Acid-grade fluorspar is the principal raw material for the manufacture of fluorine chemicals. Some of these chemicals are used in uranium processing, the alkylation of gasoline and the production of high-energy fuels. Anhydrous hydrogen fluoride has a very important use and promising future in the manufacture of fluorocarbon plastics, solvents, refrigerants and aerosol propellants. The useful and unusual properties of fluorocarbons – they are generally inert, odourless, non-toxic, non-corrosive and non-flammable – have been responsible for their remarkable growth.

Acid-grade fluorspar must contain a minimum of 97 per cent CaF_2 and a maximum of 1 per cent SiO_2, and have a fine particle size.

Ceramic-grade fluorspar is used as a flux and opacifier in opal glass and enamels. It is used in transparent glass because it is an active flux, contributes to the gloss and acts as a decolourizer. Specifications generally require at least 94 to 95 per cent CaF_2 and not more than 3 per cent SiO_2, 1 to 3 per cent calcium carbonate ($CaCO_3$) and 0.1 per cent iron (as ferric oxide, Fe_2O_3).

Fluosilicic acid, sodium fluoride and to a slight extent calcium fluoride are used to fluoridate public water supplies.

PRICES

Almost all grades in the United States, Mexico and Europe underwent price increases of about $1 to $3 a ton during 1967. Further increases were posted in the United States in the first quarter of 1968. Prices as of December 25, 1967, according to *Metals Week*, were:

United States, in bulk, f.o.b. Illinois and Kentucky, per short ton	
Metallurgical	
72 1/2% CaF_2	$41.50
70% CaF_2	39
60% CaF_2	36
Pellets, 70% CaF_2	44
Acid, dry basis 97% CaF_2	
Carload	51
Less than carload	55
Bags, $4 extra	
Wet filter cake, 8-10% moisture sold dry content, subtract approx. $2.50	
Ceramic, calcite and silica variable, Fe_2O_3 maximum 0.14%	
88-90% CaF_2	45
93-94% CaF_2	48
95-96% CaF_2	49
97% CaF_2	51
In 100-lb paper bags, $4 extra	
Europe, c.i.f. U.S. ports, duty paid, per short ton effective Jan. 1, 1968	
Acid, wet filter cake, 8-10% moisture, sold by dry content	$44.50-$45.50
Mexico, per short ton	
Metallurgical, 72 1/2% CaF_2, f.o.b., per short ton	
U.S. border, all rail, duty paid	$32-$33
Brownsville, Texas, barge, duty paid	34- 35
Tampico, Mexico, vessel lots	25
Acid, 97% CaF_2 mine.	
Eagle Pass, Texas, in bulk	40- 45

TARIFFS

CANADA – free

UNITED STATES

Fluorspar, by weight of calcium fluoride, per long ton	
containing over 97%	$2.10
containing not over 97%	8.40

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Gold

J.J. HOGAN*

Gold production in Canada in 1967 declined for the seventh successive year. Production in 1967 is estimated at 2,986,092 ounces valued at $112,719,424. In comparison with the 1966 production of 3,319,474 ounces valued at $125,177,364, the 1967 production is down about 10 per cent in ounces produced and in value. The highest production since World War II was achieved in 1960 when 4,628,911 ounces valued at $157,151,527 were produced.

The 1967 decrease is due to lower production from all sources, auriferous quartz or lode gold mines, byproduct gold from base metal mines and placer operations. In 1967, the lode gold mines produced 2,424,070 ounces, compared with 2,676,381 ounces in 1966. In 1967 base metal mines accounted for 552,670 ounces, compared with 599,724 ounces in 1966. In 1967, placer operations produced 9,352 ounces, compared with 43,369 ounces in 1966. Three lode gold mines closed in 1967. Two lode mines amalgamated while three lode mines began operations.

Ontario continued as the leading producing province in 1967 producing 50.3 per cent of the total. Quebec was in second place with 28.2 per cent. The Northwest Territories produced 12.8 per cent and British Columbia 3.9 per cent.

World production in 1966 was estimated at 46.6 million ounces by the US Bureau of Mines. In 1965, world production was 46.3 million ounces. About 66 per cent of the 1966 total or 30.88 million ounces was produced by the Republic of South Africa. The USSR produced an estimated 5.37 million ounces in 1966.

Canada has long been one of the world's leading producers of gold. Since production was first officially recorded in 1858, Canada has produced over 183.8 million ounces worth about $5,952 million to the end of 1967. Although most provinces have been contributors to the total, Ontario, Quebec, British Columbia, the Yukon Territory and the Northwest Territories, in that order, are the leaders.

Since 1948, production by the gold mining industry has received financial assistance from the Government of Canada under the provisions of the Emergency Gold Mining Assistance Act. In December 1967, the act was extended for three years to the end of 1970. In 1967 there were 41 lode gold mine operators eligible for assistance. Three lode mines do not receive assistance payments.

The closure of three lode gold mines in 1967 was due to the exhaustion of economic ore brought about by increasing costs for supplies and higher wage scales.

Production is expected to continue to decline since four mines are likely to close in 1968. Many of the mines are experiencing difficulty in maintaining operations. Placer gold production decreased substantially with the closure of The Yukon Consolidated Gold Corporation, Limited dredging operations in the Yukon.

*Mineral Resources Branch.

TABLE 1

Production of Gold, 1966-67
(troy ounces)

	1966	1967p
NEWFOUNDLAND		
Base-metal mines	25,667	24,497
NOVA SCOTIA		
Auriferous quartz	20	–
NEW BRUNSWICK		
Base-metal mines	1,953	1,632
QUEBEC		
Auriferous quartz mines		
Bourlamaque-Louvicourt	268,083	248,275
Malartic	232,168	230,710
Chibougamau	37,553	27,681
Noranda	57,889	49,532
Total	595,693	556,198
Base-metal mines	339,766	285,047
Total Quebec	935,459	841,245
ONTARIO		
Auriferous quartz mines		
Kirkland Lake	131,766	123,590
Larder Lake	186,884	199,245
Matachewan	2,062	–
Porcupine	747,996	646,898
Red Lake and Patricia	398,285	358,948
Sudbury	39,219	33,186
Thunder Bay	61,916	57,793
Kenora-Rainy River	1,587	–
Total	1,569,715	1,419,660
Base-metal mines	91,035	82,930
Total Ontario	1,660,750	1,502,590
MANITOBA-SASKATCHEWAN		
Auriferous quartz mines	22,808	13,394
Base-metal mines	84,435	88,232
Total Manitoba and Saskatchewan	107,243	101,626
ALBERTA		
Placer operations	182	119
BRITISH COLUMBIA		
Auriferous quartz mines	63,534	54,148
Base-metal mines	55,967	61,857
Placer operations	1,204	670
Total British Columbia	120,705	116,675
YUKON TERRITORY		
Auriferous quartz mines	629	–
Base-metal mines	854	8,400
Placer operations	41,983	8,563
Total Yukon Territory	43,466	16,963

TABLE 1 (Cont'd)

	1966	1967P
NORTHWEST TERRITORIES		
Auriferous quartz mines	423,982	380,670
Base-metal mines	47	75
Total Northwest Territories	424,029	380,745
CANADA		
Auriferous quartz mines	2,676,381	2,424,070
Base-metal mines	599,724	552,670
Placer operations	43,369	9,352
Total	3,319,474	2,986,092
Total value	$125,177,364	$112,719,424
Average value per ounce	$37.71	$37.75

Source: Dominion Bureau of Statistics final data for 1966 and Dominion Bureau of Statistics and Mineral Resources Division revised preliminary data for 1967.
P Preliminary; – Nil.

OPERATIONS AT PRODUCING MINES

ATLANTIC PROVINCES

Gold production in the provinces of Newfoundland, New Brunswick and Nova Scotia amounted to 26,129 ounces in 1967 as compared with 27,640 ounces in 1966. Production is derived mainly as a byproduct from base-metal mining in Newfoundland. Consolidated Rambler Mines Limited, a Newfoundland copper-zinc producer, is the largest producer of byproduct gold. Some gold is recovered from base-metal ores in New Brunswick while Nova Scotia intermittently produces small amounts of gold from auriferous-quartz deposits.

QUEBEC

Gold production decreased in 1967 by 10.1 per cent to 841,245 ounces. Eleven lode gold mines operated in the province in 1967.

Two of the eleven lode gold mines closed during the year. Production decreased both from the lode gold mines and from byproduct base-metal mines in 1967. In 1967, the base-metal mines accounted for about 34 per cent of the provincial gold total as against 36.3 per cent in 1966. The principal producers of byproduct gold are the base-metal mines of the Chibougamau and Noranda districts.

Auriferous-Quartz Mines

Bourlamaque-Louvicourt District – Four gold mines operated in 1967. Chimo Gold Mines Limited suspended operations on its property in Vauquelin Township near Louvicourt in August. Sullivan Consolidated Mines, Limited suspended operations on its lode gold mine at Sullivan at the end of 1967. Production at Sigma Mines (Quebec) Limited and at Lamaque Mining Company Limited (Lamaque Division) remained unchanged from 1966.

Malartic District – Five lode mines operated in 1967. Production decreased at Barnat Mines Ltd. and at East Malartic Mines, Limited. The Little Long Lac Gold Mines Limited increased production by about 1,300 ounces to 2,577 ounces from its property adjoining Marban Gold Mines Limited. Camflo Mines Limited increased its production by 22.4 per cent while Marban Gold Mines Limited increased its production by 32.6 per cent. Kiena Gold Mines Limited produced 1,402 ounces of gold from ore stockpiled in 1965 which was milled by Malartic Gold Fields (Quebec) Limited. Malartic Gold Fields also custom mills ore from Camflo, Barnat, Marban and Little Long Lac.

Chibougamau District – Production from Norbeau Mines (Quebec) Limited, the only lode gold producer in the area, decreased by 26.3 per cent.

Noranda District – Production from Wasamac Mines Limited, the only lode gold mine producer in the area in 1967 decreased by about 7.3 per cent.

ONTARIO

Twenty-one lode gold mines operated in the province in 1967 compared with twenty-five in 1966. Two of the mines amalgamated to form a new company. One lode mine started operations. One company operated on the re-treatment of old mill tails.

Auriferous-Quartz Mines

Kirkland Lake District – Three lode gold mines operated in this district in 1967. In addition, Lake

GOLD PRODUCERS AND PROSPECTIVE PRODUCERS, 1967

(numbers refer to numbers on the map)

NEWFOUNDLAND

1 Atlantic Coast Copper Corporation Limited (a)
Consolidated Rambler Mines Limited (a)
First Maritime Mining Corporation Limited (a)
2 American Smelting and Refining Company (Buchans Unit) (a)

NEW BRUNSWICK

3 Cominco Ltd. (Wedge Mine) (a)
Heath Steele Mines Limited (a)

QUEBEC

4 Gaspé Copper Mines, Limited (a)
5 Solbec Copper Mines, Ltd. (a)
Cupra Mines Ltd. (a)
6 New Calumet Mines Limited (a)
7 *Chibougamau District*
Campbell Chibougamau Mines Ltd. (a)
Merrill Island Mining Corporation, Ltd. (a)
Norbeau Mines (Quebec) Limited (b)
Opemiska Copper Mines (Quebec) Limited (a)
The Patino Mining Corporation (Copper Rand Mines Division) (a)
8 The Coniagas Mines, Limited (a)
9 *Noranda-Rouyn District*
Lake Dufault Mines, Limited (a)
Noranda Mines Limited (a)
Quemont Mining Corporation, Limited (a)
Wasamac Mines Limited (b)
Wasamac Mines Limited (#2 shaft) (b) (d)
Malartic District
Barnat Mines Ltd. (b)
Camflo Mines Limited (b)
East Malartic Mines, Limited (b)
Kiena Gold Mines Limited (b)
The Little Long Lac Gold Mines Limited (b)
Marban Gold Mines Limited (b)
Bourlamaque-Louvicourt District
Lamaque Mining Company Limited (b)
Manitou-Barvue Mines Limited (a)
Sigma Mines (Quebec) Limited (b)
Sullico Mines Limited (a)
Sullivan Consolidated Mines, Limited (b)
Duparquet District
Normetal Mining Corporation, Limited (a)
10 *Matagami District*
Mattagami Lake Mines Limited (a)
New Hosco Mines Limited (a)
Orchan Mines Limited (a)
11 *Belleterre District*
Lorraine Mining Company Limited (a)

ONTARIO

12 *Larder-Lake District*
Kerr Addison Mines Limited (b)
Kirkland Lake District
Lamaque Mining Company Limited (Teck Mining Division) (b)
Macassa Gold Mines Limited (b)
Oakdale Mines Limited (b) (d)
Upper Beaver Mines Limited (a)
Upper Canada Mines, Limited (b)
13 *Porcupine District*
Aunor Gold Mines Limited (b)
Dome Mines Limited (b)
Hallnor Mines, Limited (b)
Hollinger Consolidated Gold Mines, Limited (Hollinger) (b)
Hollinger Consolidated Gold Mines, Limited (Ross) (b)
McIntyre Porcupine Mines Limited (a) (b)
Pamour Porcupine Mines, Limited (b)
Preston Mines Limited (b)
14 *Sudbury Mining Division*
Falconbridge Nickel Mines, Limited (a)
The International Nickel Company of Canada, Limited (a)
15 Renabie Mines Limited (b)
Surluga Gold Mines Limited (b) (d)
16 *Port Arthur Mining Division*
Noranda Mines Limited (Geco Mine) (a)
17 Consolidated Mosher Mines Limited (b)
MacLeod-Cockshutt Gold Mines, Limited (b)
MacLeod Mosher Gold Mines Limited (b)
18 North Goldstream Mines Limited (a)
19 *Red Lake Mining Division*
Annco Mines Limited (b)
Campbell Red Lake Mines Limited (b)
Dickenson Mines Limited (b)
Madsen Red Lake Gold Mines Limited (b)
Wilmar Mines Limited (b)

MANITOBA

20 Hudson Bay Mining and Smelting Co., Limited (a)
21 Hudson Bay Mining and Smelting Co., Limited (Snow Lake) (a)
The International Nickel Company of Canada, Limited (Thompson Mine) (a)
22 San Antonio Gold Mines Limited (b)
23 Sherritt Gordon Mines, Limited (a)

SASKATCHEWAN

20 Hudson Bay Mining and Smelting Co., Limited (a)
24 Anglo-Rouyn Mines Limited (a)

BRITISH COLUMBIA

25 Cominco Ltd. (a)
26 The Granby Mining Company Limited (Phoenix Copper Division) (a)
27 Bethlehem Copper Corporation Ltd. (a)
28 The Anaconda Company (Canada) Ltd., (Britannia Mine) (a)
Texada Mines Ltd. (a)
29 Coast Copper Company, Limited (a)
30 Bralorne Pioneer Mines Limited (b)
31 Small placer operations (a)

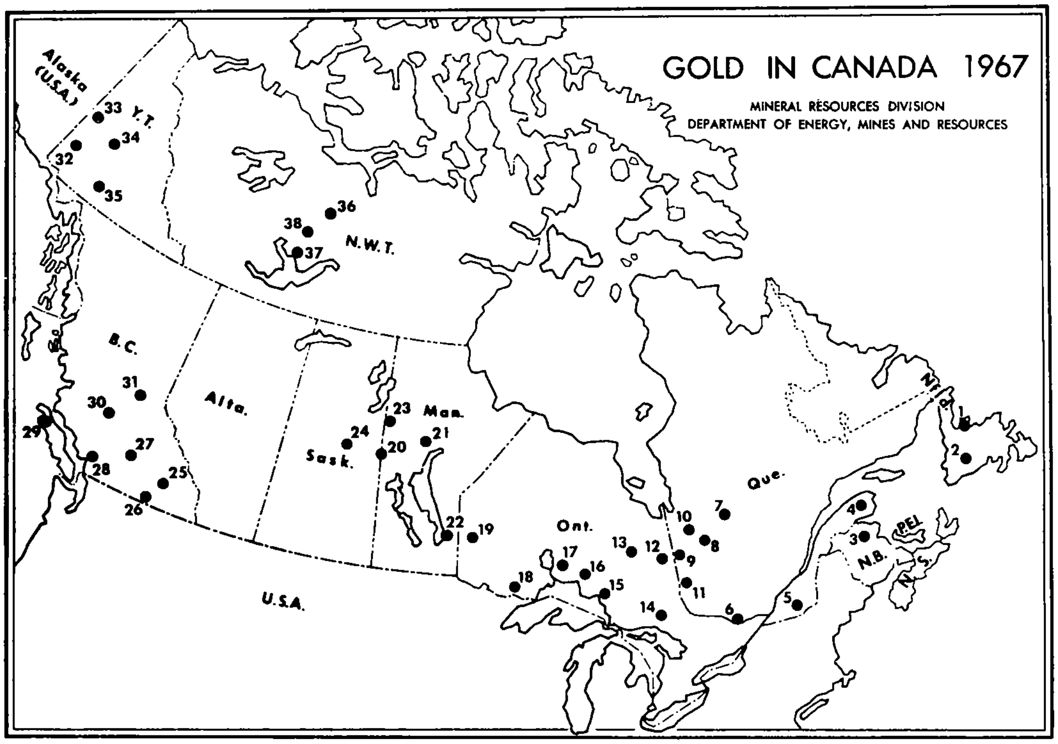
YUKON TERRITORY

32 Small placer operations (c)
33 Small placer operations (c)
34 Small placer operations (c)
35 New Imperial Mines Ltd. (a)

NORTHWEST TERRITORIES

36 Tundra Gold Mines Limited (b)
37 Cominco Ltd. (Con, Rycon and Vol mines) (b)
Giant Yellowknife Mines Limited (b)
Lolor Mines Limited (b)
Supercrest Mines Limited (b)
38 Discovery Mines Limited (b)

(a) Base metal; (b) Auriferous quartz; (c) Placer; (d) Prospective producer.



Shore Mines, Limited recovered gold from the retreatment of old tailings. This operation was discontinued in 1967. Production at Macassa Gold Mines Limited decreased in 1967. Lamaque Mining Company Limited, Teck Mining Division, increased production slightly during 1967. The mine was scheduled to close at the end of the year but was able to extend operations into 1968. Upper Canada Mines, Limited increased production slightly.

Larder Lake District – Kerr Addison Mines Limited increased production in 1967 about 6.6 per cent compared to 1966.

Porcupine District – Hollinger Consolidated Gold Mines, Limited operated throughout the year on a salvage basis at its main mine and production was substantially lower. The mine is expected to close early in 1968. McIntyre Porcupine Mines Limited continued to reduce the tonnage of gold ore treated as a greater tonnage of copper ore is milled. Gold production declined substantially. Aunor Gold Mines Limited, Dome Mines Limited and Hallnor Mines, Limited increased production slightly over 1966 while the production from Pamour Porcupine Mines, Limited and Preston Mines Limited declined slightly over that of 1966. With the exhaustion of economic ore, Preston Mines is expected to suspend operation in 1968. The Ross mine of the Hollinger Consolidated Gold Mines, Limited production declined about 15 per cent compared to that of 1966. The eight lode mines in production in 1967 produced about 13.5 per cent less gold than the operating lode gold mines in 1966.

Sudbury Mining Division – At Renabie Mines Limited, near Missinabie, production declined in 1967 compared to 1966.

Port Arthur Mining Division – The total gold production declined slightly over the 1966 production. Consolidated Mosher Mines Limited, MacLeod-Cockshutt Gold Mines Limited and Hard Rock Gold Mines, Limited situated near Geraldton, amalgamated in June 1967, to form MacLeod Mosher Gold Mines Limited.

Red Lake and Patricia Mining Division – Six lode gold mines operated in 1967, one less than in 1966. Wilmar Mines Limited produced a small amount of gold from its property adjacent to Cochenour Willans Gold Mines, Limited. The ore is mined through the extension of the Cochenour Willans workings. Dickenson Mines Limited production dropped substantially while Cochenour Willans Gold Mines, Limited had a moderate decline. Madsen Red Lake Gold Mines Limited and Annco Mines Limited produced about the same as in 1966. Campbell Red Lake Mines Limited's production increased slightly.

Base-Metal Mines

Byproduct gold was recovered from the copper-nickel ores of the Sudbury area and the zinc-copper mines at Manitouwadge. McIntyre Porcupine Mines Limited at Timmins and Upper Beaver Mines Limited near Kirkland Lake produced appreciable amounts of gold from copper-gold ores.

PRAIRIE PROVINCES

San Antonio Gold Mines Limited at Bissett, Manitoba, the only producing lode gold mine, continued operation in 1967 but production declined substantially.

Hudson Bay Mining and Smelting Co., Limited produced byproduct gold from its base-metal operations in the Flin Flon and Snow Lake areas. Sherritt Gordon Mines Limited at Lynn Lake, Manitoba produces a minor amount of gold. Anglo-Rouyn Mines Limited near Lac La Ronge in Saskatchewan, increased its production of byproduct gold. The International Nickel Company of Canada, Limited produced some byproduct gold from the nickel-copper ores in the Thompson Lake area of Manitoba.

TABLE 2

World Gold Production, 1965-66
(troy ounces)

	1965	1966
NORTH AMERICA		
Canada	3,606,031	3,319,474
United States	1,705,190	1,803,420
Nicaragua	198,152	199,108
Mexico	215,796	190,815
Other countries	11,125	9,393
Total	5,736,294	5,522,210
SOUTH AMERICA		
Colombia	319,362	275,267
Brazil	161,044	207,565
Peru	105,183	94,978
Bolivia	94,314	86,982
Chile	57,329	74,514
Other countries	43,602	38,664
Total	780,834	777,970
EUROPE		
USSR	5,030,000	5,370,000
Sweden	116,064	115,000
Yugoslavia	103,911	104,500
Other countries	107,641	91,115
Total	5,357,616	5,680,615
ASIA		
Philippines	435,545	452,672
Japan	264,842	254,345
Korea (including North Korea)	222,836	220,765
India	130,628	120,244
Other countries	110,184	115,703
Total	1,164,035	1,163,729
AFRICA		
Republic of South Africa	30,553,874	30,879,700
Ghana	755,191	684,395
Southern Rhodesia	544,100	550,000
Congo (Kinshasa)	90,408	158,632
Other countries	210,697	157,816
Total	32,154,270	32,430,543
OCEANIA		
Australia	924,392	912,385
Fiji	109,095	112,567
New Guinea	32,439	28,068
Other countries	12,501	9,003
Total	1,078,427	1,062,023
WORLD TOTAL	**46,271,476**	**46,637,090**

Source: US Bureau of Mines Minerals Yearbook, 1966; for Canada, Dominion Bureau of Statistics.

TABLE 3

Canadian Gold Production, 1958-67

Year	Auriferous Quartz Mines (troy ounces)	%	Placer Operations (troy ounces)	%	From Base-Metal Ores (troy ounces)	%
1958	3,928,187	85.9	71,955	1.6	571,205	12.5
1959	3,852,074	85.9	72,974	1.6	558,368	12.5
1960	3,930,366	84.9	80,804	1.7	617,741	13.4
1961	3,774,522	84.4	69,240	1.5	629,937	14.1
1962	3,494,821	83.6	57,760	1.4	625,815	15.0
1963	3,324,907	83.1	57,905	1.4	620,315	15.5
1964	3,151,593	82.2	58,512	1.5	625,349	16.3
1965	2,958,874	82.1	44,598	1.2	602,559	16.7
1966	2,676,381	80.6	43,369	1.3	599,724	18.1
1967p	2,424,070	81.2	9,352	0.3	552,670	18.5

Year	Total Production (troy ounces)	Total Value ($ Can.)	Average Value Per Ounce ($ Can.)	Gold as % of All Mineral Production Value
1958	4,571,347	155,334,370	33.98	7.4
1959	4,483,416	150,508,275	33.57	6.2
1960	4,628,911	157,151,527	33.95	6.3
1961	4,473,699	158,637,366	35.46	6.1
1962	4,178,396	156,313,794	37.41	5.5
1963	4,003,127	151,118,045	37.75	5.0
1964	3,835,454	144,788,388	37.75	4.3
1965	3,606,031	136,051,943	37.73	3.6
1966	3,319,474	125,177,364	37.71	3.1
1967p	2,986,092	112,719,424	37.75	2.6

Source: Dominion Bureau of Statistics and Mineral Resources Division.
p Preliminary.

A small amount of gold is recovered by gravel-washing operations on the North Saskatchewan River near Edmonton.

BRITISH COLUMBIA

Bralorne Pioneer Mines Limited is the only remaining lode gold mine in the province. Production increased 12 per cent in 1967 over that of 1966. The Cariboo Gold Quartz Mining Company, Limited ceased operations in 1967. A small amount of placer gold was produced, chiefly in the Cariboo district.

Byproduct gold production from base-metal mines increased in 1967 by 10.5 per cent. The Phoenix Copper Division of The Granby Mining Company Limited production was about the same as in 1966. Coast Copper Company, Limited production dropped substantially while Granisle Copper Limited, controlled by The Granby Mining Company Limited, production increased substantially to become one of the major byproduct producers in the province. Western Mines Limited which began operations late in 1966, contributed a relatively large amount of byproduct gold. Cominco Ltd. production declined in 1967.

NORTHWEST TERRITORIES

Production declined about 10.2 per cent from 1966. Giant Yellowknife Mines Limited, Discovery Mines Limited and Con mine of Cominco Ltd. had a substantial decline in production. Production from

Vol Mines Limited and Rycon Mines Limited, both controlled by Cominco, increased slightly. Production from Tundra Gold Mines Limited declined slightly. By the end of 1967, nearly all of the economic ore had been recovered and Tundra is expected to close early in 1968. Minor production came from Lolor Mines Limited and from Supercrest Mines Limited, both contiguous to and controlled by Giant Yellowknife Mines Limited. The ore is mined through extensions of the Giant Yellowknife Mines workings.

YUKON TERRITORY

With the closing of The Yukon Consolidated Gold Corporation, Limited in 1966, placer gold output in the Territory declined sharply in 1967. The Dawson, Mayo and Burwash areas contributed to the placer gold produced during 1967, with Dawson being the major producer.

NEW PROPERTY DEVELOPMENTS

QUEBEC

In 1967, Wasamac Mines Limited, near Noranda, continued a shaft sinking and development program on the gold property formerly owned by Francoeur Mines Limited. Plans are to bring this property into production in 1968 at a rate of about 500 tons of ore per day. The ore will be trucked about five miles to the Wasamac mill.

Eagle Gold Mines Limited, formerly Equity Explorations Limited, began sinking a 1,750-foot shaft on its gold property in the Joutel area in Northwestern Quebec. Production plans have not been completed.

ONTARIO

In 1967, Surluga Gold Mines Limited proceeded with underground development and with the construction of a 750-ton mill which is scheduled to start operating in June of 1968 on its gold property near Wawa.

MANITOBA

Agassiz Mines Limited, a gold property near Lynn Lake, is planning a shaft sinking and lateral development program scheduled to begin in early 1968.

YUKON TERRITORY

Arctic Gold and Silver Mines Limited, formerly Arctic Mining and Exploration Limited silver-gold property near Carcross began construction of a 300-ton mill scheduled to begin operation in August, 1968.

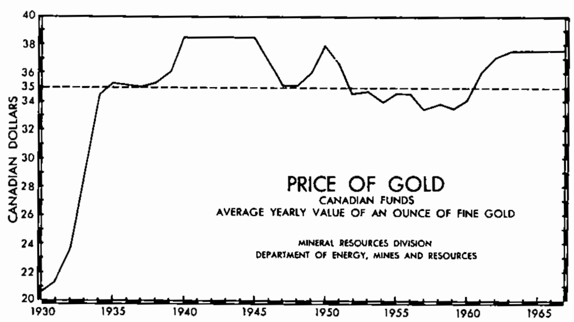
Mount Nansen Mines Limited prepared a silver-gold property near Carmacks for production. Milling operations are scheduled to begin in August, 1968 at a rate of 200 tons per day.

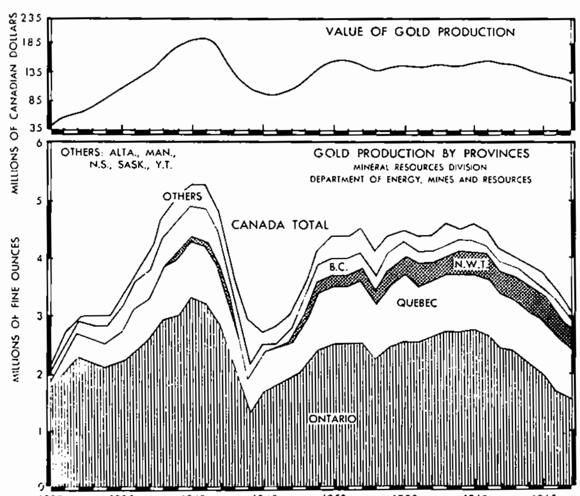
USES

Gold is principally used as a monetary reserve by governments and central banks to assist in the settlement of international trade balances.

However, the demand for gold for industrial uses, including the arts and jewellery manufactures, has greatly increased in recent years. The International Monetary Fund, in its annual report for 1967, estimated that the value of gold consumed in the world for industrial and artistic purposes increased from $520 million in 1964 to $560 million in 1965 and to $650 million in 1966.

About 75 per cent of the industrial use consists of the manufacture of jewellery and objects of art. The remainder is consumed in the electrical, electronic, chemicals, glass-making and textile fields and in various aerospace applications.





PRICES

The average price paid by the Royal Canadian Mint in 1967 was $37.75 per fine ounce. This compares with \$37.71 in 1966 and \$37.73 in 1965. During 1967, the price fluctuated between a low of \$37.56 and a high of \$37.91. The fixed value of the Canadian dollar is \$0.925 in terms of United States funds but a variation of one per cent either way is permitted. As a result of this tolerance, the Mint gold price could range from \$37.46 to \$38.22 per fine ounce.

Gypsum and Anhydrite

R.K. COLLINGS*

Canada has large, well located gypsum deposits–many containing gypsum of high purity. Deposits occur in all provinces except Prince Edward Island and Saskatchewan, and gypsum is produced in each of the remaining provinces with the exception of Quebec and Alberta. Nova Scotia annually accounts for 70 to 80 per cent of the total domestic production and ships most of its output to gypsum-product plants located along the eastern coast of the United States.

Domestic production of gypsum declined for the third consecutive year in 1967 with production dropping to 5.1 million tons. This decline is directly attributable to reduced activity in the building construction industry, the chief market for gypsum products. Exports of crude gypsum, practically all to the United States, declined over 16 per cent to 3.9 million tons in 1967. Imports also declined, from 86,000 tons in 1966 to 69,000 tons. Mostly from Mexico, this gypsum was largely to support a gypsum-products plant in the Vancouver area. Imports of finished products–prepared wall plaster and gypsum wallboard and lath–increased slightly to more than 10,000 tons valued at $563,000 in 1967.

Although domestic gypsum production has been declining during the last few years, this trend is not expected to continue. Housing shortage is still critical in many areas of Canada and the United States and efforts are being made by governments to rectify this situation. Efforts are being directed along two lines–new construction of large, multi-unit apartment buildings and the renovation of older, existing apartment buildings. Drywall construction utilizing gypsum wallboard, because it is both inexpensive and easily and rapidly installed, is the preferred method of finishing interior walls and ceilings in building construction and is widely used for this purpose.

Although many domestic gypsum deposits are very well located and reserves adequate, this is not the case in all areas of Canada, notably Quebec, Alberta, Saskatchewan and, to a lesser degree, British Columbia. The two gypsum-products plants in Montreal bring in crude from Nova Scotia, a Saskatchewan plant obtains crude from Manitoba and the two plants in Calgary obtain crude from British Columbia and Manitoba. Although gypsum deposits occur in Alberta, several of the more promising deposits are in national parks and, under present legislation, are not available for mining. One of the two gypsum-products plants in Vancouver obtains gypsum from a company-operated quarry in the southeastern part of British Columbia; the other imports its requirements from Mexico. The gypsum deposits in southeastern British Columbia are extensive but, although fairly close to the Calgary market, are distant from Vancouver. High transportation costs have to date deterred wider development of these deposits.

The gypsum-products plant at Saskatoon, built for BACM Industries Limited, formerly British-American Construction & Materials Limited, was officially opened in August. This marks the first production of gypsum products in that province. This modern, well-planned facility has only one gypsum calcining kettle, but space has been provided for a second when required. Crude gypsum for the Saskatoon plant is obtained from a company mine at Amaranth, Manitoba, approximately 400 miles from Saskatoon. At Amaranth, a 10-foot seam of gypsum is mined at a depth of 125 ft by the room and pillar system. Access is by way of a 10-ft diameter, 15° incline shaft.

*Mineral Processing Division, Mines Branch.

TABLE 1

Gypsum–Production and Trade 1966-67

	1966		1967p	
	Short Tons	$	Short Tons	$
Production (shipments)				
Crude gypsum				
Nova Scotia	4,502,836	8,140,651	3,727,829	7,100,355
Ontario	565,185	1,581,010	571,450	1,451,000
Newfoundland	459,685	1,173,401	374,672	936,680
British Columbia	206,026	576,873	225,000	675,000
Manitoba	134,225	427,211	133,770	353,510
New Brunswick	108,207	413,074	87,234	244,990
Total	5,976,164	12,312,220	5,119,955	10,761,535
Imports				
Crude gypsum				
Mexico	85,000	276,000	64,500	283,000
United States	894	32,000	4,575	42,000
Britain	19	1,000	37	2,000
Total	85,913	309,000	69,112	327,000
Plaster of paris and wall plaster				
United States	7,967	407,000	9,552	517,000
Britain	160	8,000	304	14,000
Other countries	10	1,000	14	2,000
Total	8,137	416,000	9,870	533,000
Gypsum lath, wallboard and basic products				
United States	641	17,000	434	30,000
Total imports gypsum and gypsum products		742,000		890,000
Exports				
Crude gypsum				
United States	4,672,518	8,327,000	3,896,128	7,323,000
Other countries	–	–	6	. . .
Total	4,672,518	8,327,000	3,896,134	7,323,000

Source: Dominion Bureau of Statistics.
pPreliminary; – Nil; . . . Less than one thousand dollars

The rapid expansion of Canada's phosphate fertilizer industry is resulting in the accumulation of large tonnages of byproduct, synthetic gypsum. Produced during the manufacture of phosphoric acid by the action of sulphuric acid on phosphate rock, this gypsum is finely divided and relatively impure. It is now produced in British Columbia, Alberta, Manitoba, Ontario, Quebec and New Brunswick. Production currently exceeds 2 million tons per year. Although essentially a waste material in Canada and the United States, byproduct synthetic gypsum is used for gypsum products manufactured in Japan, Britain and Germany. This material would be of interest where there are no natural gypsum deposits or where deposits are of poor quality and in such areas should be investigated as a possible source material for gypsum products manufacture. It is also of interest as a potential source of sulphur.

OCCURRENCES

Large surface and near-surface gypsum deposits occur in three of the Atlantic Provinces–in Nova Scotia, throughout the central and northern parts of the mainland and in Cape Breton Island; in the St. George's Bay area of southwestern Newfoundland; and in southeastern New Brunswick near Hillsborough.

TABLE 2

Gypsum Production, Trade and Consumption, 1958-67
(short tons)

	Production[1]	Imports[2]	Exports[2]	Apparent Consumption[3]
1958	3,964,129	108,038	2,898,230	1,173,937
1959	5,878,630	117,830	4,848,576	1,147,884
1960	5,205,731	60,011	4,273,668	992,074
1961	4,940,037	66,075	3,819,345	1,186,767
1962	5,332,809	69,947	4,162,997	1,239,759
1963	5,955,266	74,628	4,703,118	1,326,776
1964	6,360,685	80,940	5,057,253	1,384,372
1965	6,305,629	75,433	4,746,638	1,634,424
1966	5,976,164	85,913	4,672,518	1,389,559
1967[p]	5,119,955	69,112	3,896,134	1,292,933

Source: Dominion Bureau of Statistics.

[1]Producers' shipments, crude gypsum. [2]Includes crude and ground but not calcined. [3]Production plus imports minus exports.

[p]Preliminary.

TABLE 3

World Production of Gypsum 1966-67
(thousand short tons)

	1966	1967[p]
United States	9,647	8,782
France	5,512	5,600
Canada	5,976	5,120
Britain	4,804	5,000
USSR	4,850	..
Spain	3,142	..
Italy	3,638	4,000
Other countries	15,431	..
Total	53,000	53,000

Source: For 1966, US Bureau of Mines Minerals Yearbook, 1966; for 1967, US Bureau of Mines Commodity Data Summaries, January, 1968.
[p]Preliminary; .. Not available.

No gypsum occurrences are known in mainland Quebec but extensive deposits outcrop over large areas of the Magdalen Islands in the Gulf of St. Lawrence.

In Ontario, gypsum occurs in the Moose River area, south of James Bay, and in the Grand River area, south of Hamilton. The Moose River deposits are 15 to 20 feet thick and usually covered by 10 to 30 feet of overburden; the Grand River deposits occur at depths up to 200 feet and are generally thin.

Manitoba and Alberta have large gypsum deposits. The main occurrences in Manitoba are in the southern section of the province at Gypsumville, where a 30-foot thickness of gypsum is exposed; near Amaranth where 40 feet of gypsum with interbedded anhydrite occurs below 100 feet; and at Silver Plains, 30 miles south of Winnipeg, where gypsum occurs 140 feet below the surface. Gypsum occurs in Alberta in Wood Buffalo Park and is exposed along the banks of the Peace River between Peace Point and Little Rapids. It also is present along the banks of the Slave and Salt rivers north and west of Fort Fitzgerald and as narrow seams interbedded with anhydrite at a depth of 500 feet at McMurray in the northeastern section of the province. In addition, outcrops of gypsum have been found near Mowitch Creek, within the northern boundary of Jasper Park, and at the headwaters of Fetherstonhaugh Creek, near the Alberta-British Columbia border.

In British Columbia, deposits occur at Windermere, Mayook and Canal Flats, in the southeast; at Falkland near Kamloops; and near Loos in the east-central part.

Gypsum deposits have been found in the southern part of Yukon Territories, along the north shore of Great Slave Lake, along the banks of the Mackenzie, Great Bear and Slave rivers, and on several of the Arctic islands.

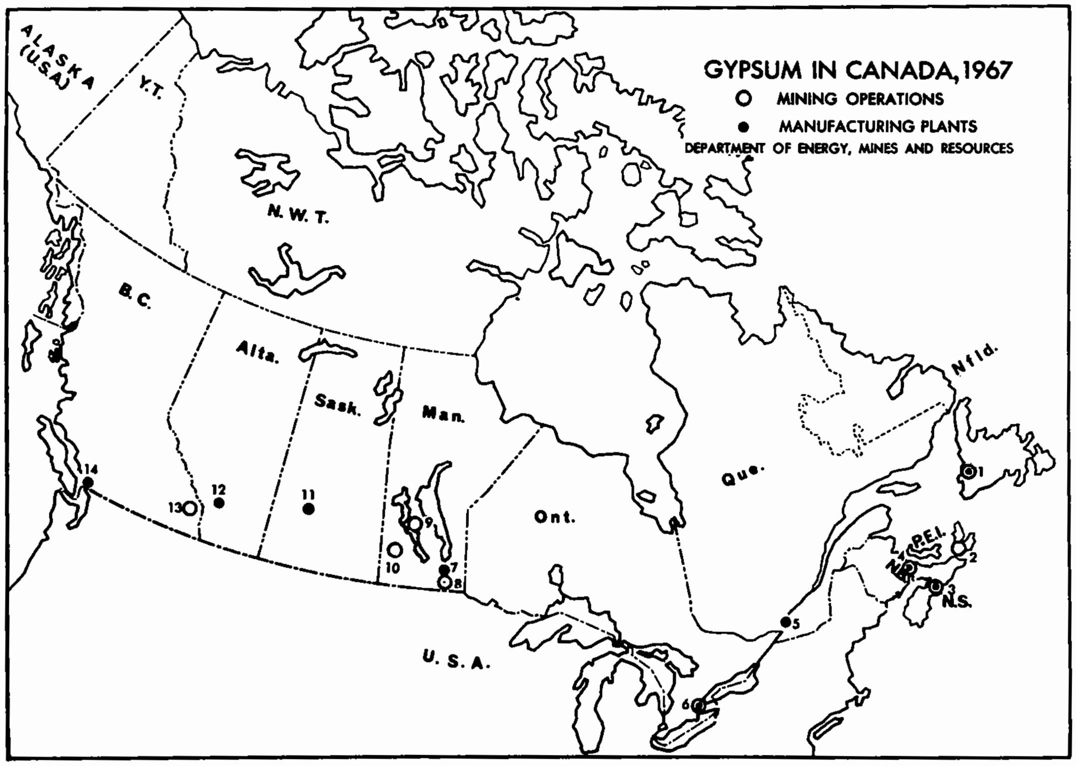
CURRENT OPERATIONS

NOVA SCOTIA

There are 5 companies actively producing gypsum in Nova Scotia. Production totalled 3.7 million tons in 1967, 73 per cent of the Canadian total. Over 90 per cent of the production of this province is exported to the United States.

Fundy Gypsum Company Limited, a subsidiary of United States Gypsum Company of Chicago, quarries gypsum for export at Wentworth and Miller Creek near Windsor. National Gypsum (Canada) Ltd., a subsidiary of National Gypsum Company of Buffalo, New York, quarries gypsum near Milford, 30 miles north of Halifax. Most is exported to company plants in the United States; however, some is used in Nova Scotia in cement manufacture and in Quebec in cement and gypsum products. Gypsum for export is also obtained at Walton, Hants County. Little Narrows Gypsum Company Limited, also a subsidiary of United States Gypsum Company, quarries gypsum at Little Narrows on Cape Breton Island, shipping crude rock to the United States and to Quebec and Ontario.

Domtar Construction Materials Ltd., with head offices in Montreal, operates a calcining plant at Windsor for the production of plaster of paris. Gypsum for this plant is obtained from deposits at McKay Settlement near Windsor. Georgia-Pacific Corporation, Bestwall Gypsum Division, quarries gypsum near River Denys, Inverness County. The crushed rock is carried by rail to Point Tupper, 20 miles from the quarry site, for shipment to the United States.



MINING OPERATIONS*

(numbers refer to numbers on map)

1. The Flintkote Company of Canada Limited, Flat Bay Station
2. Little Narrows Gypsum Company Limited, Little Narrows
   Georgia-Pacific Corporation, Bestwall Gypsum Division, River Denys
3. Fundy Gypsum Company Limited, Wentworth and Miller Creek
   National Gypsum (Canada) Ltd., Milford and Walton
   Domtar Construction Materials Ltd., McKay Settlement
4. Canadian Gypsum Company, Limited, Hillsborough
6. Canadian Gypsum Company, Limited, Hagersville (underground)
   Domtar Construction Materials Ltd., Caledonia (underground)
8. Western Gypsum Limited, Silver Plains (underground)
9. Domtar Construction Materials Ltd., Gypsumville
10. British-American Construction & Materials Limited, (BACM Industries Limited) Amaranth
13. Western Gypsum Mines Ltd., Windermere

MANUFACTURING PLANTS

1. Atlantic Gypsum Limited, Humbermouth
3. Domtar Construction Materials Ltd., Windsor
4. Canadian Gypsum Company, Limited, Hillsborough
5. Canadian Gypsum Company, Limited, Montreal
   Domtar Construction Materials Ltd., Montreal
6. Canadian Gypsum Company, Limited, Hagersville
   Domtar Construction Materials Ltd., Caledonia
   Western Gypsum Limited, Clarkson
7. Domtar Construction Materials Ltd., Winnipeg
   Western Gypsum Limited, Winnipeg
11. British-American Construction & Materials Limited, (BACM Industries Limited) Saskatoon
12. Domtar Construction Materials Ltd., Calgary
    Western Gypsum Limited, Calgary
14. Domtar Construction Materials Ltd., Port Mann
    Western Gypsum Limited, Vancouver

*Surface operations except where noted otherwise.

ONTARIO

Gypsum is mined from underground deposits at Caledonia, near Hamilton, by Domtar Construction Materials Ltd., and at Hagersville, southwest of Caledonia, by Canadian Gypsum Company, Limited. It is used in the manufacture of plaster and wallboard at company plants located near each mine.

NEWFOUNDLAND

Atlantic Gypsum Limited produces gypsum plaster and wallboard at Humbermouth, on the west coast of the island. This plant is managed by Lundrigans Limited of St. John's. Crude gypsum is obtained from deposits at Flat Bay Station, 60 miles southwest of Humbermouth, which are quarried by The Flintkote Company of Canada Limited. The bulk of the production from Flat Bay is transported by aerial conveyor to St. George's, 6 miles distant, where it is loaded on boats for export to company plants along the eastern coast of the United States. Part of the production is shipped to markets in Ontario and Quebec.

BRITISH COLUMBIA

Western Gypsum Mines Ltd., a subsidiary of Western Gypsum Limited, quarries gypsum near Windermere in the southeastern part of the province. The gypsum is shipped to company plants in Calgary and Vancouver and to Domtar Construction Materials Ltd. for use in its Calgary plant. Windermere gypsum is also used by cement plants in Alberta and British Columbia.

MANITOBA

Gypsum is quarried at Gypsumville, 150 miles northwest of Winnipeg, by Domtar Construction Materials Ltd. This gypsum is used at Winnipeg and Calgary for plaster and wallboard manufacture at company-owned plants.

Western Gypsum Limited obtains gypsum from an underground deposit near Silver Plains, 30 miles south of Winnipeg, for use in company-owned gypsum-products plants in Winnipeg and Calgary. The deposit is 140 feet below the surface.

As noted earlier in this review, BACM Industries Limited obtains gypsum from a mine at Amaranth for use in a newly constructed gypsum-products plant at Saskatoon. The seam mined is 125 feet below the surface.

NEW BRUNSWICK

Gypsum is quarried near Hillsborough by Canadian Gypsum Company, Limited, for plaster and wallboard manufacture at a company-owned plant at Hillsborough. Canada Cement Company, Limited, obtains gypsum from Havelock, west of Moncton, for cement manufacture at Havelock.

OTHER PROCESSING PLANTS

QUEBEC

Domtar Construction Materials Ltd. and Canadian Gypsum Company, Limited operate gypsum-products plants in Montreal East. Crude gypsum is obtained from Nova Scotia.

ONTARIO

Western Gypsum Limited produces gypsum products at Clarkson, southwest of Toronto. Crude gypsum is obtained from mines in southern Ontario.

ALBERTA

Domtar Construction Materials Ltd. and Western Gypsum Limited produce plaster and wallboard in Calgary. Gypsum is obtained from British Columbia and Manitoba.

BRITISH COLUMBIA

Domtar Construction Materials Ltd. and Western Gypsum Limited have plants in Vancouver for gypsum plaster and wallboard production. The former obtains crude gypsum from Mexico, the latter from its Windermere deposit.

USES

Gypsum, hydrous calcium sulphate ($CaSO_4.2H_2O$), is chiefly used for the production of calcined gypsum, or plaster of paris, which in turn is the main constituent used in manufacturing gypsum board and lath, gypsum tile and roof slabs, and all types of industrial plasters. Plaster of paris is mixed with water and aggregate (sand, vermiculite or expanded perlite) and applied over wood, metal or gypsum lath to form an interior wall finish. Gypsum board, lath and sheathing are formed by introducing a slurry consisting of plaster of paris, water, foam, accelerator, etc., between two sheets of absorbent paper, where it sets, producing a firm, strong wallboard. These products are used by the building-construction industry for sheeting interior walls and ceilings.

Crude uncalcined gypsum is used in the manufacture of portland cement. The gypsum acts as a retarder to control set. Reduced to 100 mesh or finer, crude gypsum is used as a filler in paint and paper. Ground gypsum is used to a small extent as a substitute for salt cake in glass manufacture. Powdered gypsum improves alkaline soils; aids in restoring impervious, dispersed soil; and is a fertilizer for peanuts.

ANHYDRITE*

Anhydrite, anhydrous calcium sulphate ($CaSO_4$), is commonly associated with gypsum. It is produced in Nova Scotia by Fundy Gypsum Company Limited at Wentworth; by Little Narrows Gypsum Company Limited at Little Narrows; and for National Gypsum (Canada) Ltd. by B.A. Parsons at Walton.

*Production and trade statistics for anhydrite are not reported separately by the Dominion Bureau of Statistics but are included with gypsum in the gypsum section of this review.

Production in 1967 was about 250,000 tons. Most of this was shipped to the United States for use in portland cement manufacture and as a fertilizer for peanut crops. Anhydrite also has a small application as a soil conditioner.

Gypsum and anhydrite are potential sources of sulphur compounds but are not utilized as such in Canada. In Europe, gypsum or anhydrite is calcined at a high temperature with coke, silica and clay to produce sulphur dioxide, sulphur trioxide and co-product cement. The gases are then converted into sulphuric acid.

TARIFFS

	British Prefer-ential (%)	Most Favoured Nation (%)	General (%)
CANADA			
Gypsum, crude . . .	free	free	free
Gypsum, ground, not calcined . . .	10	12-1/2	15
Gypsum wallboard and lath.	15	20	35
Plaster of paris and prepared wall plaster, per 100 lb	free	11¢	12-1/2¢

UNITED STATES

Gypsum, crude. . . .	free
Gypsum, ground or calcined per long ton.	$1.19
Gypsum wallboard and lath.	12-1/2%

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Indium

D.B. FRASER*

Indium occurs in minute quantities in certain ores of zinc, lead, tin, tungsten and iron. It is most commonly associated with sphalerite, the most abundant zinc mineral, and becomes concentrated in zinc residues and smelter slags formed during zinc and lead smelting operation. Indium is recovered commercially at only a few of the world's zinc and lead smelters.

Statistics on the production of indium are not available. Cominco Ltd., the only producer in Canada, recovers indium from zinc and lead metallurgical operations at Trail, British Columbia, and is one of the world's largest producers. Indium is recovered by two companies in the United States; it is recovered also in Peru, West Germany, Japan and USSR.

PRODUCTION

Indium was first recovered at Trail in 1941, though the presence of indium in the lead-zinc-silver ores of Cominco's Sullivan mine at Kimberley, British Columbia, had been known for many years. In the following year, 437 ounces were produced by laboratory methods. After several years of intensive research and development, production began in 1952 on a commercial scale. At present, the potential annual production at Trail is 1 million troy ounces, or about 35 tons.

Indium enters the Trail metallurgical plants with the zinc concentrates. In the electrolytic zinc process, indium remains in the zinc calcine during roasting and in the insoluble residue during leaching. The residue is then delivered to the lead smelter for recovery of contained lead and residual zinc. In the lead blast furnaces, the indium enters lead bullion and blast-furnace slag in about equal proportions. From the slag, it is recovered along with zinc and lead during slag-fuming. The fume is leached for recovery of zinc, and indium again remains in the residue, which is retreated in the lead smelter. From the lead bullion, indium is removed in bullion dross. The dross is retreated for recovery of copper matte and lead, and in this process a slag is recovered which contains lead and tin together with 2.5to 3.0 per cent indium.

The dross retreatment slag is reduced electro-thermally to produce a bullion containing lead, tin, indium and antimony, which is treated electrolytically to yield a high (20 to 25 per cent) indium anode slime. The anode slime is then treated chemically to give a crude (99 per cent) indium metal, which is refined electrolytically to produce a standard grade (99.97 per cent), or high-purity grades (approximately 99.999 and 99.9999 per cent) indium. The metal is cast in ingots varying in size from 10 ounces to 10 kilograms. Also produced are various alloys and chemical compounds of indium and a variety of fabricated forms such as disks, wire, ribbon, foil and sheet, powder and spherical pellets.

PROPERTIES AND USES

Indium is a silvery-white, soft metal that resembles tin in its physical and chemical properties. Its chief characteristics are its extreme softness, its low melting point and high boiling point. It is easily scratched with the fingernail and can be made to adhere to other metals by hand-rubbing. It has a melting point of

*Mineral Resources Branch.

156°C. Like tin, a rod of indium will emit a high-pitched sound if bent quickly. The metal has an atomic weight of 114.8; its specific gravity at room temperature is 7.31, which is about the same as that of iron.

Indium forms alloys with silver, gold, platinum and many of the base metals, improving their performance in certain special applications. Its first major use, still an important outlet, was in high-speed silver-lead bearings in which the addition of indium increases the strength, wettability and corrosion resistance of the bearing surface. Such bearings are used in aircraft engines, diesel engines and several types of automobile engines; the standard grade (99.97 per cent) is satisfactory for this purpose. Indium is used also in low-melting-point alloys containing bismuth, lead, tin and cadmium, in glass-sealing alloys containing about equal amounts of tin and indium, in certain solder alloys in which resistance to alkaline corrosion is required and in gold dental alloys.

A newer use of indium, probably the most extensive now, is found in various semiconductor devices. In these, high-purity indium alloyed in the form of disks or spheres into each side of a germanium wafer modifies the properties of the germanium. Indium is especially suitable for this purpose because it alloys readily with germanium at low temperatures and, being a soft metal, does not cause strains on contracting after alloying.

Discovered in 1863 but in commercial use only since 1934, indium and its compounds are relatively new materials whose potential applications are still being explored. Uses have been found in intermetallic semiconductors, electrical contacts, resistors, thermistors and photoconductors. Indium can be used as an indicator in atomic reactors since artificial radioactivity is easily induced in indium by neutrons of low energy. Indium compounds added to lubricants have been found to have a beneficial anticorrosive effect. Indium is used in certain very small lightweight batteries.

TRADE AND CONSUMPTION

No statistics are available on export, import or domestic consumption of indium. Much of Canada's output is exported to the US and Britain, and smaller amounts go to a number of countries in Europe.

PRICES

Prices of indium as quoted in *Metals Week* remained during 1967 at the levels that became effective on October 5, 1965:

Sticks, 30-90 troy oz	– \$2.75 a troy oz
Ingot	
100 troy oz	– \$2.30 a troy oz
10,000+ troy oz	– \$2.00 a troy oz

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in some countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Iron Ore

V.B. SCHNEIDER*

Iron ore shipments reached an all-time high of 37.8 million tons** in 1967, valued at $467 million. This was the sixth consecutive year that shipments increased; gains were made by all producing provinces – Newfoundland-Labrador, Quebec, Ontario and British Columbia. The performance of the Canadian iron ore industry was satisfactory if one considers the competitive nature of the international iron ore industry, the shipping strike by members of the Seafarer's International Union of Canada from August 17 to mid-September, and the decline in iron ore consumption in the United States of about 7 per cent from 1966.

Canadian iron ore exports were up about 2 per cent from those of 1966; exports in 1966 were 30.7 million tons valued at $369 million and in 1967 they were 31.4 million tons valued at $383 million. Exports to Italy, Britain and the Netherlands were higher, while those to the United States, France, West Germany and Japan were about the same or a little lower than in 1966.

Annual iron ore production capacity in Canada at the end of 1967 was 46 million tons, which included 21.43 million tons of pellet capacity. Iron ore shipments from both the head of the Great Lakes and via the St. Lawrence Seaway extended from April into December. Iron ore shipments via the St. Lawrence section of the Seaway amounted to 14.64 million tons, all upbound; iron ore shipments via the Welland Canal Section were 12.59 million tons upbound and 1.88 million tons downbound.

Falconbridge Nickel Mines, Limited announced that construction will begin in the spring of 1968 on a new $35-million reduction plant near Sudbury, Ontario. The plant is expected to go on stream late in 1969 and will produce about 300,000 tons annually of reduced iron ore pellets containing about 90 per cent iron and 1.5 per cent nickel. The new product, which can be charged directly into steelmaking furnaces, will be marketed primarily to alloy steel and stainless steel producers. Iron Ore Company of Canada expanded its pellet producing capacity at Labrador City from 5.5 million tons to 10 million tons.

In Ontario, Steep Rock Iron Mines Limited shipped 274,511 tons of pellets from its new plant at Atikokan. The Griffith Mine of The Steel Company of Canada, Limited (Stelco) at Bruce Lake was just about completed as was the Sherman Mine of Dominion Foundries and Steel, Limited (Dofasco) near Timagami. Both are expected to commence regular shipments of pellets early in 1968.

In British Columbia, Empire Development Company, Limited ceased production at its mine on Vancouver Island as did Orecan Mines Ltd. at its mine also on Vancouver Island.

CANADIAN DEVELOPMENTS IN 1967

NEWFOUNDLAND AND LABRADOR

Iron Ore Company of Canada (IOC), Labrador City: The annual capacity of the pellet plant at the Carol operation was expanded from 5.5 million tons to 10 million tons and that of the concentrator from 7 million tons to 10 million tons. Shipments of pellets and concentrates were 7,874,515 tons, of which 6,517,208 tons were pellets. In order to produce 10 million tons of pellets some 22.4 million tons of crude

*Mineral Resources Branch.
** The long or gross ton (2240 pounds) is used throughout unless otherwise noted.

TABLE 1

Canada, Iron Ore Production and Trade, 1966-67

	1966		1967p	
	Long Tons	$	Long Tons	$
Production (shipments)				
Newfoundland	14,773,383	188,603,259	14,965,024	210,025,224
Quebec	12,364,679	130,348,844	13,037,969	136,263,587
Ontario	7,271,687	91,700,740	7,812,847	99,144,399
British Columbia	1,921,254	21,006,240	1,972,019	21,630,124
Total	36,331,003	431,659,083	37,787,859	467,063,334
Byproduct iron ore*	1,003,487	. .	904,900	. .
Imports				
Iron ore				
United States	3,937,149	52,442,000	2,247,349	31,484,000
Brazil	327,853	3,145,000	108,609	1,062,000
Liberia	–	–	44,711	323,000
Other countries	58,119	437,000	–	–
Total	4,323,121	56,024,000	2,400,669	32,869,000
Exports				
Iron ore, direct shipping				
United States	6,033,833	61,887,000	6,017,640	62,675,000
Italy	548,898	5,296,000	525,038	4,888,000
Britain	274,859	2,612,000	14,777	142,000
Total	6,857,590	69,795,000	6,557,455	67,705,000
Iron ore concentrates				
United States	8,865,778	96,146,000	7,886,771	84,059,000
Britain	1,424,793	13,287,000	1,889,526	17,278,000
Japan	1,689,409	18,145,000	1,631,299	17,291,000
Netherlands	372,522	3,826,000	763,474	7,804,000
Italy	272,975	2,387,000	249,571	1,837,000
West Germany	532,353	3,225,000	86,097	627,000
Bahamas	–	–	5,000	46,000
Belgium and Luxembourg	83,885	674,000	–	–
Sweden	35,797	378,000	–	–
Total	13,277,512	138,068,000	12,511,738	128,942,000
Iron ore, agglomerated				
United States	8,896,733	135,203,000	9,176,244	138,629,000
Britain	521,820	7,880,000	961,687	14,406,000
Italy	311,925	5,175,000	864,660	12,963,000
Netherlands	161,132	2,329,000	495,320	7,370,000
West Germany	118,970	1,795,000	416,820	6,208,000
France	62,399	931,000	–	–
Austria	16	1,000	–	–
Total	10,072,995	153,314,000	11,914,731	179,576,000
Iron ore, not elsewhere specified including byproduct iron ore				
United States	485,605	7,831,000	422,528	6,838,000
West Germany	43	1,000	78	1,000
Total	485,648	7,832,000	422,606	6,839,000

TABLE 1 (Cont'd)

	1966		1967p	
	Long Tons	$	Long Tons	$
Total export, all classes				
United States	24,281,949	301,067,000	23,503,183	292,201,000
Britain	2,221,472	23,779,000	2,865,990	31,826,000
Italy	1,133,798	12,858,000	1,639,269	19,688,000
Japan	1,689,409	18,145,000	1,631,299	17,291,000
Netherlands	533,654	6,155,000	1,258,794	15,174,000
West Germany	651,366	5,021,000	502,995	6,836,000
Bahamas	–	–	5,000	46,000
Belgium and Luxembourg	83,885	674,000	–	–
France	62,399	931,000	–	–
Sweden	35,797	378,000	–	–
Austria	16	1,000	–	–
Total	30,693,745	369,009,000	31,406,530	383,062,000

Source: Dominion Bureau of Statistics.
*Total shipments of byproduct iron ore compiled by Mineral Resources Division from data supplied by individual companies. Total iron ore shipments include shipments of byproduct iron ore.
p Preliminary; – Nil; . . Not available.

ore must be mined and therefore, in addition to expanding the pellet plant and concentrator, a modest expansion in the open-pit mining operations was undertaken, mostly in the form of additional loading and hauling equipment.

Wabush Mines (Scully Mine): Wabush Mines commenced a program to expand its mining operations and concentrator annual capacity to 6 million tons. All production will be converted to pellets at Pointe Noire, Quebec. In 1967, 5,094,250 tons of concentrates grading 64.23 per cent iron (Fe) were shipped to the pelletizing plant and 4,961,169 tons of pellets and 12,940 tons of chips were shipped from Pointe Noire.

LABRADOR-QUEBEC

Iron Ore Company of Canada, Schefferville: IOC operated five open-pit mines in the Schefferville area of which the Redmond No. 1, in Labrador, was a new operation. The Gagnon, in Quebec, was not operated in 1966 but was reactivated in 1967. Stripping operations began at the Retty mine in Labrador and production is expected from it in 1968. In all, some 6.8 million tons were shipped from Schefferville to Sept-Iles during the year, slightly more than in 1966.

QUEBEC

Quebec Cartier Mining Company: Quebec Cartier shipped 8.2 million tons of specular hematite concentrate in 1967, only slightly less than in 1966. The company leased a site at its loading terminal at Port Cartier, to Louis Dreyfus Canada Ltd. which built a 10.6-million-bushel capacity grain elevator on the site. This means that one in four ships arriving for ore up-bound through the St. Lawrence Seaway can carry grain on its down-bound trip, taking into account the relative sizes of the grain and iron ore facilities.

TABLE 2

Canada, Iron Ore Production, Trade and Consumption, 1958-67
(long tons)

	Production (Shipments)	Imports	Exports	Con-sumption* (Indicated)
1958	14,041,360	3,047,301	12,391,314	4,697,347
1959	21,864,576	2,500,894	18,552,488	5,812,982
1960	19,241,813	4,514,596	16,942,140	6,814,269
1961	18,177,681	4,132,280	14,868,166	7,441,795
1962	24,428,282	4,604,819	21,645,758	7,387,343
1963	26,913,972	5,325,713	23,854,973	8,384,712
1964	34,219,484	5,233,434	30,473,701	8,979,217
1965	35,677,621	4,763,029	30,799,252	9,641,398
1966	36,331,003	4,323,121	30,693,745	9,960,379
1967p	37,787,859	2,400,669	31,406,530	8,781,998

Source: Dominion Bureau of Statistics.
* Shipments plus imports less exports with no account taken of changes in stocks at consuming plants.
p Preliminary.

The Hilton Mines: Hilton Mines, Ltd., a wholly-owned subsidiary of Pickands Mather & Co., is the managing agent for this operation. Shipments totalled 911,396 tons in 1967 of which 874,371 were pellets and the remainder were chips, and concentrate which is used as heavy media. Some 500,000 tons of pellets were shipped to Canadian consumers and the remainder was exported to the United States.

Quebec Iron and Titanium Corporation: Quebec Iron and Titanium Corporation mines ilmenite, a titanium-iron oxide, at Lac Tio, Quebec, and smelts it in electric furnaces at Sorel, Quebec, to produce titania slag (70-72 per cent TiO_2) and pig iron. Consumption of ilmenite at Sorel was 1,109,169 tons from which 546,538 tons of slag and 372,544 tons of pig iron were produced. This is an increase in pig iron production of 15 per cent from 1966 and is an all-time high.

ONTARIO

Algoma Ore Division of The Algoma Steel Corporation, Limited: Algoma shipped 1.6 million tons in 1967, nearly all as sinter; about 1.4 million tons were shipped to Algoma Steel's plants in Canada and the balance was exported to the United States. During the year, 2.7 million tons of siderite, grading 32.52 per cent iron (Fe), were mined of which 325,972 tons came from the Sir James open-pit mine, 2.4 million tons from the George W. MacLeod underground mine and 52,517 tons from the company's new Ruth & Lucy open-pit mine, 5 miles northeast of the MacLeod mine.

Production ceased at the Sir James open-pit mine in 1967 after a total of 7.6 million tons of ore had been removed since mining started in 1958. A modified underground development at the Sir James Mine started in 1966 and has progressed to the point where it can be brought into production, in a minimum of time, when required.

Caland Ore Company Limited: Caland shipped 2,184,897 tons of which 971,167 tons were pellets and the remainder was coarse concentrates. Most of its shipments went to its parent company, Inland Steel Company, in the United States. The 50-per-cent increase from 1966 shipments was mainly due to an increase in pellet production from 452,696 tons in 1966. Annual pellet capacity is now 1 million tons a year.

Adams Mine (Jones & Laughlin Mining Company, Ltd.): Adams Mine shipped 1,086,008 tons of pellets, all to its parent company's steel plants in the United States. It was an increase of 10 per cent from shipments in 1966. Pellet-producing capacity is 1 million tons a year and shipments are made the year-round by rail. The company expects shipments in 1968 to be at least equal to those in 1967.

Marmoraton Mining Company, Ltd., Division Bethlehem Chile Iron Mines Company: Marmoraton shipped 453,432 tons of pellets in 1967. The company shipped 448,960 tons by boat from its shipping terminal at Picton, Ontario, where the shipping season extended from April 9 to December 10. The remaining 4,472 tons were shipped by rail from Marmora to Lackawanna, N.Y.

National Steel Corporation of Canada, Limited: Shipments of pellets at 646,023 tons were up slightly from 1966. All shipments were to its parent company's steel plants in the United States.

Steep Rock Iron Mines Limited: Steep Rock's shipments in 1967 amounted to 1,164,671 tons with most of them going to The Algoma Steel Corporation, Limited. Steep Rock's new pellet plant began production in September 1967 and by the end of the year had produced 274,511 tons of pellets grading 64.34 per cent Fe. Built at a cost of $26 million, the plant has an annual rated capacity of 1.35 million tons of pellets.

The company's Roberts open pit, which began production in 1962, was the source of all ore mined in 1967 but future plans call for open-pit mining of both the Roberts and Hogarth orebodies. The "C" ore zone in the East Arm of Steep Rock Lake is under lease to the Inland Steel Company of Chicago, through its Canadian subsidiary, Caland Ore Company Limited; during 1967 Caland mined 2,326,102 tons of royalty ore.

The Griffith Mine (Stelco): Construction of the new concentrator and pelletizing plant was just about completed in 1967 at this property near Bruce Lake. The plant has an annual capacity of 1.5 million tons of pellets and production is expected to reach rated capacity during 1968. The pellets will be shipped by rail to Port Arthur and then by boat to Stelco's Hilton Works at Hamilton, Ontario. Cost of the project was $62 million. The ore is mined from an open pit.

The Sherman Mine (Dofasco): Preparation for mining was completed at the Sherman Mine property near Timagami in 1967 and it is expected that the pellet plant will be operating at its rated capacity of 1.0 million tons annually early in 1968. The mine's output will be shipped in specially designed tank cars in 35-car unit trains to Dofasco's steel plant in Hamilton, Ontario. The first train load of pellets was scheduled for March 1968. This is an open-pit operation.

BRITISH COLUMBIA

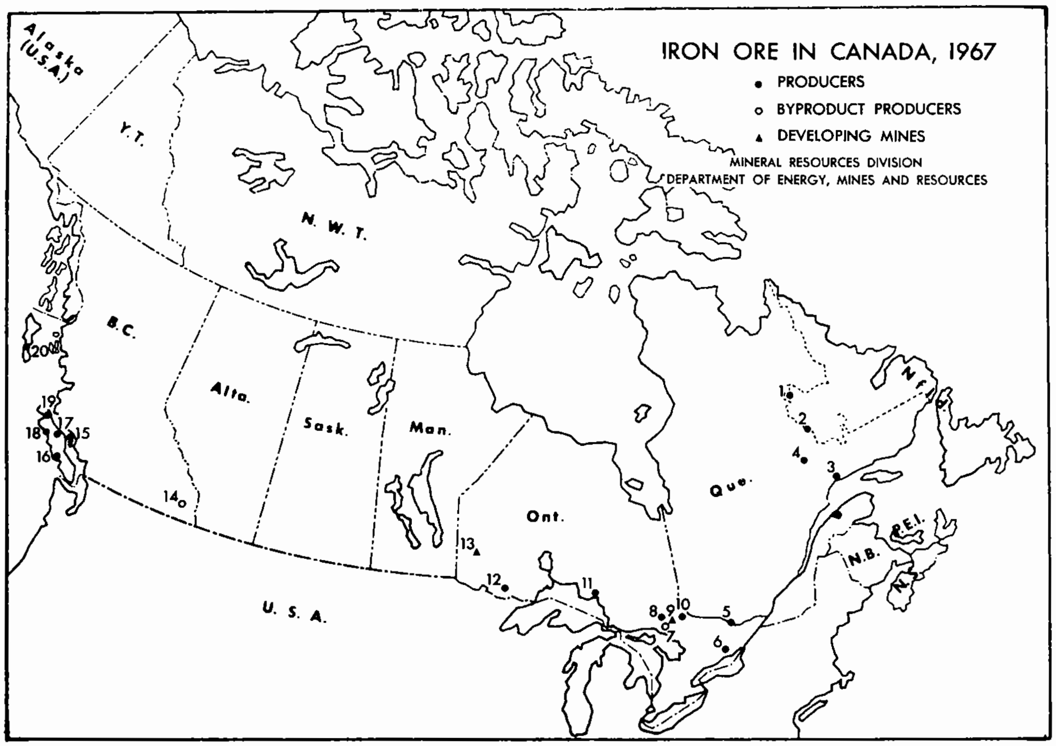
Brynnor Mines Limited, Kennedy Lake Division: This mine was still being affected by a labour strike that began in July 1966. Magnetic concentrate was shipped to Japan at an annual rate of 500,000 tons until July 1966. During 1967 a total of 326,383 tons of ore were mined from which 141,657 tons of concentrate containing 63 per cent Fe were produced and 122,525 tons were shipped to Japan.

Coast Copper Company, Limited: Shipments of 91,780 tons of magnetite concentrate were 65,600 tons more than in 1966. The magnetite concentrate is recovered at the company's Benson Lake property as a byproduct of copper recovery operations. Annual rated capacity is 112,000 tons and all shipments are contracted for by Japanese customers. This is an underground mining operation.

Empire Development Company, Limited: Empire Development ceased production at its mine on Vancouver Island on August 15 due to exhaustion of iron ore reserves. All shipments went to Japan.

Jedway Iron Ore Limited: Jedway shipped 396,722 tons of concentrates from its open-pit and underground mining operations on Moresby Island. Due to the exhaustion of its orebodies, the mine is expected to close early in 1968. All of the company's concentrates are shipped as sinter feed to Japan.

Texada Mines Ltd.: Texada Mines Ltd. (a private company) was acquired in 1967 by Kaiser Aluminum & Chemical Corporation. In 1967, Texada shipped 680,448 tons of concentrate of which about 95 per cent came from underground workings and the remainder from an open-pit operation. All the concentrates were shipped to Japan.



PRODUCERS

(numbers refer to numbers on map)

1. Iron Ore Company of Canada
2. Iron Ore Company of Canada, Wabush Mines
3. Arnaud Pellets
4. Quebec Cartier Mining Company
5. Hilton Mines, Ltd.
6. Marmoraton Mining Company, Ltd.
8. National Steel Corporation of Canada, Limited
10. Jones & Laughlin Mining Company, Ltd. (Adams Mine)
11. The Algoma Steel Corporation, Limited, Algoma Ore Division
12. Caland Ore Company Limited
    Steep Rock Iron Mines Limited
15. Texada Mines Ltd.
16. Brynnor Mines Limited
17. Orecan Mines Ltd.
18. Zeballos Iron Mines Limited
19. Empire Development Company, Limited
20. Jedway Iron Ore Limited, Wesfrob Mines Limited

BYPRODUCT PRODUCERS

7. Falconbridge Nickel Mines, Limited
   The International Nickel Company of Canada, Limited
14. Cominco Ltd.
19. Coast Copper Company, Limited

PROSPECTIVE PRODUCERS

9. The Sherman Mine (1968)
13. Griffith Mine (1968)

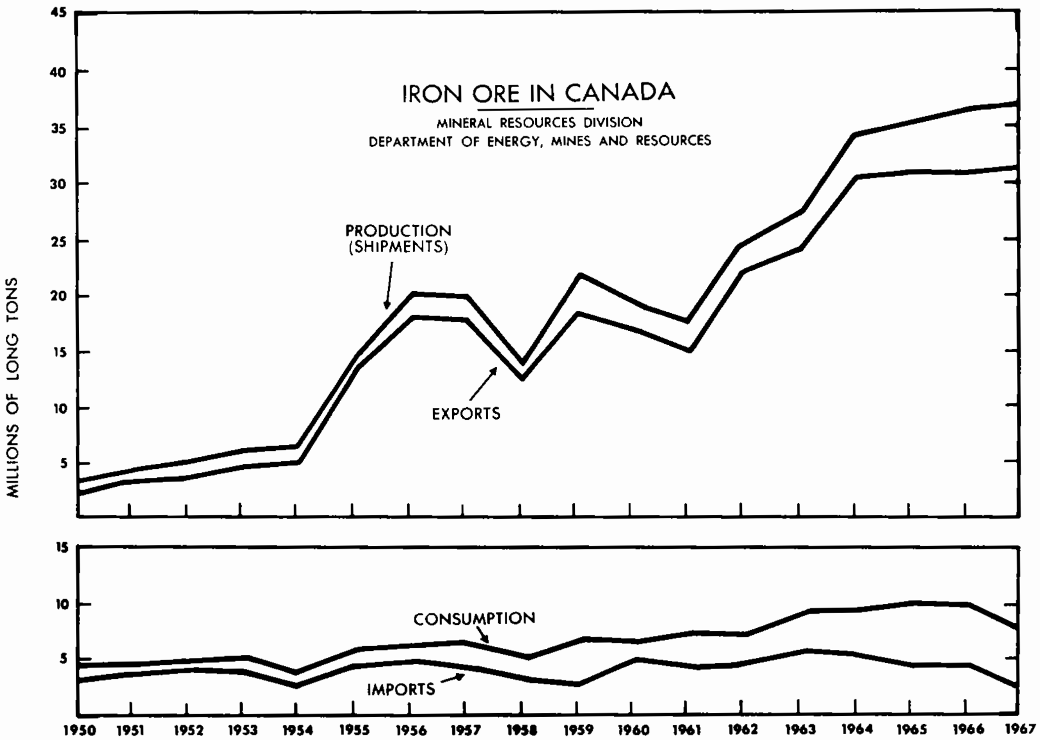


TABLE 3

Consumption of Iron Ore in Canadian Iron and Steel Plants, by Type of Furnace, 1966-67
(tons)

	1966	1967
In blast furnaces direct	8,001,746	7,654,696
In steel furnaces direct	256,515	192,480
In sintering plants before ore is charged to blast or steel furnaces	1,104,562	948,053
Miscellaneous	388	444
Total	9,363,211	8,795,673

Source: American Iron Ore Association compiled from company submissions.

Wesfrob Mines Limited: Wesfrob officially opened its copper and iron ore mine and plant at Tasu in the Queen Charlotte Islands on June 19. Ore is mined from an open-pit operation and annual rated capacity of iron ore is 400,000 tons of sinter feed concentrate and 550,000 tons of pellet feed concentrate. Shipments in 1967 amounted to 156,130 tons of sinter feed concentrate and 52,350 tons of pellet feed concentrate. A 10-year contract has been signed with Mitsubishi, one of Japan's leading trading companies, for Wesfrob's entire iron ore production.

TABLE 4

Consumption and stocks of Iron Ore at Canadian Iron and Steel Plants, by Source, 1966-67
(tons)

	1966	1967
Receipts imported	4,282,295	2,442,405
Receipts from domestic sources	5,293,265	5,945,948
Total receipts at iron and steel plants	9,575,560	8,388,353
Consumption of iron ore	9,363,211	8,795,673
Stocks of ore at iron and steel plants, December 31	4,065,764	3,751,314
Change from previous year	+251,230	-314,450

Source: American Iron Ore Association compiled from company submissions.

TABLE 5

Production and Capacity of Pig Iron and Crude Steel at Canadian Iron and Steel Plants, 1966-67
(short tons)

	1966	1967[p]
Pig iron		
Production	7,212,543	6,940,374
Capacity at December 31	7,764,000	9,276,000
Steel ingots and castings		
Production	10,002,868	9,694,371
Capacity at December 31	12,181,226	12,894,075

Source: Dominion Bureau of Statistics.
[p] Preliminary.

Zeballos Iron Mines Limited: Shipments totalled 218,845 tons, all as concentrates from underground mining operations, compared with 289,093 tons in 1966. Concentrates are all exported to Japan.

WORLD PRODUCTION, MARKETS AND TRADE

World production of iron ore in 1967 amounted to some 623 million long tons, an increase of 12 million tons, or 2 per cent above that of 1966. This increase followed the trend in production of crude steel as world production increased to some 535 million net tons from 519 million net tons in 1966. Countries with significant growth in steel production included Japan where production rose nearly 30 per cent to 68 million tons, Italy where output rose 19 per cent to just under 18 million tons, and the USSR where output increased by 6 per cent to 113 million tons. Production of crude steel fell 5½ per cent in the United Statesto just under 127 million net tons and 1.5 per cent in Britain to 26.8 million tons.

TABLE 6

Canadian Producers of Iron Ore During 1966 and 1967

Company and Property Location	Participating Companies	Product Mined and/or Produced (Average natural grade % Fe)	Product Shipped (Average natural grade % Fe)	Shipments[1] ('000 long tons) 1966	1967
The Algoma Steel Corp., Ltd., Algoma Ore Division; mines and sinter plant near Wawa, Ont.	Wholly owned	Siderite (30.4-32.9% Fe)	Beneficiated ore, sintered (50.4% Fe, 2.9 Mn)	1,793	1,572
Brynnor Mines Ltd.; near Ucluelet, Vancouver Island, B.C.	Noranda Mines Ltd.	Magnetite (54% Fe)	Magnetite concentrate (63% Fe)	287	123
Caland Ore Co. Ltd.; E. Arm of Steep Rock Lake, near Atikokan, Ont.	Inland Steel Co.	Hematite and goethite (53.8% Fe)	Pellets and concentrate (61.52% Fe & 56.3-58.1% Fe)	1,445	2,185
Carol Pellet Company; adjacent to IOC's concentrator, Labrador City, Labrador	US participants in IOC	Company's plant operated by IOC, to process IOC concentrate	Pellets & concentrate (64.32% Fe & 62.78% Fe)	5,214[p] 2,017[c]	6,517[p] 1,357[c]
Coast Copper Co., Ltd.; Benson L., northern Vancouver Is., B.C.	Cominco Ltd.	Copper ore, containing 33.3% Fe, as magnetite by-product, underground mine	Magnetite concentrate (64.0% Fe Dry)	66	92
Dosco Industries Limited, Wabana Mines Division; Bell Island E. coast of Nfld.[3]	Wholly owned subsidiary of Dominion Steel and Coal Corporation, Limited	Hematite-chamosite (48.82% Fe)	Heavy media concentrate (50.3% Fe)	136	–
Empire Development Co., Ltd.; Benson R., 25 miles S.W. of Port McNeill, Vancouver Is., B.C.[3]	Loram Ltd., (35%) Quatsino Copper-Gold Mines, Ltd. (40%) and others	Magnetite (31.3% Fe)	Magnetite concentrate (55.69% Fe)	59	. .

TABLE 6 (Cont'd)

Company and Property Location	Participating Companies	Product Mined and/or Produced (Average natural grade % Fe)	Product Shipped (Average natural grade % Fe)	Shipments[1] ('000 long tons) 1966	1967
Hilton Mines, Ltd.; near Shawville, Que., 40 miles N.W. of Ottawa	The Steel Co. of Canada, Ltd.; Jones & Laughlin Steel Corp.; Pickands Mather & Co.	Magnetite (35.19% Fe)	Pellets (66.74% Fe)	816	911
Iron Ore Company of Canada (IOC); Schefferville, Que.	The Hanna Mining Co.; Hollinger Consolidated Gold Mines, Ltd.; Labrador Mining and Exploration Co. Ltd., Armco Steel Corp.; Bethlehem Steel Corp.; National Steel Corp.; Republic Steel Corp.; Wheeling Steel Corp.; The Youngstown Sheet and Tube Co.	Geothetite-limonite (53.6% Fe)	Direct-shipping ore (54.1% Fe)	6,653	6,516
Jedway Iron Ore Ltd.; Moresby Island, Queen Charlotte Is., B.C.	The Granby Mining Co. Ltd.	Magnetite (36.6% Fe - estimated)	Magnetite concentrate (60.3% Fe)	478	397
Jones & Laughlin Mining Co., Ltd. (Adams Mine); Boston Twp., near Kirkland Lake, Ont.	Jones & Laughlin Steel Corp.	Magnetite (19.5% Fe)	Pellets (64.25% Fe)	985	1,086
National Steel Corporation of Canada, Ltd.; Sudbury area, 20 miles north of Capreol, Ont.	National Steel Corp.; The Hanna Mining Co. (managing agents)	Magnetite	Pellets (63.62% Fe)	630	646
Marmoraton Mining Co., Ltd., Division of Bethlehem Chile Iron Mines Company; near Marmora, Ont.	Bethlehem Steel Corp.	Magnetite (44.5% Fe)	Pellets (65.67% Fe)	496	453
Orecan Mines Ltd.; Menzies Bay, Vancouver Island, B.C.[3]	Public Stock Company	Magnetite (45% Fe)	Magnetite concentrate (62% Fe)	113[e]	. .
Quebec Cartier Mining Co.; Gagnon, Quebec	United States Steel Corp.	Specular hematite-magnetite (34.5% Fe)	Specular hematite concentrate (64.69% Fe)	8,319	8,245
Steep Rock Iron Mines Ltd.; Steep Rock Lake, N. of Atikokan, Ont.	Premium Iron Ores Ltd. The Cleveland-Cliffs Iron Co., and others	Hematite-goethite	Concentrate and pellets (53.9-57.2% Fe & 64.57% Fe)	1,236	890[c] 275[p]
Texada Mines Ltd.; Texada Island, B.C.	Kaiser Aluminum & Chemical Corp.	Magnetite (23.7% Fe)	Concentrate (61.46% Fe)	515	680
Wabush Mines, Scully Mine and Pointe Noire; Pickands Mather & Co. Managing agents; Wabush, Lab. and Pointe Noire, Quebec	The Steel Co. of Canada, Ltd.; Dom. Foundries and Steel, Ltd.; Wabush Iron Co. Ltd. (The Youngstown Sheet and Tube Co.;	Specular hematite-magnetite (33.9% Fe)	Pellets (64.24% Fe)	3,838	4,974

TABLE 6 (Cont'd)

Company and Property Location	Participating Companies	Product Mined and/or Produced (Average natural grade % Fe)	Product Shipped (Average natural grade % Fe)	Shipments[1] ('000 long tons) 1966	1967
	Inland Steel Co.; Interlake Steel Corp.; Pittsburgh Steel Co.; Finsider of Italy and Pickands Mather & Co.)				
Wesfrob Mines Limited; Tasu Harbour, Moresby Is., Queen Charlotte Is., B.C.	Falconbridge Nickel Mines, Limited	Magnetite and chalcopyrite (32% Fe)	Magnetite concentrate (66% Fe) for sintering and pelletizing	–	208
Zeballos Iron Mines Ltd.; near Zeballos, Vancouver Is., B.C.	Falconbridge Nickel Mines, Limited	Magnetite (38.23% Fe)	Concentrate (59.78% Fe)	289	219
BYPRODUCT PRODUCERS					
Cominco Ltd.; Kimberley, B.C.	Wholly owned	Pyrrhotite flotation concentrates roasted for acid production. Calcine sintered (61.1% Fe)	Iron oxide sinter (62.2% Fe) is further reduced into pig iron at plant	136	151
Falconbridge Nickel Mines, Limited, Falconbridge, Ont.	Wholly owned	Pyrrhotite flotation concentrates treated	Calcine	90	65
The International Nickel Co. of Canada, Ltd.; Copper Cliff, Ont.	Wholly owned	Pyrrhotite flotation concentrates treated	Pellets	687	708
Quebec Iron and Titanium Corp.; mine at Lac Tio, Que.; electric smelter at Sorel, Que.	Kennecott Copper Corp.; Gulf & Western Industries, Inc. (The New Jersey Zinc Co.)	Ilmenite-hematite (40% Fe, 35% TiO_2)	TiO_2 slag, and various grades of desulphurized pig iron or remelt iron	951[2]	1,092[2]

Source: Company reports, personal communication and others.
1. Statistics supplied by companies to Mineral Resources Division. 2. Ilmenite consumed. 3. No longer operating.
– Nil; [e] Estimated; [c] Concentrate; [p] Pellets; . . not available.

Pellet capacity in Canada as of December 1967 was 21.43 million tons and in the United States it was 51.05 million tons; world pellet capacity is estimated at 84.35 million tons. Pellet plants under construction in Canada will add an additional 3.8 million tons to capacity, bringing the Canadian total to 25.2 million tons early in 1968. Long-range projections of world growth in pellet-production capacity are subject to much questioning and speculation though the trend toward using high-grade, sized feed for blast furnaces remains strong. More companies are also announcing increased interest in using partially reduced pellets.

Trends in international iron ore trading patterns are important to the Canadian iron ore industry because of its dependence on exports for the bulk of its sales. United States, Britain, Japan and Western Europe constitute Canada's largest present and potential export markets. The domestic market, presently about 9 million tons a year, is supplied mostly by Canadian sources. The participation of Canada's largest steel producer in United States iron ore mines predates the modern iron ore industry in Canada, which started in 1939 with the revival of operations at the site of the Helen Mine at Michipicoten, Ontario.

TABLE 7

World Production of Iron Ore* by Country, 1964-67
(thousand long tons)

	1964	1965	1966	1967p
USSR	143,695	150,584	158,458	. .
United States	84,836	87,842	91,089	83,000
France	59,971	58,585	54,778	48,000
Canada	34,219	35,678	36,331	37,789
China	36,400	38,400	30,511	. .
Sweden	26,116	29,019	27,541	28,000
India	14,646	16,634	28,768	27,500
Venezuela	15,403	17,125	17,480	17,500
Liberia	10,291	15,707	16,732	. .
Britain	16,068	15,413	13,661	11,000
Brazil	14,763	17,220	17,913	20,000
Chile	9,697	11,229	12,106	. .
West Germany	11,430	10,676	9,318	8,000
Total	477,535	504,112	514,686	. .
Other countries	88,878	102,369	94,314	. .
World total	566,413	606,481	609,000	622,900e

Sources: For 1964-66, American Iron and Steel Institute Report, 1966.
For 1967, United States Bureau of Mines Commodity Data Summaries, January 1968.

* Direct shipping, concentrates and agglomerates.

p Preliminary; . . Not available; e Estimated.

From a small exporter in 1950 Canada became the world's leading exporter of iron ore in 1963, a position maintained through 1967. Canada is by far the largest supplier to the United States followed by Venezuela, Liberia and Brazil. It is the second largest supplier to Britain after Sweden; Britain consumes increasing tonnages of pellets each year, most of which come from Canada.

After the United States, Japan is the world's second largest iron ore importer and its sources are many. Japanese ore requirements have increased rapidly in recent years and new sources are continually being sought with Australia becoming Japan's major supplier in 1967. Other major suppliers are India (including Goa), Malaysia, Chile and Peru. In 1967 Australia exported an estimated 7.8 million tons of iron ore to Japan. According to the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development, Australia, the various projects under way have export contracts amounting to some 455 million tons to be fulfilled during the next 25 years. Some contracts are of long duration and others are as short as 3 years, but the average exports from 1970 on, based on existing contracts, could well increase to 26 million tons a year.

TRANSPORTATION

OCEAN TRANSPORT

Little definitive information has been available on the cost of transporting iron ore in ocean or lake carriers. Trade and marine transport journals list rates for ocean and lake routes but in nearly all cases these rates have little relation to the actual rates because they are for single charter or short charter terms whereas most iron ore is carried in either company-owned vessels or in vessels that are under long-term lease to the iron ore company. The true transport rates are therefore difficult to determine because they are, of course, not made public.

TABLE 8

Companies Under Development with Announced Plans for Production

Company and Production or Expansion Date	Property Location	Participating Companies	Product to be Mined or Processed	Product to be shipped	Designed Annual Capacity (long tons)
Falconbridge Nickel Mines, Limited (1969)	Falconbridge, Ontario	Wholly owned	Pyrrhotite flotation concentrate	Pellets (about 90% Fe, 1.5% Ni)	330,000
The International Nickel Co. of Canada, Limited (1970)	Copper Cliff, Ontario	Wholly owned	Pyrrhotite flotation concentrate	Pellets (67.9% Fe)	300,000 expansion to 1,200,000

TABLE 8 (Cont'd)

Company and Production or Expansion Date	Property Location	Participating Companies	Product to be Mined or Processed	Product to be shipped	Designed Annual Capacity (long tons)
Wabush Mines, Scully Mine; Pickands Mather & Co. managing agent; Wabush Lab., 190 m. N. of Sept-Iles (1968)	Wabush, Labrador	See Table 7	Expand concentrating plant capacity by 700,000 tons a year.	Specular-hematite concentrate (64.24% Fe)	6,000,000
Wabush Mines, Pointe Noire, operated by Pickands Mather & Co. to process Wabush Mines' concentrates (1968)	Pointe Noire, Quebec	All participants of Wabush Mines	Expand pellet producing capacity by 1.1 million tons a year.	Pellets. (65.77% Fe)	6,000,000
The Sherman Mine (1968)	Near Timagami, Ontario	Dominion Foundries and Steel, Limited (90%) and The Cleveland-Cliffs Iron Company (10%) through Tetapaga Mining Company Limited, a wholly-owned subsidiary.	Magnetite iron formation from open-pit mine (22-25% Fe)	Pellets (about 65% Fe)	1,200,000
The Griffith Mine (1968)	Bruce Lake, near Red Lake, Ontario	The Steel Company of Canada, Limited and Pickands Mather & Co. (managing agent)	Magnetite iron formation from open-pit mine (30-33% Fe)	Pellets (about 65% Fe)	1,500,000

Sources: Company reports and others.

The following information relative to sea transport rates for iron ore was obtained from such sources as the Steel Committee of the Economic Commission for Europe, Canadian Ports and Seaway Directory, Skillings' Mining Review, Fairplay, and publications of some of the major iron ore shipping companies.

The cost of water transport of iron ore can be treated as a function of the transport distance, the size of the ore carrier, the iron content of the ore and its humidity. Aside from the physical structure of the ore, users of iron ore are interested only in the c.i.f. price of the dry iron unit. For instance, for an ore containing 55% Fe and 5% water the transport costs are 20 per cent higher than those of a dry ore containing 63% Fe and no water. Ores vary considerably in grade and moisture content.

For transport routes from Africa, South America and North America to Rotterdam, representative sea-transport rates, and for bulk carriers of cargoes from 15,000 to 65,000 tons, are summarized in the following table:

Size of Cargo (tons)	Cost per ton-Mile (US cents)
15,000	0.126
25,000	0.096
35,000	0.067
45,000	0.062
65,000	0.053

In 1966, the average deadweight tonnage of bulk carriers, including iron ore and oil carriers, was 25,000 tons for a fleet of 446 vessels having a total carrying capacity of 10.6 million tons. The average tonnage of ships built each year for iron ore has increased from

TABLE 9

World Pellet Capacity, 1967, and Estimated Capacity in 1970
(million long tons)

Year	United States	Canada	Balance of World	Total
1967	49.30	21.43	13.62	84.35
1970	51.05	26.56	25.02	102.63

Canadian Pellet Plants, 1967

Operating Company	Location	Annual Capacity (million long tons)
Bethlehem Steel Corp.	Ontario (Marmora)	0.50
The Hanna Mining Company		
Carol Pellet Co. (IOC)	Nfld. (Labrador City)	10.00
National Steel Corporation of Canada, Limited (Lowphos)	Ontario (Moose Mtn.)	0.63
The International Nickel Co. of Canada, Limited	Ontario (Copper Cliff)	0.90
Jones & Laughlin Mining Company, Ltd., Adams Mine	Ontario (Kirkland Lake)	1.25
Inland Steel Company, Caland Ore Company Limited	Ontario (Steep Rock Lake)	1.00
Pickands Mather & Co. Hilton Mines, Ltd.	Quebec (Shawville)	0.90
Wabush Mines, Pointe Noire	Quebec (Pointe Noire)	4.90
Steep Rock Iron Mines Limited	Ontario (Steep Rock Lake)	1.35
Total Canada		21.43

Sources: American Iron Ore Association, company reports, and trade publications.

21,000 tons in 1961 to 29,000 tons in 1962, 33,000 tons in 1963, 38,000 tons in 1964, 50,000 tons in 1965, and to 57,000 tons in the first half of 1966. The only port receiving iron ore in Europe capable of handling 65,000-ton cargoes at the present time is Rotterdam but it is expected that by 1975 most receiving ports will be capable of accommodating iron ore carriers of 65,000 tons and more.

GREAT LAKES TRANSPORT

From published information, the cost-per-ton-mile of transporting iron ore between certain ports on the Great Lakes-St. Lawrence River system in 1966 has been calculated and listed in the following table:

Route	Distance (miles)	Listed Price ($ US)	Cents per Ton-Mile
1. Duluth to Chicago	808	1.90	0.236
2. Escanaba to Chicago	274	1.14	0.416
3. Ashland to Ashtabula	830	1.90	0.228
4. Escanaba to Ashtabula	588	1.43	0.245
5. Marquette to Ashtabula	641	1.71	0.266
6. Duluth to Ashtabula	876	1.90	0.217
7. Sept-Iles to Ashtabula	894	2.00	0.224
Average	. .	. .	0.262
Average except (2) above	. .	. .	0.236

. . Not applicable

The above table shows that in 1966 the average long-haul charter rate for transporting iron ore on the Great Lakes was 0.236 cent per-ton-mile if the charter rate for moving over the short haul distance, Escanaba to Chicago, is not included. The principal reason for higher transport costs for short distances is the fixed charge (turn-around charge) that is levied against all ships at receiving and discharging ports. These fixed charges are not related to haul-distance.

For short-hauls of up to 400 miles the cost per-ton-mile of transporting iron ore on the Great Lakes in 1966 ranged from 0.3 to 0.416 cents and for long-haul distances the cost range from 0.217 to 0.266 cents per-ton-mile. The average size of cargo carried in lake transports was about 15,000 tons* in 1966.

Vessels carrying up to 28,000 tons of iron ore traverse the Montreal-Lake Ontario and Welland Canal sections of the St. Lawrence Seaway. The maximum permissible draught throughout the Seaway from Montreal to Lake Erie is 25 feet 6 inches with a water depth in canals and channels of 27 feet.

Vessels of about the same carrying capacity pass through a series of locks on St. Marys River, connecting Lake Superior to Lake Huron, on their downward trip with iron ore from mines in the Head of the Lakes area in Canada. In the United States, consideration is being given by United States authorities to deepening lock facilities to accommodate bulk carriers of up to 45,000 tons and perhaps 60,000 tons capacity. In such a case it is important to estimate the savings that might be realized on the cost of transporting iron ore from the Head of the Lakes to Lower Lake ports in larger carriers. If savings were substantial, iron ore from the Head of the Lakes would be in an improved competitive position with iron ore from the Quebec-Labrador area.

If a comparative cost analysis is done for lake bulk carriers of varying capacities on the same basis as for sea carriers then close approximations of cost savings can be made when larger lake carriers are used. This has been done in calculating the costs listed in the following table.

Size of Cargo (tons)	Cents (US Per-Ton-Mile) Sea Carrier	Lake Carrier
15,000	0.126	0.236
25,000	0.096	0.180
35,000	0.067	0.126
45,000	0.062	0.117
65,000	0.053	0.101

The lake carrier costs do not include tolls but do include in-harbour (turn-around) charges.

PRICES AND TARIFFS

Prices received by most iron ore producers in central and eastern Canada for sale to North American consumers reflect the Lake Erie base price, which is the price paid for a long ton unit of iron**, in iron ore delivered at rail of vessel at Lake Erie ports. The Canadian mine price can be approximated by deducting the appropriate handling and transportation charges. The Lake Erie price is based on a natural iron content of 51.5 per cent and various other physical and chemical specifications.

The Lake Erie price rose steadily from the mid-1940s until April 1962 when it declined 7 per cent as a result of increasing supplies in a weak market and falling prices in international markets. Great Lakes freight rates were reduced 10 cents a ton in mid-1963, thereby lowering the Lake Erie base price by that amount at which level it has remained.

TABLE 10

Iron Ore Lake Erie Base Prices, 1951-67
(Mesabi, non-Bessemer grade)

	($ US) Per Long Ton†	Per Long Ton Unit†
1951-52 (to July)	8.30	0.1612
1952	9.05	0.1757
1953 (to July)	9.70	0.1884
1953-54	9.90	0.1922
1955	10.10	0.1961
1956	10.85	0.2107
1957-61	11.45	0.2223
1962-63 (to July)	10.65	0.2068
1963-67	10.55	0.2049

† Basis 51.50% Fe, unscreened, delivered to rail of vessel at Lake Erie ports. Premium for coarse ore 80¢ a ton; penalty for fine ore 45¢ a ton.

Prices received by British Columbia mines on ore sales to Japan are negotiated between producers and consumers but are generally about 15 cents a dry metric ton unit (22.04 lb of iron) f.o.b. shipping port, based on ore grading 58 to 62 per cent iron. Recently-negotiated contracts call for somewhat lower prices because of more severe marketing conditions in Japan that have been caused by greater availability of supplies from Australia and more substantial sources of supply each year. Following is a series of quoted prices paid by Japanese steel producers:

*The Cleveland-Cliffs Iron Company, Cleveland, Ohio, Cliffs Iron Ore Analyses, 1967.

**Equals 22.4 pounds of iron (i.e. 1% of 2,240 pounds). An iron ore containing 60% Fe, therefore has 60 units.

Source of Information	% Fe	Source of Ore	Cost in US ¢/Unit
Metals Week 11/3/68	68(d)	Brazil (VRD) (1)	22.6(a)
" " "	" (d)	" (1)	20.2(a)
" " "	" (d)	" (2)	19.6(a)
Japan Metal Daily 8/3/68	"	Sierra Leone	16 (a)
" " " 10/2/68	65(p)	India	15.4(b)
" " " "	66	"	15.9(b)
Metals Week 25/12/68	63.5(p)	" (Robe River)	18.75(b)
" " "	56(f)	" "	10.75(b)
Japan Metal Daily 5/12/67	63(d)	" (Mt. Newman)	14.8(b)
" " " "	61(f)	" "	12.3(b)
Metals Week 11/9/67	57(d)	China	15.6(b)

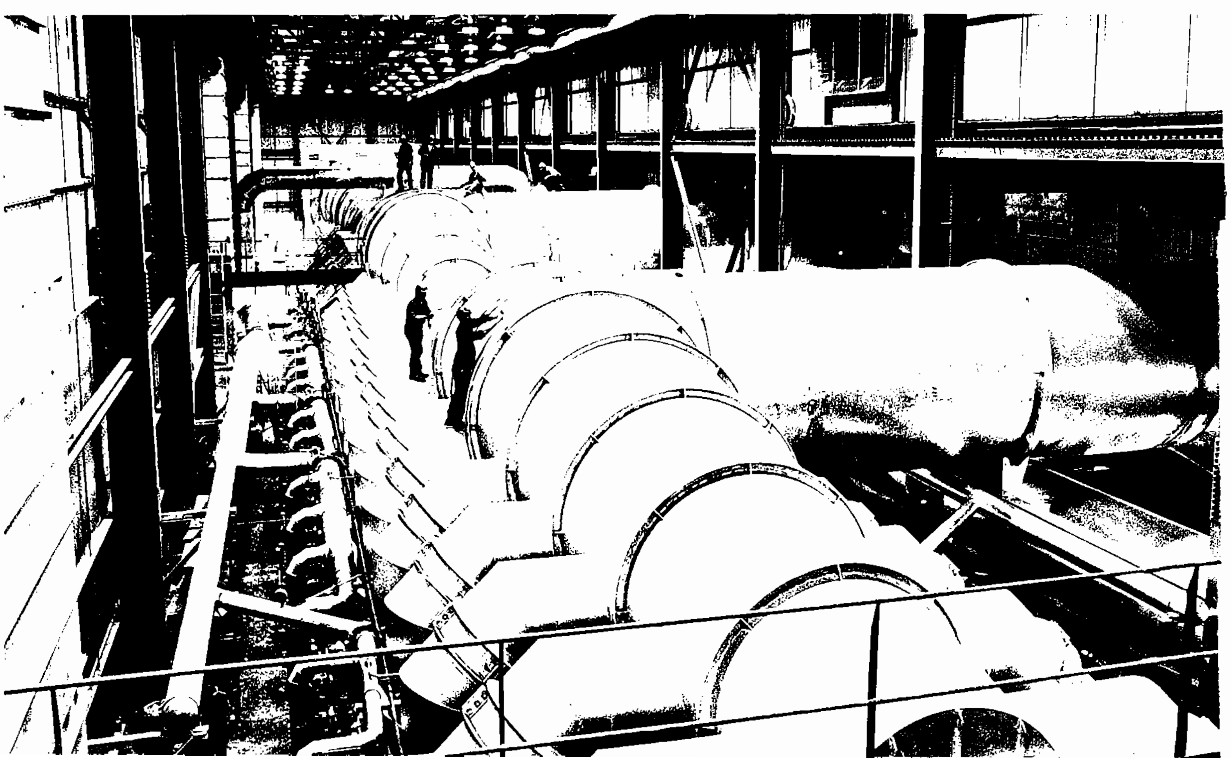
a – C & F Japan; b – Fob; 1 – 90,000 ton vessels; 2 – 125,000 ton vessels; p – pellets; f – fines; d – direct shipping.

There has been accelerated investment in pelletizing plants but pellet list prices have held firm. Lake Superior pellets grading 62 to 63 per cent iron are quoted at 25.2 cents a long ton unit (US $15.62 to $15.88 a ton) delivered to rail of vessel at lower lake ports. There has been no price change for pellets for several years. Recent reports indicate that the Japanese have negotiated contracts in Australia for pellets at 22.4¢ a long ton unit, c.i.f. Japan.

Neither Canada nor any of its iron ore customers have tariffs on iron ore.

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

NEW PELLET PLANT: final touches being given to the furnaces to Steep Rock Iron Mines' pellet plant just before it went into operation in September 1967. Annual rated capacity is 1.35 million of pellets grading 64.57% iron.



NEW MINING COMMUNITY: housing and community area for Wesfrob Mines Limited, the iron-ore-copper operation on Moresby Island, Queen Charlotte Islands, British Columbia. The community centre is middle foreground, hotel and shopping centre on right and houses and apartments on the left. Wesfrob ships iron ore and copper concentrates on a ten-year contract to Japan.

Iron and Steel

G.E. WITTUR*

Lower steel production rates that began in mid-1966 continued throughout most of 1967. Crude steel output during the year totalled 9.7 million tons** compared with 10.0 million tons in 1966 and 10.1 million tons in 1965. Indicated consumption fell 5.9 per cent to 10.2 million tons. It is believed that a trend of steel inventory liquidation by consumers began in 1966 and continued throughout 1967 and that the decline in real consumption was not as great as indicated. Other factors in reduced operating rates included strikes at several steel plants and reduced activity in some sectors, notably construction.

The net trade deficit in primary iron and steel products declined for the second consecutive year in 1967, as exports rose and imports fell, reflecting the easing in domestic demand and increasing productive capacity. There was a substantial decline in investment in new facilities as a number of major projects neared completion. Only a slight increase in investment is expected in 1968.

The outlook for the steel industry for the first two to three quarters of 1968 is for significantly higher operating rates. There was some recovery in demand late in 1967 and as consumer steel inventories were at very low levels at year-end expected further increases in demand should be reflected quickly in new steel orders. Consumers in Canada are not likely to increase their steel inventories significantly, however, since most steel products are expected to be readily available throughout the year. Exports are likely to increase in 1968. Prospects for the final four to five months of the year are more uncertain and operating rates may ease slightly. However, crude steel production for the year is expected to exceed 10.5 million tons. The outlook for the next three to five years is for moderate growth in production, in the order of 5 per cent annually.

WORLD PRODUCTION

Canada fell from eleventh to twelfth place among world steel producers in 1967, having been displaced by Belgium. According to preliminary figures, world steel production rose 5 per cent to 546 million tons, led by strong growth in Japan where production rose 30 per cent to 68.6 million tons. Output rose slightly in most other countries with some exceptions, including the United States and Britain. The trend towards increasing world steel overcapacity showed little sign of abating in 1967. Excess capacity beginning in the late 1950's has resulted in a price decline in both export and many domestic markets and a steady rise in intercountry trade by major steel producers. Growing imports by the United States have prompted that country's steel industry to press for a government-imposed import quota system.

* Mineral Resources Branch.

** The net ton of 2000 pounds is used throughout.

TABLE 1

Canada, General Statistics of the Domestic
Primary Iron and Steel Industry, 1965-67

	1965	1966	1967^{p}
Production			
Volume Indexes (1949 = 100)			
Total Industrial Production	254.9	275.1	282.7
Primary Iron and Steel Industry	320.0	324.8	317.1
	($ millions)	($ millions)	($ millions)
Value of shipments*	1,214.8	1,230.5	1,179.1
Value of unfilled orders, year-end*	135.2	145.2	158.4
Value of inventory owned, year-end*	263.4	275.6	273.3
Value of exports*	206.2	214.7	223.2
Value of imports*	373.6	308.4	310.7
Employees			
Administrative	7,249	7,463	8,224 ^{e}
Hourly rated	37,025	38,536	36,031 ^{e}
Total	44,274	45,999	44,255 ^{e}
Employment index, all employees, (1961 = 100)	129.6	133.8	129.4
Average hours per week by hourly rated	40.7	40.3	39.9
Average earnings per hour by hourly rated	2.83	2.94	3.11
Average wages and salaries per week, all employees	119.22^{r}	123.06	130.90
Expenditures			
Capital			
On construction	34,338	35,100	21,480
On machinery	128,868	175,460	94,517
Total	163,206	210,560	115,997
Repair			
On construction	6,439	7,135	6,754
On machinery	119,400	138,004	133,706
Total	125,839	145,139	140,460
Total Capital and Repair	289,045	355,699	256,457

Source: Dominion Bureau of Statistics.
* Includes pig iron, steel castings, steel ingots and rolled products but does not include steel in forgings or manufactured products such as machinery and equipment.
^{p}Preliminary; ^{r} Revised; ^{e} Estimate.

TABLE 2

World Production of Steel, 1965-1967
(thousands of net tons)

	1965	1966	1967^{p}
North America, total	141,530	144,104	136,614
Canada	10,068	10,003	9,694
United States	131,462	134,101	126,920
Latin America, total	9,227	9,956	10,484
Western Europe, total	142,813	139,677	142,469
Belgium	10,099	9,828	10,706
France	21,604	21,590	21,668
West Germany	40,588	38,920	40,503
Italy	13,980	15,017	17,519
Luxembourg	5,054	4,839	4,939
Netherlands	3,467	3,625	3,753
Total ECSC	94,792	93,819	99,088
Britain	30,247	27,233	26,763
Other	17,774	18,625	16,618
Eastern Europe, total	131,305	139,320	151,368
Czechoslovakia	9,480	9,983	10,913
Poland	10,013	10,793	11,376
USSR	100,328	106,422	112,655
Other	11,484	12,122	16,424
Africa, total	3,911	3,893	4,211
Middle East, total	392	442	336
Far East, total	67,735	75,904	93,429
China	13,228	13,700	15,432
India	7,065	7,388	7,308
Japan	45,372	52,657	68,612
Other	2,070	2,159	2,076
Oceania, total	6,209	6,546	7,161
Australia	6,059	6,396	7,011
Other	150	150	150
World total	503,122	519,842	546,071

Sources: Annual Statistical Report, American Iron and Steel Institute. 1967 from Metal Bulletin, April 30, 1968 (original source, Statistisches Bundesamt Aussenstelle) and others.

^{p} Preliminary.

CANADIAN PRIMARY IRON AND STEEL INDUSTRY*

Pig iron is made at seven plants in Canada, while steel ingots are made at 18 plants; five of these produce both iron and steel. There are also two plants, both at Contrecoeur, Quebec, that have only rolling mills. The four largest integrated plants – two at Hamilton, Ont., and one each at Sault Ste. Marie, Ont. and Sydney, N.S. – accounted for 90.5 per cent of 1967 pig iron production and 87.4 per cent of crude steel production.

* A complete listing of Canadian primary iron and steel plants (including steel foundries) is in the booklet *"Operators List 1, Part I: Primary Iron and Steel"*, available from the Mineral Resources Division or The Queen's Printer, Ottawa,

PIG IRON

Production of pig iron declined 3.8 per cent in 1967 to 6.94 million tons (Table 3). Shipments rose slightly but both exports and imports fell. Capacity rose sharply in 1967 with the completion of one blast and one electric furnace; engineering for another blast furnace was completed and planning for another was under way.

CRUDE STEEL

Production of crude steel fell 3 per cent in 1967 (Table 4). Steel ingot and continuous-cast steel production fell 2.7 per cent to 9,551,174 tons while castings production fell 24.2 per cent to 143,197 tons. Open hearth furnaces produced 53.9 per cent of total crude steel, up from 52.8 per cent in 1966, while basic oxygen furnaces accounted for 33.2 per cent, down from 33.8 per cent the previous year. This was a reversal of the trend over the past few years and is probably temporary, but total open hearth furnace capacity is expected to continue to increase until at least 1970. Electric furnaces produced 12.9 per cent of the total in 1967, compared with 13.4 per cent in 1966.

Total crude steel capacity was 12.89 million tons at the end of 1967, a 5.6-per-cent rise during the year. Only a slight increase is expected during the next two years, with a rise to about 13.3 million tons by the end of 1969.

SHIPMENTS OF STEEL PRODUCTS

Almost all types of steel products made in Canada were readily available from the mills throughout 1967. Shipments of hot- and cold-rolled steel products declined 2.1 per cent to 6,980,421 tons (Table 6). Shipments from iron and steel mills were valued at $1,179.1 million (Table 1), down 0.4 per cent. The record among products was variable. Shipments of most rolled steel products were down at least slightly in 1967, led in particular by concrete reinforcing bars and heavy structurals which reflected reduced construction activity. There was a significant rise in shipments of light structurals, however, and slight increase in semis, hot-rolled bar mill products and sheet and strip.

Shipments of rolled products by industry (Table 7) were equally variable. Significant declines occurred in deliveries to the construction, wholesalers and warehouses, railway equipment, and ship-building sectors. Increased shipments were made to the pipe and tube, and automobile industries in particular.

TABLE 3

Canada, Pig Iron Production, Shipments, Trade and Consumption, 1965-67
(net tons)

	1965	1966	1967p
Furnace capacity, December 31	7,643,000	7,764,000	9,276,000
Production			
Basic iron	6,315,576	6,365,258	6,170,176
Foundry iron	492,610	467,633	532,159
Malleable iron	271,253	379,652	238,039
Total	7,079,439	7,212,543	6,940,374
Shipments			
Basic iron	98,817	59,160	43,749
Foundry iron	491,956	412,702	472,341
Malleable iron	318,849	267,739	234,943
Total	909,622	739,601	751,033
Imports – net tons	33,474	32,456	28,743
– value ($000)	$1,395	$1,451	$1,295
Exports – net tons	578,879	507,239	485,695
– value ($000)	$29,482	$27,056	$25,382
Consumption of pig iron			
Steel furnaces	6,180,721	6,320,969	6,094,505
Iron foundries	412,260	303,114	281,080
Consumption of iron and steel scrap			
Steel furnaces	5,236,580	5,013,356	4,968,422
Iron foundries	919,607	1,056,885	970,381

Source: Dominion Bureau of Statistics, Primary Iron and Steel (monthly) and Iron and Steel Mills (annual).

p Preliminary

TRADE

Canada's balance of trade in primary steel products plus castings, forgings, pipe and wire improved in 1967 for the second consecutive year. In terms of tonnage (Table 8), imports declined by 4.9 per cent and exports rose by 4.7 per cent. In terms of value, however imports rose by 0.8 per cent while exports rose 5.4 per cent (Table 9). The net deficit (excluding pig iron) therefore declined only from $120.7 million to $111.6 million.

The trend in exports away from primary products such as ingots and semis and toward more fully processed hot- and cold-rolled products continued in 1967. Among individual products, there were few significant departures from overall trade trends except that exports of ingots and semis declined. In pipe however, the tonnage of imports rose and of exports declined, reflecting heavy pipe-laying programs in Canada.

The United States is the most significant individual supplier of Canadian steel imports as well as the largest export market (Table 10). That country accounted for 27.1 per cent of 1967 imports and 62.2 per cent of exports, both of which were lower than in 1966. The European Coal and Steel Community (ECSC) as a bloc supplied 35.1 per cent of imports, a reduction from 1966. Imports from Japan, the third largest source also declined. Trade with Britain increased in 1967, particularly in exports. Latin America is one of Canada's more important export markets for steel, although exports to the area fell in 1967. It is expected that the trend to declining imports and increasing exports will continue during the first three quarters of 1968, at least, despite the very strong competition on world markets. The threat of a strike in the third quarter affecting much of the United States steel industry will result in significant inventory-build up by consumers there. Should a strike not occur, or should it be short, exporters in other countries are expected to shift their marketing efforts partly to Canada towards the end of 1968.

TABLE 4

Canada, Crude Steel Production, Shipments, Trade and Consumption, 1965-67
(net tons)

	1965	1966	1967^{p}
Furnace capacity, December 31			
Steel ingot			
Basic open-hearth	6,270,000	6,470,000	6,970,000
Basic oxygen converter	3,550,000	3,630,000	3,630,000
Electric	1,434,650	1,616,826	1,793,650
Total	11,254,650	11,716,826	12,393,650
Steel castings	543,120	464,400	500,425
Total	11,797,770	12,181,226	12,894,075
Production			
Steel ingot			
Basic open-hearth ^{e}	5,552,904	5,278,104	5,225,967
Basic oxygen ^{e}	3,232,572	3,377,733	3,208,655
Electric	1,117,883^{r}	1,158,228	1,116,552
Total	9,903,359^{r}	9,814,065	9,551,174
of which continuously cast	347,437	442,680	647,252
Steel castings			
Basic open-hearth	251	*	*
Electric	164,732^{r}	188,803	143,197
Total	164,983^{r}	188,803	143,197
Total Steel Production	10,068,342^{r}	10,002,868	9,694,371
Alloy Steel in Total	761,360^{r}	812,606	746,188
Shipments from plant			
Steel ingots	259,656^{r}	272,581	296,136
Steel castings	155,232^{r}	174,404	141,561
Rolled steel products	7,101,650	7,128,390	6,980,421
Total	7,516,538	7,575,375	7,418,118
Exports in equivalent steel ingots	1,235,208	1,289,809	1,367,702
Imports in equivalent steel ingots	2,891,970	2,096,261	1,845,813
Indicated consumption**	11,725,104	10,809,320	10,172,482

Source: Dominion Bureau of Statistics; estimates by Department of Energy, Mines and Resources, Ottawa.
* Included with electric; ** Crude steel production plus imports less exports.
^{p} Preliminary; ^{r} Revised; ^{e} Estimated.

MANPOWER AND LABOUR

The index of employment in the primary iron and steel industry (1961 = 100) declined from 133.8 in 1966 to 129.4 in 1967; total employment fell to an estimated 44,255 (Table 1). Average weekly hours worked in 1967 were 39.9 and earnings by hourly-rated employees averaged $3.11 an hour, up 5.8 per cent from 1966. Several work-stoppages through strikes occurred in 1967, both in the steel industry and in other major steel consuming sectors. The Montreal Works of Dosco Steel Limited was closed for three months ending January 22, 1967, while the Sault Ste. Marie Works of Algoma was partially, and finally completely closed over a three-week period ending January 15. A second strike occurred in February. The Mannesmann tube mill at Sault Ste. Marie was closed for nearly 3 months during the second quarter of 1967 and shorter strikes occurred at several other steel plants. Strikes in the construction industry, particularly in Ontario, delayed steel-consuming projects as well as investment projects at steel plants.

TABLE 5

Canada, Production, Trade and Apparent Consumption of Primary Iron and Steel, 1958-67
(thousand net tons ingot equivalent)

	Crude Steel Production	Imports*	Exports*	Indicated Consumption**
1958	4,359	1,841	383	5,817
1959	5,901	1,506	602	6,805
1960	5,809	1,353	994	6,168
1961	6,488	1,096	841	6,743
1962	7,173	1,046	990	7,229
1963	8,190	1,295	1,369	8,116
1964	9,128	2,135	1,485	9,778
1965	10,068	2,892	1,235	11,725
1966	10,003	2,096	1,290	10,809
1967p	9,694	1,846	1,368	10,172

Source: Dominion Bureau of Statistics.

* From Trade of Canada adjusted to equivalent crude steel by Mineral Resources Division.
** Production plus imports, less exports with no account taken of stocks.

p Preliminary.

RAW MATERIALS

The supply of nearly all raw materials used in the steel industry was adequate in 1967. Although regional shortages of scrap may have existed, abundant supplies were available in Ontario and Quebec and prices generally declined. A number of steelmakers continued to investigate alternative sources of primary iron in the form of reduced ore but no definite plans to proceed with commercial production of such a product were announced. Three companies are constructing or planning iron powder plants; iron powder is used to make pressed, sintered parts and for welding-rod coatings, ferrites, etc.

The supply of most additive materials, including ferro-alloys, was adequate in 1967 with the exception of nickel for which continued tight supply is anticipated. However, prices rose for molybdenum, cobalt and nickel, and Russian suppliers of chromite raised their prices in anticipation of shortages of high-grade metallurgical ore. Tungsten prices remained high. Prices declined for vanadium pentoxide, ferro-vanadium, manganese and ferromanganese.

The trend towards increased use of domestic iron ore accelerated in 1967. Approximately 74 per cent of the ore consumed was mined in Canada compared with 56 per cent in 1966 and 51 per cent in 1965.

TABLE 6

Canada, Shipments of Rolled Steel Products by Type, 1965-67
(net tons)

	1965	1966	1967p
Hot-rolled products			
Semis	382,909	326,262	343,908
Rails	213,469	282,293	279,076
Wire rods	444,659	428,109	424,793
Structurals			
Heavy	442,482	433,159	373,908
Light	99,675	86,787	123,856
Bars, concrete reinforcing	643,009	655,525	495,202
Bars, other hot-rolled	680,123	686,120	694,850
Tie plate and track material	55,953	62,872	56,526
Sheet and strip	1,181,385	1,210,119	1,289,444
Plates	951,463	935,687	915,842
Total	5,095,127	5,106,933	4,997,405
Cold-rolled products			
Bars	74,207	78,987	74,801
Sheet, tin mill blackplate and tinplate	1,412,556	1,401,589	1,372,051
Galvanized sheet	519,760	540,881	536,164
Total	2,006,523	2,021,457	1,983,016
Total shipments	7,101,650	7,128,390	6,980,421
Alloy steel in shipments	342,904	366,348	395,205

Source: Dominion Bureau of Statistics, Primary Iron and Steel (monthly).

p Preliminary.

TABLE 7

Canada, Rolled Steel Products, Shipments to Consuming Industries, 1965-67
(net tons)

	1965	1966	1967^p
Automotive and aircraft	586,261	642,939	697,591
Agricultural equipment manufacturers	191,962	214,925	191,312
Construction	1,373,751	1,406,735	1,194,946
Containers	440,646	462,279	461,942
Machinery and tools	272,890	300,567	261,606
Wire, wire products and fasteners	545,757	513,349	520,019
Resources and extraction	176,745	176,643	180,832
Appliances, utensils, stampings, pressings	600,891	544,106	518,659
Railway operating	207,185	258,939	240,300
Railway cars and locomotives	132,114	127,182	85,787
Shipbuilding	125,136	101,240	59,655
Pipes and tubes	797,868	762,652	823,079
Wholesalers and warehouses	1,025,072	924,364	811,175
Miscellaneous	15,754	19,771	28,149
Total	6,492,032	6,455,691	6,075,052
Direct Exports*	609,618	672,699	905,369
Total	7,101,650	7,128,390	6,980,421

Source: Dominion Bureau of Statistics, Primary Iron and Steel (monthly).
* Does not include exports by nonproducers nor ingots and castings.
^{p} Preliminary.

This trend will continue in 1968 as new pellet producers, owned in part by Canadian steel companies, are completed.* Imports are expected to decline from the 1967 level of 2.6 million tons to an annual rate of 1.5 to 2 million tons by 1970. Most imported ore comes from the United States Lake Superior area with smaller tonnages coming from Brazil and other countries. Similarly, the trend towards increased use of beneficiated ore continued in 1967. Pellets constituted 58 per cent of all ore used in blast furnaces while sinter accounted for a further 31 per cent. Corresponding figures in 1966 were 52 and 32 per cent.

New coke batteries were completed in 1967 at Algoma in Sault Ste. Marie, and at Stelco and Dofasco in Hamilton. Thus, coke supply problems are not expected for several years. Coal supply is also adequate, with three of the four major integrated steel firms having ownership interests in United States coal mines. Stelco completed development of a new mine, having an annual capacity of 1 million tons, in Kentucky. Algoma neared completion of a new mine in West Virginia. Dofasco increased its ownership share in Itmann Coal Company in West Virginia.

Details on raw materials consumed at the major integrated steel plants are listed in Table 12.

ENERGY AND REDUCTANT MATERIALS

Table 13 lists consumption of selected energy and reductant materials at the four integrated plants in 1967. Although the list is not complete, the use of these materials in various processes is indicated. One significant source of energy, blast furnace gas, is not listed. This gas, recovered from the top of blast furnace stacks and cleaned, contains only 9 per cent of the energy in natural gas but it is estimated that about 440 trillion cubic feet is used annually by the companies in Table 13. It is used mainly for heating blast furnace stoves, steam raising and miscellaneous heating.

* For further information on iron ore developments, see the annual review in this series on Iron Ore by V.B. Schneider.

TABLE 8

Canada, Trade in Steel Castings, Ingots and Rolled Products, 1965-67
(thousand net tons)

	Imports			Exports		
	1965	1966	1967p	1965	1966	1967p
Steel castings	5.9	9.0	9.0	18.3	20.8	25.6
Steel forgings	6.5	9.9	11.9	16.4	22.9	25.4
Steel ingots	1.2	16.1	3.1	194.7	133.7	121.5
Hot-rolled products						
Semis	28.4	21.7	29.6	109.0	87.3	54.3
Rails	7.4	6.1	4.0	72.6	77.4	90.4
Wire rod	183.5	144.0	130.6	5.8	8.0	16.7
Structurals	528.9	369.1	351.8	18.6	37.2	56.7
Bars	382.1	244.5	207.9	28.1	49.0	50.2
Track material	2.0	3.5	1.9	14.3	13.9	6.0
Plates	396.2	221.2	210.1	25.7	40.3	47.3
Sheet and strip	210.4	80.3	82.1	104.0	131.6	154.9
Total, hot-rolled	1,738.9	1,090.4	1,018.0	378.1	444.7	476.5
Cold-rolled and other products						
Bars	12.3	11.3	11.8	9.3	8.9	6.9
Sheet and strip						
Cold-rolled	30.1	24.6	22.3	135.0	115.2	113.8
Galvanized	8.0	7.3	7.4	59.9	57.2	88.4
Other	113.8	112.3	110.8	133.3	157.4	170.3
Pipe	158.9	197.6	220.0	55.2	60.0	39.8
Wire	82.1	74.9	62.9	6.7	7.0	7.9
Total, cold-rolled	405.2	428.0	435.2	399.4	405.7	427.1
Total, rolled-products	2,144.1	1,518.4	1,453.2	777.5	850.4	903.6
Total, steel	2,157.7	1,553.4	1,477.2	1,006.9	1,027.8	1,076.1

Source: Dominion Bureau of Statistics, Trade of Canada.
Note: Related values are in Table 9.
p Preliminary.

TABLE 9

Canada, Value of Trade in Steel Castings, Ingots and Rolled Products, 1965-67
(thousand dollars)

	Imports			Exports		
	1965	1966	1967p	1965	1966	1967p
Steel castings	4,881	6,783	6,800	5,586	7,450	7,679
Steel forgings	6,413	10,911	13,652	9,259	11,803	12,626
Steel ingots	336	1,320	1,065	21,891	13,691	14,220
Rolled products						
Hot-rolled	218,299	138,547	133,069	55,453	69,850	71,042
Cold-rolled and other	142,273	149,417	154,808	84,579	84,871	92,238
Total	360,572	287,964	287,877	140,032	154,721	163,280
Total steel	372,202	306,978	309,394	176,768	187,665	197,805

Source: Dominion Bureau of Statistics, Trade of Canada.
Note: The values in this table relate to the tonnage shown in Table 8.
p Preliminary.

TABLE 10
Canada, Trade in Steel by Country, 1965-67
(thousand net tons)

	Imports From:			Exports To:		
	1965	1966	1967^p	1965	1966	1967^p
United States	658.0	467.3	400.2	701.9	732.9	668.3
Britain	251.7	127.9	169.7	12.3	22.1	115.1
ECSC Countries	927.9	560.1	518.6	9.3	10.3	49.4
Other Europe*	54.5	113.0	145.5	59.0	27.1	13.8
Africa	–	0.1	0.1	13.1	17.6	11.3
Japan	250.4	249.2	226.4	0.2	0.05	0.1
Other Asia	1.1	0.4	0.6	13.6	13.1	31.2
Latin America	–	–	3.3	163.5	187.2	158.4
Middle East	–	0.3	0.6	7.1	4.5	1.0
Oceania	14.1	35.1	12.2	26.9	12.9	27.5
Total	2,157.7	1,553.4	1,477.2	1,006.9	1,027.8	1,076.1

Source: Dominion Bureau of Statistics Trade of Canada.
Note: Products included are those listed in Table 8.
* Includes the U.S.S.R. in Europe and Asia.
^{p} Preliminary; – Nil.

TABLE 11

Canada, Steel, Iron, Coke and Sinter Capacity and Production at Integrated[1] Plants, 1967
(net tons)

	Algoma							
	Sault Ste. Marie	Port Colborne	Cominco Kimberley	Dofasco Hamilton	Dosco Sydney[2]	QIT Tracy	Stelco Hamilton[2]	National Total
Crude Steel								
Facilities Dec. 31								
Open Hearth:								
Number	6	–	–	–	6	–	14	26
Capacity	1,150,000	–	–	–	1,070,000	–	4,750,000	6,970,000
Basic Oxygen:								
Number	3	–	1	3	–	–	–	7
Capacity	1,450,000	–	75,000	2,100,000	–	–	–	3,625,000
Electric:								
Number	–	–	–	4	1	–	–	..
Capacity	–	–	–	50,850	30,000	–	–	2,299,075
Total Capacity	2,600,000	–	75,000	2,150,850	1,100,000	–	4,750,000	12,894,075
Production	2,072,505	–	..	1,879,280	616,460	–	3,888,277	9,694,371
Pig Iron								
Facilities Dec. 31								
Blast furnaces:								
Number[3]	4	1	–	3	2	–	5	15
Capacity	2,335,000	240,000	–	1,550,000	876,000	–	3,700,000	8,701,000
Elec. furnaces:								
Number	–	–	2	–	–	9	–	11
Capacity	–	–	110,000	–	–	465,000	–	575,000
Total Capacity	2,335,000	240,000	110,000	1,550,000	876,000	465,000	3,700,000	9,276,000
Production	1,809,061	147,848	108,000	1,564,128	465,804	410,659	2,456,671	6,940,374
Coke from Coal								
Facilities Dec. 31								
Number of Ovens[3]	260	–	–	158	114	–	264	898
Total Capacity	1,852,000	–	–	950,000	612,000	–	2,100,000	5,964,625
Production	1,294,709	–	–	818,973	368,644	–	1,366,672	4,430,299

TABLE 11 (Cont'd)

	Algoma Sault Ste. Marie	Algoma Port Col-borne	Cominco Kimber-ley	Dofasco Hamil-ton	Dosco Sydney[2]	QIT Tracy	Stelco Hamil-ton[2]	National Total
Sinter								
Facilities Dec. 31								
Number of Strands	1	–	1	–	1	–	1	8[4]
Total Capacity	725,000	–	300,000	–	250,000	–	900,000	4,515,000[4]
Production	678,746	–	177,200	–	143,102	–	775,375	3,529,865

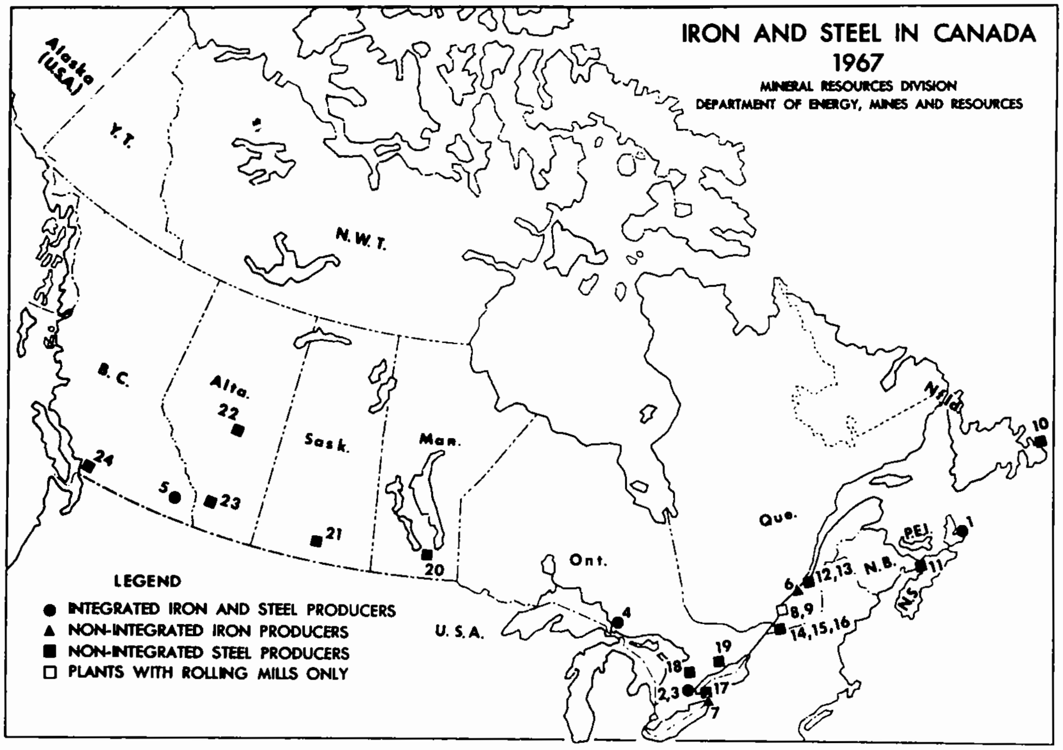
Source: Company data supplied directly to Mineral Resources Division; national total from Dominion Bureau of Statistics.
[1]The seven plants listed accounted for all pig iron and 87 per cent of the crude steel produced in 1967. [2] Dosco and Stelco also have electric furnace steel plants at Montreal (156,000 tons a year capacity) and Edmonton (128,000 tons), respectively. [3] Includes facilities entering production very early in 1968. [4] Includes four strands at Algoma Ore Properties Division, Wawa, Ontario.
. . Not available; – Nil.

TABLE 12

Canada, Consumption of Raw Materials at Pig Iron and Integrated Steel Plants[1], 1967
(net tons)

	In Sinter Plants	In Iron and Steel Furnaces: Pig Iron Furnaces[2]	Steel Furnaces	Total in Furnaces
Iron Ore				
Crude and concentrate	959,317	2,347,706[3]	84,975	2,432,681
Pellets	81,585	5,856,618	129,438	5,986,056
Sinter (from mines)	31,337	1,558,905	–	1,558,905
Total	1,072,239	9,763,229[3]	214,413	9,977,642
Sinter (produced at plant)	–	1,786,146	241	1,786,387
Total iron ore	1,072,239	11,549,375[3]	214,654	11,764,029
Contained iron	589,023	6,662,000[3]	139,898	6,801,898
Other Iron-Bearing Materials				
Calcine and pyrite	169,300	–	–	–
Flue dust	120,139	–	–	–
Scale, sponge iron, etc.	366,043	112,537	99,306	211,843
Total	655,482	112,537	99,306	211,306
Contained iron	422,661	71,089	96,684	167,773
Other Materials				
Ferromanganese	–	20	66,023	66,043
Pig iron	–	4,886	6,104,096	6,108,982
Coal	8,173	220,000[4]	–	220,000[4]
Coke: Own make	69,496	3,618,854	406	3,619,260
Purchased	16,100	146,063	–	146,063
Total	85,596	3,764,917	406	3,765,323
Scrap: Own make	57,986	65,845	2,629,669	2,695,514
Purchased	455	133,578	892,372	1,025,950
Total	58,441	199,423	3,522,041	3,721,464
Stone: Limestone	77,937	616,571	178,233	794,804
Dolomite	300,689	312,392	96,853	409,245
Total	378,626	928,963	275,086	1,204,049
Burnt Stone: Lime	–	–	258,854	258,854
Dolomite	3,100	–	84,705	84,705
Total	3,100	–	343,559	343,559

Source: Company data supplied directly to Mineral Resources Division.
[1]Includes the 7 plants in Table 11. [2] Blast and electric furnaces. [3] Includes 1,222,649 tons of ilmenite containing about 450,000 tons of iron. [4] Estimated consumption of coal and coal char directly in iron furnaces.
– Nil.



INDEX FOR MAP

IRON AND STEEL IN CANADA, 1967

INTEGRATED IRON AND STEEL PRODUCERS ●

1. Dosco Steel Limited (Sydney)
2. Dominion Foundries and Steel, Limited (Hamilton)
3. The Steel Company of Canada, Limited (Hamilton)
4. The Algoma Steel Corporation, Limited (Sault Ste. Marie)
5. Cominco Ltd. (Kimberley)

NON-INTEGRATED IRON PRODUCERS ▲

6. Quebec Iron and Titanium Corporation (Tracy)
7. Canadian Furnace Division of Algoma (Port Colborne)

PLANTS WITH ROLLING MILLS ONLY □

8. Dosco Steel Limited (Contrecoeur)
9. The Steel Company of Canada, Limited (Contrecoeur)

NON-INTEGRATED STEEL PRODUCERS (a partial listing) ■

10. Newfoundland Steel Company Limited (Octagon Pond)
11. Enamel & Heating Products, Limited (Amherst)
12. Atlas Steels Company (Tracy)
13. Crucible Steel of Canada Ltd. (Sorel)
14. Canadian Steel Foundries Division (Montreal)
15. Canadian Steel Wheel Limited (Montreal)
16. Dosco Steel Limited (Montreal)
17. Atlas Steels Company (Welland)
18. Burlington Steel Company (Hamilton)
19. Lake Ontario Steel Company Limited (Whitby)
20. Manitoba Rolling Mill Division (Selkirk)
21. Interprovincial Steel and Pipe Corporation Ltd. (Regina)
22. Premier Works of Stelco (Edmonton)
23. Western Canada Steel Limited (Calgary) (plant leased from Western Rolling Mills Ltd.)
24. Western Canada Steel Limited (Vancouver)

TABLE 13

Canada, Energy and Reductant Consumption at Major Integrated*
Steel Plants, 1967

	Coal (net tons)	Coke (net tons)	Coke Oven Gas (mill. cu. ft.)	Tar and Pitch (000 imp. gal.)	Natural Gas (mill. cu. ft.)	Fuel Oil (000 imp. gal.)	Oxygen (mill. cu. ft.)	Electricity (mill. Kwh)
In coke ovens	5,332,519	–	15,077	–	–	–	–	44
In sinter plants	–	69,496	463	–	–	–	–	27
In blast furnaces	–	3,747,917	4,703	. .	. .	24,274	3	63
In steel furnaces	–	406	2,074	. .	. .	73,312	11,510	122
For other uses	160,069	27,305	31,934	. .	. .	95,660	881	1,760
Total Consumption	5,492,588	3,845,124	54,251	6,231	8,878	193,246	12,394	2,016

Source: Company data supplied directly to Mineral Resources Division.

*Includes Algoma (Sault Ste. Marie and Port Colborne Works), Stelco (Hilton Works), Dofasco (Hamilton Works), and Dosco (Sydney Works).

– Nil; . . Included in total, publication would disclose individual company data.

INVESTMENTS AND CORPORATE DEVELOPMENTS

Capital expenditures at iron and steel mills fell significantly to $116.0 million in 1967 from $210.6 million in 1966 and $163.2 million in 1965. Large investment programs, begun several years ago at several major plants, neared completion in 1967. Although further projects are planned, industry investment during the next two years is expected to be well below that in 1966. Repair expenditures totalled $140.5 million in 1967 compared with $145.1 million in 1966 and $146.2 million in 1965. A survey of industry intentions late in 1967 indicated that capital and repair expenditures in 1968 might be $121.9 million and $164.9 million, respectively.

ABEX INDUSTRIES OF CANADA LTD.

A $1-million expansion at the Joliette, Quebec, plant was completed in 1967.

THE ALGOMA STEEL CORPORATION, LIMITED

Capital and mine development expenditures were $39.0 million in 1967 compared with $33.5 million in 1966 and $25.2 million in 1965. Major items included in 1967 expenditures at Sault Ste. Marie were: a 60-oven coke battery (which replaced an older, smaller battery) and a four-strand continuous casting machine for blooms, both completed in September; a second reheating furnace for the rail and structural mill and wide flange beam mill; a blast furnace turbo-blower; relining of a blast furnace; a large oil storage tank; several new buildings; and expansion of railway transfer yards. The new Ruth and Lucy Mine near Wawa began production and a new coal mine in West Virginia neared completion. The first pellets were received from Steep Rock Iron Mines Limited under a long-term joint agreement. Among projects under way in 1967 were a two-strand continuous casting machine for slabs and beam blanks; new bloom scarfer and other improvements at the 44-inch blooming mill; a phenol recovery plant to reduce water pollution; a slab storage yard for the new plate and the hot strip mills, and preparation for the new 160-inch plate mill to be completed in 1970. Projects to begin in 1968 include services for the plate mill; additional finishing equipment for wide hot strip and sheet; conversion to more efficient coke gas cleaning equipment; a coil banding line for cold-rolled sheet and strip; and additional light-oil recovery equipment. Design engineering for a new blast furnace and two 200-ton basic oxygen furnaces has been completed, but firm plans to begin installation have not yet been announced; construction is expected to begin upon completion of the plate mill.

ATLAS STEELS DIVISION OF RIO ALGOM MINES LIMITED

The construction program at Tracy, Quebec, was virtually completed in 1967, with the exception of a vacuum degassing unit which will be installed in 1968. Increased capital expenditures for new equipment and processes are planned for the Welland plant over the next several years.

BURLINGTON STEEL DIVISION OF SLATER STEEL INDUSTRIES LIMITED

Installation of a new 40-ton electric furnace, to increase annual steelmaking capacity to 250,000 tons, neared completion in 1967 and construction of a three-strand curved-mold continuous casting machine for billets began. The company also plans to modernize and expand its bar mill.

CANADIAN PHOENIX STEEL & PIPE LTD.

In 1967, the company announced a $750,000-expansion to buildings and equipment at the Edmonton pipe plant and began construction on a program to double capacity at the Calgary large-diameter pipe plant. The Calgary expansion, to cost over $2-million, includes a second pipe mill plus additional heating and testing equipment.

CANADIAN STEEL FOUNDRIES, DIVISION OF HAWKER SIDDELEY CANADA LTD.

A $3-million expansion was completed in 1967; it included a 20-ton electric steelmaking furnace plus additional annealing and shot-blast facilities. Two 25-ton open hearth furnaces were dismantled.

DOMINION FOUNDRIES AND STEEL, LIMITED

Capital expenditures totalled $45.2 million in 1967, divided evenly between steel plant and mine development, compared with $81.7 million in 1966 and $44.8 million in 1965. Major units completed in 1967 included a 53-oven coke battery, the fourth oxygen plant (400 tpd), an automatic scarfing machine ahead of the hot strip mill, a 5-stand continuous cold-reduction mill, and several major air and water pollution-control facilities. The No. 3 sheet galvanizing line neared completion at year-end. The company announced a $10-million program to expand facilities for silicon electrical steel, including a continuous annealing furnace, high-temperature batch annealing furnaces and other equipment; completion is scheduled for late-1968. The company also plans a $3.5-million blast furnace turbo-blower to serve existing furnaces plus a new furnace on which engineering work has begun. Construction of the 90-per-cent-owned Sherman Mine and expansion of 16.4-per-cent-owned Wabush Mines both neared completion at the end of 1967. In 1967, Dofasco purchased two tracts of land, totalling 93 acres, adjoining its plant and early in 1968 acquired an additional 200 acres on Queen Elizabeth Way just east of the Hamilton city limits.

DOSCO STEEL LIMITED

The reversing slabbing and hot strip mills at Contrecoeur, Quebec, were completed in 1967 and three additional wire-drawing machines were installed at Montreal. No major capital expenditures are planned for 1968. After the company announced in October 1967 plans to close the Sydney Works, negotiations between the company and the Government of Nova Scotia resulted in an agreement by which the latter agreed to purchase substantially all the assets of the Sydney Works as of December 31, 1967. Sydney Steel Corporation was formed as a Crown agency to operate the plant until at least April 30, 1969. Sidbec, formed by the Government of the Province of Quebec to develop a steel plant in the province, was authorized to negotiate for the purchase of certain Dosco facilities outside the Maritime provinces.

FALCONBRIDGE NICKEL MINES, LIMITED

Early in 1968 the company announced plans to build a $35-million plant to produce reduced iron from pyrrhotite. The plant at Falconbridge, Ont., will produce 300,000 tons a year of pellets containing about 90 per cent iron and 1.5 per cent nickel. An associated sulphuric acid plant will be built by Allied Chemical Canada, Ltd.

FINA METAL LTD.

The company is building a $4.1-million plant at Pointe aux Trembles, Quebec, to produce about 16,000 tons a year of iron powder, beginning late in 1968.

INTERPROVINCIAL STEEL AND PIPE CORPORATION LTD.

A $2-million program to increase steel finishing capacity was completed in 1967 and the company announced plans to spend an additional $2 million on a large diameter spiral-weld pipe mill and $500,000 to expand ingot capacity. The pipe mill, capable of producing to 48,000 tons a year of pipe from 20 to 60 inches in diameter, was completed early in 1968. Ingot capacity will be raised to 200,000 tons a year later in 1968 by increasing furnace transformer capacity. A third electric furnace, acquired but not yet installed, will raise capacity to 350,000 tons a year when the company obtains a supply of primary iron, probably in the form of reduced pellets.

DOMINION BRIDGE COMPANY, LIMITED MANITOBA ROLLING MILL DIVISION

The company officially opened its new melt shop in June 1967. It consists of two 40-ton electric furnaces with an annual capacity of 160,000 tons and two twin-strand, curved-mold continuous casting machines for billets.

TABLE 14

Canada, Customs Tariffs on Selected Iron and Steel Items in 1967

	British Preferential	Most Favoured Nation	General	Tariff Item
Iron ore	free	free	free	32900-1
Iron and steel scrap	free	free	free	37301-1
				37302-1
				37303-1
Pig iron ($ per ton)	$1.50	$2.50	$2.50	37400-1
Ingots, n.o.p. ($ per ton)	free	$3.00	$5.00	37700-1
Semis (blooms, billets, slabs)	free	5%	10%	37800-1
Bars or rods, hot-rolled	5%	10%	20%	37900-1
Bars or rods, cold-rolled	5%	15%	25%	37905-1
Rods for wire manufacture ($ per ton)	free	$3.00	$5.00	37915-1
Shapes and sections either hot-rolled or cold-rolled				
General, n.o.p.	5%	10%	20%	38001-1
Large sections not made in Canada ($ per ton)	free	$5.00	$20.00	38002-1
	free	free	10%	38003-1
Plate, hot- or cold-rolled	5%	10%	20%	38100-1
Sheet and strip				
Hot-rolled	5%	10%	20%	38201-1
Cold-rolled	5%	15%	25%	38202-1
Coated with tin or enamel	10%	15%	25%	38203-1
Galvanized	7.5%	15%	25%	38204-1
Skelp (plate and sheet for pipe)	free	7.5%	15%	38400-1
Rails	5%	10%	20%	38700-1
Castings, n.o.p.	15%	17.5%	27.5%	39000-1
Forgings	17.5%	22.5%	30%	39200-1
Pipe, large diameter	10%	15%	30%	39900-1
Wire, n.o.p.	15%	15%	20%	40107-1

Note: Details for specific variations of which there are many can be found in the Department of National Revenue's The Customs Tariff and Amendments.
n.o.p. Not otherwise provided for.

PEACE RIVER MINING & SMELTING LTD.

The company announced plans for a $16-million iron powder plant near Windsor, Ont., to have an initial annual capacity of 50,000 tons, expandable to 100,000 tons. Production is expected to begin late in 1969 and will be based on a chemical process using scrap that was developed by the company in co-operation with the Alberta Research Council.

PRUDENTIAL STEEL LTD.

The company's pipe mill at Calgary, Alta., was completed early in 1967. The plant produces electric resistance-weld pipe from 2 to 8 inches in outside diameter. Annual capacity is about 120,000 tons in the product mix expected.

QUEBEC IRON AND TITANIUM CORPORATION (QIT)

A $13.5-million expansion program, raising pig iron and titania slag capacity by 20 per cent, was completed in 1967. A new furnace, the ninth, was placed into production. Early in 1968, the company announced that a wholly-owned subsidiary, Quebec Metal Powders Limited, would build an $8-million plant at Sorel to produce 70,000 tons a year of iron powder from QIT iron. Plant completion is scheduled for late 1968.

SIDBEC

The company began negotiations to purchase certain steel industry assets of Dominion Steel and Coal Corporation, Limited.

THE STEEL COMPANY OF CANADA, LIMITED

Capital expenditures were $89.2 million in 1967, compared with $99.5 million in 1966 and $75.5 million in 1965. At the year-end, the amount still to be spent on approved capital projects was $32 million, compared with $112 million a year earlier, reflecting the near-completion of the company's recent major expansion program. Major projects nearing completion at the Hilton Works at year-end included a large blast furnace (the fifth), a third continuous galvanizing line for 60-inch coils, and a 73-oven coke battery. Miscellaneous improvements to increase steelmaking, slabbing, plate and skelp capacity will be completed in the first half of 1968. A billet reheating furnace is being installed at the Premier Works in Edmonton, Alta., a second electro-galvanizing line for wire was completed at the Dominion Works in Lachine, Quebec, and additional facilities were added and improvements made at a number of other company plants. The company's new research centre at Burlington, Ont. was officially opened in June. Expansion at Erie Mining Company, a producer of pellets in Minnesota and owned 10 per cent by Stelco, and development of the wholly-owned Chisholm coal mine in Kentucky, were completed in 1967. Expansion of the 25.6-per-cent-owned Wabush Mines and construction of the 90-per-cent-wholly-owned Griffith Mine near Red Lake, Ont., both producers of iron ore pellets, will be completed early in 1968. In March 1968, the company announced that it was seeking options on a large parcel of land on Lake Erie near Nanticoke, Ont., for possible long-range expansion.

PRICES AND TARIFFS

Early in 1967, several producers revised their list prices on a wide range of steel products resulting in some decreases (certain rod, bar and merchant products, electrical sheet, and plate delivered to eastern Canada) and some increases of between 2 and 3 1/2 per cent (for hot- and cold-rolled and galvanized sheet and strip, heavy structurals and specialty bar products). Some of the increases were either rescinded for, or did not apply to, western Canada. A few price changes were made during the rest of the year, notably increases for stainless steel because of higher nickel costs.

Negotiations at the Kennedy Round under the General Agreement on Tariffs and Trade (GATT) resulted in agreement to reduce certain Canadian MFN tariffs on iron and steel products (Table 15) and to revise Canadian laws and regulations to conform to the International Code on Anti-dumping.

TABLE 15

Canada, Revisions to Iron and Steel Tariffs Negotiated at the Kennedy Round, GATT, 1967

		Most Favoured Nation	
	Tariff Item	As of Dec. 31, 1967	Eventual*
Pig iron, n.o.p. ($ per ton)	37400-1	$2.50	free
Ingots of iron or steel, n.o.p. ($ per ton)	37700-1	3.00	free
Bars or rods, cold-rolled	37905-1	15%	12 ½%
Sheet or strip, cold-rolled	38202-1	15%	12 ½%
Sheet or strip, coated tin or enamel	38203-1	15%	12 ½%
Sheet or strip, galvanized	38204-1	15%	12 ½%
Castings, iron or steel rough, n.o.p.	39000-1	17.5%	15%
Forgings	39200-1	22.5%	17 ½%

*The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Lead

J.G. GEORGE*

Canada's recoverable production of lead rose to 321,563 short tons in 1967, about 7 per cent more than in 1966 and the highest on record. An increase of almost 26 per cent in output from the Northwest Territories, together with smaller increases in Newfoundland, Ontario, Manitoba and Saskatchewan, offset decreases in the other provinces and the Yukon Territory. Higher production by Pine Point Mines Limited in the N.W.T. and substantial byproduct output from the Kidd Creek base-metal mine of Ecstall Mining Limited, a wholly-owned subsidiary of Texas Gulf Sulphur Company, near Timmins, Ontario, accounted for most of the 7 per cent rise in total output. Also contributing to the increase were smaller amounts from Nigadoo River Mines Limited near Bathurst, New Brunswick, Share Mines & Oils Ltd. in the Hanson Lake area of Saskatchewan, and Western Mines Limited on Vancouver Island, British Columbia, all of which came into production in 1967. The value of Canadian output was only slightly higher than that of 1966 because of lower prices.

Refined lead output totalled 190,279 tons compared with 184,871 tons in 1966. Cominco Ltd. operated its smelter and refinery at Trail, British Columbia, at close to capacity of 190,000 tons annually. At Belledune, New Brunswick, East Coast Smelting and Chemical Company Limited, a subsidiary of Brunswick Mining and Smelting Corporation Limited, began production of primary lead metal early in 1967 from an Imperial Smelting Furnace, which has an annual capacity of 33,000 tons. Secondary smelters in 1966, the latest year for which statistics are available, shipped 32,454 tons of antimonial lead and unalloyed lead recovered from secondary materials; shipments in 1965 were 34,497 tons.

Most of the lead ores and concentrates from western Canada were treated by Cominco Ltd. at Trail, British Columbia; the remainder were treated at plants in northwestern United States, Japan and Europe. Lead concentrates produced in eastern Canada, excluding that portion of the output of Brunswick Mining and Smelting Corporation Limited smelted at the East Coast plant, were shipped to smelters in Europe and the United States.

Exports of ores and concentrates increased again and were almost 12 per cent higher than in 1966, with more than a third of them going to Japan, and a half to Belgium and the United States. Metal exports were nearly 25 per cent higher than in 1966. Britain and the United States were again the main markets.

Reported consumption of primary and secondary lead in Canada was 3 per cent less than in 1966. Less use of primary lead for semi-finished products and cable covering, and lower consumption of secondary lead in the production of antimonial lead were mainly responsible for the decrease.

UNITED STATES IMPORTS AND STOCKPILES

United States imports of lead metal and lead in ores and concentrates in 1967 totalled 488,400 tons, 13 per cent greater than those of 1966. In January 1967, further legislation was introduced in the House of Representatives and the Senate to establish flexible import quotas on lead and zinc ores and metal. The Bills, H.R. 51 and S. 289, were referred to Congressional Committees for further study.

*Mineral Resources Branch.

TABLE 1

Canada, Lead Production, Trade and Consumption, 1966-67

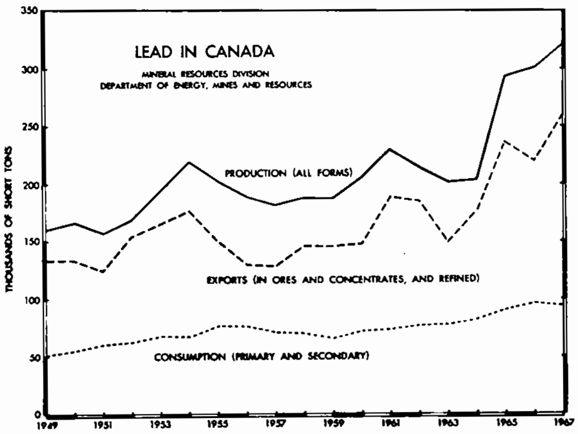
	1966		1967p	
	Short Tons	$	Short Tons	$
Production				
All forms[1]				
Northwest Territories	105,330	31,472,562	132,500	37,100,000
British Columbia	105,747	31,598,418	102,332	28,652,840
New Brunswick	51,864	15,497,058	45,361	12,701,192
Newfoundland	21,754	6,500,156	23,500	6,580,042
Yukon	7,988	2,386,684	7,401	2,092,164
Ontario	1,985	593,188	5,055	1,415,309
Quebec	3,909	1,167,975	2,095	586,695
Manitoba	557	166,371	1,926	539,375
Saskatchewan	–	–	1,000	280,000
Nova Scotia	1,488	444,660	393	109,903
Total	300,622	89,827,072	321,563	90,057,520
Mine Output[2]	323,175		349,300	
Refined[3]	184,871		190,279	
Exports				
Lead contained in ores and concentrates				
Japan	13,125	2,316,000	42,634	6,868,000
Belgium and Luxembourg	33,003	5,313,000	31,512	4,037,000
United States	56,095	10,038,000	30,299	5,386,000
West Germany	5,057	822,000	17,872	2,440,000
Britain	4,652	740,000	2,625	371,000
Other countries	1,002	192,000	1,252	159,000
Total	112,934	19,421,000	126,194	19,261,000
Lead in pigs, blocks and shot				
Britain	43,046	9,985,000	51,179	9,793,000
United States	36,304	10,476,000	45,604	12,148,000
Netherlands	10,209	2,439,000	9,712	1,853,000
West Germany	2,913	697,000	8,587	1,637,000
India	7,788	1,850,000	7,579	1,636,000
Japan	2,651	689,000	3,468	681,000
Italy	580	142,000	1,887	367,000
Denmark	224	45,000	1,579	305,000
Pakistan	173	50,000	896	182,000
Norway	–	–	451	86,000
Other countries	2,580	628,000	1,378	281,000
Total	106,468	27,001,000	132,320	28,969,000
Lead and lead-alloy scrap (gross weight)				
United States	3,412	676,000	5,404	987,000
Britain	160	46,000	433	98,000
Venezuela	–	–	113	19,000
Belgium and Luxembourg	–	–	45	11,000
Japan	159	70,000	29	62,000
Other countries	754	128,000	10	2,000
Total	4,485	920,000	6,034	1,179,000

TABLE 1 (Cont'd)

	1966		1967P	
	Short Tons	$	Short Tons	$
Lead fabricated materials not elsewhere specified				
United States	1,746	611,000	2,480	855,000
West Germany	3	1,000	283	52,000
India	203	162,000	29	21,000
Britain	–	–	23	6,000
Jamaica	30	11,000	23	8,000
Other countries	136	48,000	18	10,000
Total	2,118	833,000	2,856	952,000
Imports				
Lead pigs, blocks and sheet	626	188,000	438	139,000
Lead oxide; litharge, red lead, mineral orange	1,504	541,000	2,441	711,000
Lead fabricated materials, not elsewhere specified	227	237,000	304	252,000
Total	2,357	966,000	3,183	1,102,000

	1966			1967P		
	Primary	Sec.[4]	Total	Primary	Sec.[4]	Total
	(short tons)			(short tons)		
Consumption						
Lead used for, or in, the production of:						
Antimonial lead	2,446	17,612	20,058	1,554	15,957	17,511
Battery and battery oxides	21,495	2,539	24,034	21,851	2,207	24,058
Cable covering	5,476	1,914	7,390	4,138	1,385	5,523
Chemical uses: white lead, red lead, litharge, tetraethyl lead, etc.	14,652	2,725	17,377	20,688	3,168	23,856
Copper alloys: brass, bronze, etc.	483	53	536	321	59	380
Lead alloys – Solders	2,895	2,849	5,744	2,545	2,089	4,634
– Others (including babbitts, type metal, etc.)	465	2,114	2,579	568	1,749	2,317
Semifinished products: pipe, sheet, traps, bends, blocks for caulking, ammunition, foil, collapsible tubes, etc.	13,665	1,674	15,339	11,256	802	12,058
Other	2,267	1,359	3,626	2,309	1,307	3,616
Total	63,844	32,839	96,683	65,230	28,723	93,953

Source: Dominion Bureau of Statistics.
[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] Lead content of domestic ores and concentrates produced. [3] Primary refined lead from all sources. [4] Includes all remelt scrap lead and scrap lead used to make antimonial lead.
[P] Preliminary; – Nil.



In April 1965, the United States government authorized the release of 200,000 short tons of lead from its stockpiles, which included 50,000 tons for governmental use only. Of the 200,000 tons authorized for sale, 126,997 tons were sold to the end of 1967. The stockpile lead inventory at the end of 1967 amounted to some 1.19 million tons, all of which was considered to be surplus to conventional and nuclear war requirements.

WORLD PRODUCTION AND CONSUMPTION

Non-communist world mine production of lead, at 2.40 million short tons in 1967, was 2 per cent higher than in 1966. Greater production in Canada, Ireland, and Peru more than offset substantial decreases in the Republic of South Africa and United States. Canada became the non-communist world's second largest mine producer, with Australia retaining its position as the leading producer. Non-communist world production of refined lead was an estimated 3.01 million short tons, about 12,700 tons more than in 1966. West Germany, Japan, Britain and Belgium were the countries reporting the largest increases. Output in the United States, where many smelters and refineries were closed by a strike that lasted from July 1967 to the end of the first quarter of 1968, decreased from 867,100 tons in 1966 to 779,800 tons.

Consumption of lead in the non-communist world, at 3.05 million short tons in 1967, was slightly less than in 1966. In the United States, which is the world's largest consumer and which took almost 30 per cent of Canada's combined exports of lead concentrates and metal in 1967, consumption was 1.13 million tons compared with 1.19 million tons in 1966. Most of the decrease resulted from reductions in the production of caulking lead, red lead, litharge and solder, and in the manufacture of storage batteries.

In reviewing the statistical position for lead at its October 1967 meeting in Geneva, Switzerland, the International Lead and Zinc Study Group reported that non-communist world supply and demand were well balanced in 1967, although they were at lower

TABLE 2

Canada, Lead Production, Trade and Consumption, 1958-67
(short tons)

	Production		Exports				
	All Forms[1]	Refined[2]	In Ores & Concentrates	Refined	Total	Imports Refined [3]	Consumption[4]
1958	186,680	132,987	54,081	92,351	146,432	1,668	69,769
1959	186,696	135,296	53,726	92,252	145,978	1,810	65,935
1960	205,650	158,510	51,336	96,449	147,785	620	72,087
1961	230,435	171,833	70,967	117,637	188,604	1,121	73,418
1962	215,329	152,217	59,495	125,802	185,297	578	77,286
1963	201,165	155,000	53,756	97,144	150,900	1,741	77,958
1964	203,717	151,372	80,357	95,867	176,224	73	82,736
1965	291,807	186,484	106,964	129,065	236,029	71	90,168
1966	300,622	184,871	112,934	106,468	219,402	626	96,683
1967p	321,563	190,279	126,194	132,320	258,514	438	93,953

Source: Dominion Bureau of Statistics.
[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.

TABLE 3

Non-communist World Mine Production of Lead, 1966-67
(short tons)

	1966	1967P
Australia	399,500	407,900
Canada	323,200	349,300
United States	341,100	322,300
Mexico	185,400	183,600
Peru	159,600	174,400
Yugoslavia	113,100	116,800
Morocco	86,000	. .
Sweden	76,300	78,900
Republic of South Africa	99,000	77,400
West Germany	66,800	71,300
Japan	69,600	70,000
Spain	68,800	69,000
Ireland	44,100	64,300
Italy	40,600	42,700
Other countries	273,800	. .
Total	2,346,900	2,395,400*

Source: International Lead and Zinc Study Group.
* Total includes estimates for those countries for which figures are not available.
P Preliminary; . . Not available.

levels than estimated a year earlier at the previous session of the Study Group. For 1968 the forecast was that mine and metal production would resume their rapid growth of recent years. Consumption, however, was not expected to rise so much and a statistical surplus of about 6 per cent of current metal production was anticipated. The Group said, however, that production had been generally over-estimated in recent years and that any surplus might be less than forecast.

Lead smelter capacity was increased in 1967 with the opening of new plants in Canada and Japan and an expansion of capacity from 120,000 to 200,000 tons annually at the Herculaneum, Missouri, plant of St. Joseph Lead Company. In 1968, Imperial Smelting Furnace (ISF) plants were scheduled to open in Britain and Poland, and two new lead smelters, with total annual capacity of 180,000 tons of refined lead, were scheduled to begin operations in southeast Missouri to treat new mine production from that district. A 30-per-cent increase in capacity was also planned in 1968 at a lead smelter in Yugoslavia. An ISF plant was expected to open in Japan in 1969 and one in Sardinia in 1970.

Mine output is expected to increase in 1968 following the opening of the Silvermines mine in Ireland and of two mines in the new Missouri Lead Belt, the Magmont and the Buick. The Magmont mine, near Salem, is a joint venture of Cominco American Incorporated, a wholly-owned subsidiary of Cominco Ltd., and Dresser Industries, Inc., of Dallas, Texas; it is scheduled to begin production in the spring of 1968 at a rate of 70,000 tons of lead concentrate annually. Mines already in operation in this important mining district are the Viburnum, opened in 1960, and the Fletcher, opened in 1967. In the second half of 1969, the Anvil mine in Canada is scheduled to start operations at an annual rate of 90,000 tons of lead in concentrates. Large increases in Australia's mine output are also planned to begin in the period from 1968 to 1970.

CANADIAN DEVELOPMENTS

YUKON TERRITORY

Late in 1967, United Keno Hill Mines Limited curtailed underground development at its producing mines and reduced mining and milling operations because of a depletion of ore reserves and a serious shortage of skilled miners. In order to permit underground exploration and development of the company's Husky claims, in the vicinity of the Elsa mine, a 500-foot shaft will be sunk starting in March 1968. United Keno Hill also began underground development work to rehabilitate the old Sadie Ladue workings for re-evaluation. In August 1967, Anvil Mining Corporation Limited announced plans to bring into production its zinc-lead-silver property in the Vangorda Creek area about 130 miles northeast of Whitehorse. Anvil is owned 60 per cent by Cyprus Mines Corporation, Los Angeles, California, and 40 per cent by Dynasty Explorations Limited. Further drilling during 1967 increased ore reserves in the Faro orebodies to approximately 63 million tons averaging more than 9 per cent combined lead and zinc and over 1 ounce of silver a ton. In 1967, Anvil began construction of a 5,500-ton-a-day concentrator and began stripping of waste rock from its open-pit mine. Initial production was scheduled for late 1969 at an annual rate of 130,000 tons of lead concentrates averaging 69 per cent lead and 240,000 tons of zinc concentrates averaging 54 per cent zinc.

Following discovery of zinc-lead mineralization at its Pay property east of Fortin Lake, Atlas Explorations Limited planned a diamond drilling program to begin early in 1968. Kerr Addison Mines Limited conducted a geochemical survey over its Swim Lakes lead-zinc-silver property in the Vangorda Creek area. The survey disclosed an anomalous zone which will be trenched in 1968. Metallurgical testing of material from the known deposit on the property was initiated.

NORTHWEST TERRITORIES

Pine Point Mines Limited, 69 per cent owned by Cominco Ltd., remained Canada's largest mine producer of lead. Output from its zinc-lead property at Pine Point, Northwest Territories, was 125,640 tons in 1967, about 36 per cent of Canada's mine production of lead. In 1967, high grade ore accounted for 42 per cent of the total sales revenue and the quantity shipped was 333,000 tons averaging 18.0

per cent lead and 27.9 per cent zinc. The company continued preparation of its Pyramid zinc-lead orebodies for open-pit production. The Pyramid mining claims were purchased from Pyramid Mining Co. Ltd. in June 1966. To treat the Pyramid ore, a new 3,000-ton-a-day addition to Pine Point's existing 5,000-ton concentrator is scheduled for completion late in 1968. At the end of 1967, ore reserves totalled 40,500,000 tons averaging 2.6 per cent lead and 6.8 per cent zinc.

Coronet Mines Ltd. continued exploration work at its property in the Pine Point area. Previous work indicated a mineral deposit of 1.1 million tons grading 13.2 per cent combined lead and zinc. The deposit adjoins the property of Pine Point Mines Limited. Yellowknife Base Metals Limited, a subsidiary of Consolidated Manitoba Mines Limited, carried out diamond drilling and exploration work on its lead-zinc property in the Pine Point area, about 5 miles east of Buffalo River.

BRITISH COLUMBIA

Combined output at the Sullivan and Bluebell mines, owned and operated by Cominco Ltd. in southeastern British Columbia, was slightly lower than in 1966. Lead concentrates from these mines, from Pine Point Mines Limited, and from custom shippers were treated at the Trail metallurgical works where refined lead output was 187,600 tons. Combined production of refined lead and zinc was derived approximately 30 per cent from the Sullivan mine, 59 per cent from the Pine Point mine, 8 per cent from other company mines and from accumulated slags and residues, and 3 per cent from purchased ores and concentrates.

Two zinc-lead silver mines in southeastern British Columbia suspended operations late in 1967. The first closure was that of the Mineral King mine of Aetna Investment Corporation Limited, in the Invermere district, which began production in 1954. The company changed its name from "Sheep Creek Mines Limited" to its present name in 1965. The second closure was that of Giant Soo Mines Limited which brought back into production the old Estella mine near Cranbrook in August 1966. Columbia River Mines Ltd. continued exploration and underground development work at its silver-lead-zinc property near Golden and conducted production feasibility studies.

ONTARIO

In 1967, Ecstall Mining Limited, with a 9,000-ton-a-day concentrator, completed its first full year's operation at its zinc-copper-silver-lead property near Timmins, and became the province's largest mine producer of lead. Diamond drilling and exploration work continued at the Trout Bay copper-zinc-lead prospect of Cochenour Willans Gold Mines, Limited in the Red Lake district. Golsil Mines Limited arranged to repair or replace buildings and equipment that were damaged in a fire at its silver-gold-lead-zinc prospect in the Favourable Lake area of northwestern Ontario. The company expected to dewater the shaft and proceed with its underground development program.

QUEBEC

Sinking of the winze and other preliminary development work continued at the property of D'Estrie Mining Company Ltd., a new affiliate of the Sullivan group of companies. Diamond drilling on the company's property, adjoining that of Cupra Mines Ltd. at Stratford Place in the Eastern Townships, has outlined a zone containing 300,000 tons averaging 3.81 per cent copper, 4.25 per cent zinc, 0.94 per cent lead, 0.015 ounce of gold and 1.31 ounces of silver a ton.

NEW BRUNSWICK

East Coast Smelting and Chemical Company Limited, a subsidiary of Brunswick Mining and Smelting Corporation Limited, began production of primary lead and zinc metal at its Imperial Smelting type blast furnace at Belledune. Intermittent operations at much less than full capacity resulted in the production of 5,800 tons of lead. In June 1967, Brunswick Mining and Smelting Corporation Limited accepted an offer from Noranda Mines Limited to provide additional financing and take over its management, with the option of eventually acquiring 51 per cent of Brunswick's voting shares.

Completion of a diamond drilling program during 1967 resulted in substantial additions to indicated ore reserves at the zinc-lead-copper-silver property of Heath Steele Mines Limited, 40 miles northwest of Newcastle. Work on the shaft sinking and mine development program, initiated in 1965, was on schedule and completion was expected during the second quarter of 1968. Treatment of custom ore from another nearby mine was expected to cease about mid-1968 when the mill will be converted to process increased ore production from the Heath Steele mine.

Exploration work continued on the property of Chesterville Mines Limited in Northumberland county and a new company, Chester Mines Limited, was incorporated by the Sullivan group of companies to take over the property. Metallurgical tests were being conducted and a feasibility study will follow. Diamond drilling had indicated 4.2 million tons of potential open-pit ore with average grade, before dilution, calculated to be 0.82 per cent copper. Some 1.2 million tons of this ore in the central massive sulphide and east zones also contains about 2.0 per cent zinc and 0.8 per cent lead. Cominco Ltd. was granted the right to acquire a 25-per-cent interest in the Caribou zinc-lead-copper property of The Anaconda Company (Canada) Ltd. some 36 miles west of Bathurst. Joint efforts of both companies were concentrated on metallurgical research work on material from the deposit, which is one of the larger known sulphide deposits in the province and has a potential of 25 to 50 million tons.

TABLE 4

Principal Lead Producers in Canada, 1967

Company and Location	Mill Capacity (short tons ore/day)	Grade of Ore Milled in 1967 (principal metals): Lead (%)	Zinc (%)	Copper (%)	Silver (oz/ton)	Ore Produced 1967 (1966) (short tons)	Lead in Concentrates and Direct-Shipping Ores 1967 (1966) (short tons)	Remarks
BRITISH COLUMBIA								
Aetna Investment Corporation Limited, Mineral King mine, Toby Creek	500	1.60	4.35	..	..	111,332 (114,737)	1,850 (1,612)	Operations suspended in November 1967.
Canadian Exploration, Limited, Jersey mine, Salmo	1,900	1.04	2.87	–	..	493,029 (417,440)	4,574 (3,249)	
Cominco Ltd., Sullivan mine, Kimberley	10,000	..	..	–	..	2,118,377 (2,135,660)	90,169 (88,861)	
Bluebell mine, Riondel	700	..	..	–	..	255,536 (246,390)	10,879 (12,733)	
Giant Soo Mines Limited, Estella mine, Wasa	150	5.5	10.3	–	2.46	31,743 (11,141)	1,661 (514)	Operations suspended in October 1967.
Mastodon-Highland Bell Mines Limited, Beaverdell	100	1.47	1.37	–	20.98	34,020 (24,138)	502 (528)	
Reeves MacDonald Mines Limited, Remac	1,200	0.89	3.14	–	0.06	404,782 (395,921)	2,768 (3,989)	
Utica Mines Ltd., Keremeos	350	..	..	–	..	38,442 (–)	40 (–)	Began production in August 1967.
Western Mines Limited, Myra Falls, Vancouver Island	750	0.8	8.2	1.90	2.0	293,276 (–)	2,369 (–)	Started production early in 1967.
YUKON TERRITORY – NORTHWEST TERRITORIES								
United Keno Hill Mines Limited, Calumet, Elsa, Keno and Comstock Keno mines, Mayo district, Y.T.	500	7.97	5.89	–	37.69	106,189 (120,374)	7,735 (8,324)	
Pine Point Mines Limited, Pine Point, N.W.T.	5,000	4.7	9.7	–	..	1,521,279[1] (1,457,990)[1]	125,640 (121,023)	

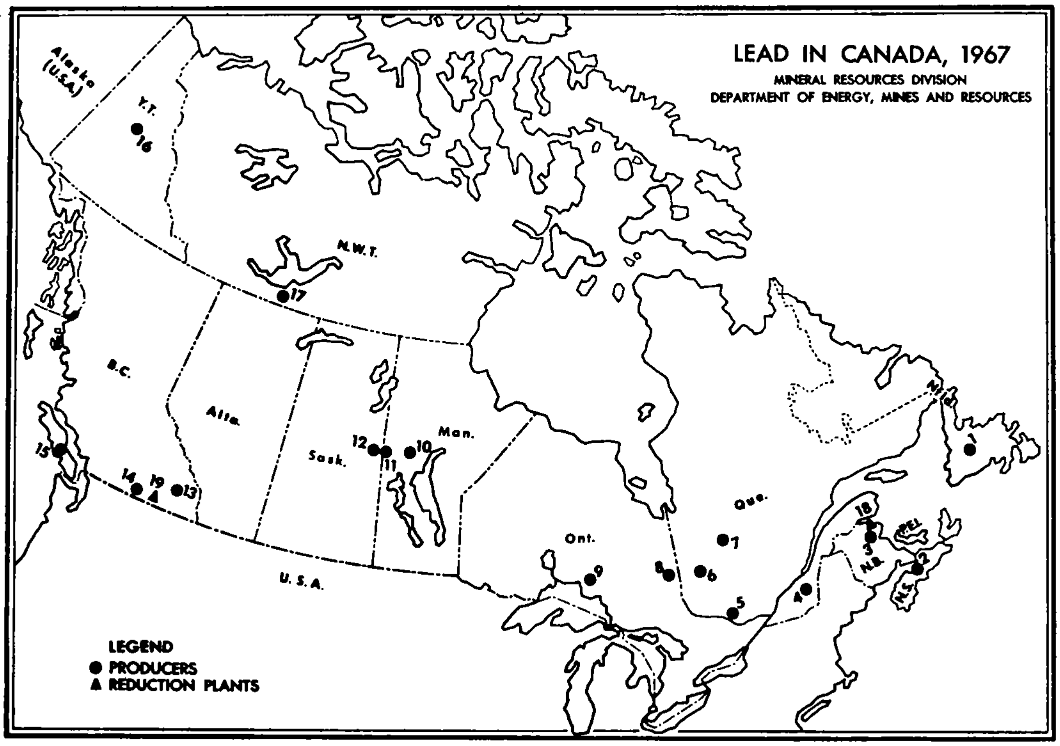
TABLE 4 (Cont'd)

Company and Location	Mill Capacity (short tons ore/day)	Grade of Ore Milled in 1967 (principal metals) Lead (%)	Zinc (%)	Copper (%)	Silver (oz/ton)	Ore Produced 1967 (1966) (short tons)	Lead in Concentrates and Direct-Shipping Ores 1967 (1966) (short tons)	Remarks
MANITOBA – SASKATCHEWAN								
Hudson Bay Mining and Smelting Co., Limited, Flin Flon mine, Flin Flon, Man.	6,000 (treated at central mill at Flin Flon)	0.2	3.00	2.24	0.71	943,811 (1,044,206)	1,821[2] (566)[2]	
Chisel Lake mine, Snow Lake, Man.		0.99	10.56	0.63	1.17	254,118 (250,524)		
Share Mines & Oils Ltd., Hanson Lake mine, Hanson Lake area, Sask.	350	4.85	8.11	0.46	5.25	41,898 (–)	1,592 (–)	Began operations in June 1967.
ONTARIO								
Ecstall Mining Limited (Texas Gulf Sulphur Company), Kidd Creek mine, Timmins	9,000	0.3	9.0	1.9	3.0	3,039,219 (. .)	5,000 (. .)	
Noranda Mines Limited (Geco Division), Manitouwadge	3,700	0.13	3.69	2.02	2.02	1,461,000 (1,459,586)	1,128 (836)	
Willroy Mines Limited, Manitouwadge	1,700	0.12	3.3	0.66	1.25	165,053) (219,400)	165 (443)	
Willecho Mines Limited, Lun-Echo mine, Manitouwadge	ore custom-milled	0.19	3.52	0.58	1.91	338,437 (325,738)	564 (639)	
QUEBEC								
The Coniagas Mines, Limited, Coniagas mine, Bachelor Lake	500	0.39	4.99	–	2.71	41,398 (140,093)	153 (600)	Operations suspended in May 1967.
Cupra Mines Ltd., Cupra mine, Stratford Place	1,500[3]	0.42	3.16	3.42	1.344	308,347 (158,130)	1,156 (157)	
Manitou-Barvue Mines Limited, Golden Manitou mine, Val d'Or	1,300	0.14	2.57	. .	1.34	181,350 (173,130)	223 (455)	Copper and zinc ore milled separately.
		–	–	0.70	. .	294,640 (295,875)	– (–)	

TABLE 4 (Cont'd)

Company and Location	Mill Capacity (short tons ore/day)	Grade of Ore Milled in 1967 (principal metals)				Ore Produced 1967 (1966) (short tons)	Lead in Concentrates and Direct-Shipping Ores 1967 (1966) (short tons)	Remarks
		Lead (%)	Zinc (%)	Copper (%)	Silver (oz/ton)			
New Calumet Mines Limited, Calumet Island	800	2.19	7.35	0.16	4.33	90,779 (95,761)[4]	1,881 (1,924)[4]	
Solbec Copper Mines, Ltd., Stratford Place	ore custom-milled	0.78	4.54	1.39	1.694	75,310 (154,795)	524 (1,021)	Production curtailed by labour lockout which lasted from September 9, 1966 until March 7, 1967.
NEW BRUNSWICK								
Brunswick Mining and Smelting Corporation Limited,								
No. 12 mine, Bathurst	4,500	3.47	9.07	0.29	2.39	1,669,000 (1,650,100)	.. (..)	
No. 6 mine, Bathurst	2,250	2.93	5.96	0.40	1.79	867,400 (300,700)	.. (..)	
Heath Steele Mines Limited, Newcastle	1,500[5]	2.71	8.87	0.56	2.64	308,866 (287,515)	6,166 (3,829)	
Nigadoo River Mines Limited, Bathurst	1,000	2.15	2.06	0.43	3.22	22,630 (–)	359 (–)	Began operations in November 1967.
NOVA SCOTIA								
Dresser Minerals, Division of Dresser Industries, Inc., Walton	125	3.4	0.4	0.32	7.4	50,330 (50,213)	1,749 (1,432)	Name changed from Magnet Cove Barium Corporation.
NEWFOUNDLAND								
American Smelting and Refining Company, (Buchans Unit), Buchans	1,250	7.52	13.51	1.15	4.04	378,000 (355,000)	27,301 (24,752)	

Source: Company reports.
[1] Figures represent tons of ore milled. In 1967, company also shipped 333,000 tons of direct-shipping ore of grade averaging 18.0 per cent lead and 27.9 per cent zinc. [2] Lead content of lead concentrates only. [3] In 1967, the company acquired the 1,500-ton mill of Solbec Copper Mines, Ltd. [4] Statistics for 1966 refer to production for fiscal year ended September 30, 1966. [5] Part of Heath Steele's mill capacity used to treat copper ore from nearby Wedge mine operated by Cominco Ltd.
– Nil; . . Not available.



PRINCIPAL PRODUCERS

(numbers refer to numbers on the map)

1. American Smelting and Refining Company (Buchans Unit)
2. Dresser Minerals, Division of Dresser Industries, Inc.
3. Brunswick Mining and Smelting Corporation Limited (Nos. 12 and 6 mines)
   Heath Steele Mines Limited
   Nigadoo River Mines Limited
4. Cupra Mines Ltd.
   Solbec Copper Mines, Ltd.
5. New Calumet Mines Limited
6. Manitou-Barvue Mines Limited
7. The Coniagas Mines, Limited
8. Ecstall Mining Limited
9. Noranda Mines Limited (Geco Division)
   Willecho Mines Limited
   Willroy Mines Limited
10. Hudson Bay Mining and Smelting Co., Limited (Chisel Lake mine)
11. Hudson Bay Mining and Smelting Co., Limitea (Flin Flon mine)
12. Share Mines & Oils Ltd.
13. Aetna Investment Corporation Limited (Mineral King mine)
    Canadian Exploration, Limited
    Cominco Ltd. (Bluebell mine, Sullivan mine)
    Giant Soo Mines Limited
    Reeves MacDonald Mines Limited
14. Mastodon-Highland Bell Mines Limited
    Utica Mines Ltd.
15. Western Mines Limited
16. United Keno Hill Mines Limited
17. Pine Point Mines Limited

REDUCTION PLANTS

18. East Coast Smelting and Chemical Company Limited
19. Cominco Ltd.

USES

Many useful chemical and mechanical properties give lead a wide range of industrial applications. Lead is soft, ductile, malleable and easily worked. It alloys readily with many other metals, has a high specific gravity, high boiling point, low melting point, and good corrosion resistance.

The major uses of lead are for storage batteries, gasoline antiknock additives, solders and type metals, and pigments. It is also used extensively for cable sheathing and in the manufacture of ammunition and collapsible tubes, corrosive-liquid containers, various types of lead-base babbitts, caulking materials, and plumbing equipment such as pipes, drains and bends. Smaller quantities are used in the manufacture of ceramics, rubber, and in oil refining.

Because of its unique sound attenuation characteristics, lead is being increasingly used in the architectural and building fields for acoustical privacy and noise reduction in both commercial and residential construction. In the allied field of vibration isolation, lead-asbestos antivibration pads are widely used in foundations for office buildings, hotels and apartments exposed to severe vibration from nearby trains, subways, or heavy haulage vehicles. Because of its sound control qualities lead is also used in the mounting of various types of equipment including air-conditioning systems, printing presses and commercial laundry machines.

TABLE 5

United States Consumption of Lead by End-Use, 1966-67
(short tons)

	1966	1967P
Batteries	472,492	454,859
Gasoline antiknock additives	246,879	247,170
Pigments	119,888	100,308
Solder, type metal, terne metal and bearing metals	132,873	108,990
Ammunition and collapsible tubes	90,422	88,907
Caulking	63,250	46,990
Cable sheathing	66,491	62,644
Sheet and pipe	48,922	42,748
Miscellaneous	82,660	63,829
Estimated undistributed consumption	–	23,800
Total	1,323,877	1,240,245

Source: US Bureau of Mines Mineral Industry Surveys, United States Lead Indu..y, December 1967.
P Preliminary; – Nil.

Other miscellaneous uses include ship ballast, wheel weights, roofing systems, sprayed lead coatings, various alloys and terne steel, and as lead-ferrite for permanent magnets in small electric motors. Relatively new and growing uses are for leaded porcelain-enamelled aluminum and for radiation shielding against gamma rays in nuclear power reactors, nuclear-powered merchant ships and submarines, and shipping casks for transporting radioactive materials. Research is developing new markets for organometallic lead compounds in lubricating oils, antifouling paints, as wood impregnants for repelling marine borers, biocides, fungicides, insecticides, curing agents for rubber and polyurethane foam catalysts.

Refined lead is marketed in several grades that vary mainly according to the content of impurities, which include silver, copper, arsenic, antimony, tin, zinc, iron and bismuth. The three principal grades are: corroding (99.94%), chemical (99.90%) and common desilverized (99.85%). The corroding grade has the highest purity and is used chiefly in the manufacture of pigments, battery oxides, and tetraethyl lead. Common lead finds its greatest use in industrial and home construction. Chemical lead possesses superior creep and corrosion resistance and is ideally suited for cable sheathing.

PRICES AND TARIFFS

The Canadian price, f.o.b. Toronto and Montreal, remained unchanged throughout 1967 at 14 cents a pound. The US domestic price for common lead, f.o.b. New York, also remained unchanged at 14 cents a pound. Between January 1 and November 17, 1967, the London Metal Exchange (LME) settlement and cash sellers' price fluctuated between a low of £78.125 per long ton on February 7 and a high of £86.375 on July 25. LME quotations were adjusted upwards following devaluation of the pound sterling on November 17 and, during the post-devaluation part of the year, the low and high prices were £93.375 and £95.500, respectively.

Canadian and US tariffs in 1967 were as follows:

	British Preferential	Most Favoured Nation	General
CANADA			
Lead in ores and concentrates	free	free	free
Lead, old, scrap, pig and block, per lb.	1/2¢	1/2¢	1¢
Lead in bars and sheets	10%	10%	25%
UNITED STATES			
Lead in ores and concentrates	0.75¢ per lb on lead content		
Lead, bullion, waste and scrap	1.0625¢ per lb on 99.6% of lead content		
Other forms of unwrought lead	1.0625¢ per lb on lead content		

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT) that was convened in 1964 to consider reductions in tariffs submitted its report in 1967. Agreement was reached on a series of reductions of lead tariffs in some countries with reductions beginning on January 1, 1968 and final reductions on January 1, 1972.

EXPANSION: only eighteen months after the 5,000 ton mill of Pine Point Mines Limited on the south shore of Great Slave Lake, Northwest Territories was constructed a 3,000 ton addition was added to process zinc-lead ore from the company's nearby Pyramid deposit scheduled for production by the end of 1968.

Lime

D.H. STONEHOUSE*

During 1967 production of commercial lime in Canada decreased–preliminary statistics indicate a reduction of 13 per cent to 1.35 million tons valued at $16.7 million. The iron and steel industry and the pulp and paper industry, the two largest single consumers of lime, were less active during 1967 and the amount of lime consumed by each was reduced significantly.

Information on lime consumption is obtained from the producers, not from an individual survey of lime users. In some cases the end use to which the lime is put is not known. From available information, the group of industries falling into the chemical and metallurgical field continues to use about 85 per cent of the lime produced; a considerable portion of this amount is used captively. In the construction field, the competition continues between mason's lime and masonry cement and between finishing lime and hardwall, while consumption of lime for these purposes remains quite steady. Lime used for production of sand-lime brick shows a slight increase but the use of this type of brick in Canada and in the United States has not developed as it has in European countries.

The amount of lime used in water and sewage treatment plants and the amount used for soil stabilization are comparatively small. Increasing consumption for these purposes is expected.

PRODUCTION

Lime industries have been established near major urban and industrial centres in Canada where, fortunately, there are ample reserves of limestone suitable for the manufacture of high-quality lime for various uses, and where most of the large consumers of lime are located. The cost of transportation of a relatively low-cost, high-bulk commodity such as lime limits the area in which a lime manufacturer can successfully compete. It would be uncommon for a market in one area to be supplied by a lime producer from another area. It is not at all surprising to note that over two-thirds of Canada's total lime production comes from Ontario and that Ontario and Quebec together account for 92 per cent of the total production. The lower production in other provinces is due to the more limited markets available, as in the case of Alberta, Manitoba and New Brunswick. Prince Edward Island and Saskatchewan provide an exception in that there are no commercial deposits of limestone in these provinces to support a lime industry even though limited markets are available.

Commercial lime was not produced in 1967 in Newfoundland, Nova Scotia, Prince Edward Island, Saskatchewan or British Columbia although the pulp and paper industry in British Columbia recovered and consumed some secondary lime during its pulping

*Mineral Processing Division, Mines Branch.

TABLE 1

Lime – Production and Trade

	1966		1967p	
	Short Tons	$	Short Tons	$
Production*				
By type				
Quicklime	1,293,982	14,793,000	1,128,101e	
Hydrated lime	261,055	3,547,000	226,162e	
Total	1,555,037	18,340,000	1,354,263	16,737,960
By province				
Ontario	1,078,350	12,232,867	931,456	11,151,254
Quebec	344,243	3,750,568	309,568	3,548,900
Alberta	72,875	1,316,557	65,626	1,219,172
Manitoba	55,835	939,643	44,441	739,214
New Brunswick	3,734	100,089	3,172	79,420
Total	1,555,037	18,339,724	1,354,263	16,737,960
Imports				
Quick and hydrated				
United States	29,155	561,000	21,950	445,000
Britain	76	1,000	147	3,000
France	18	6,000	16	6,000
Total	29,249	568,000	22,113	454,000
Exports				
Quick and hydrated				
United States	176,921	2,087,000	87,652	1,006,000
Guyana	2,703	26,000	1,500	16,000
Bermuda	427	9,000	404	7,000
Bahamas	460	11,000	393	10,000
Leeward and Windward Islands	340	7,000	168	3,000
Other countries	13	1,000	8	1,000
Total	180,864	2,141,000	90,125	1,043,000

Source: Dominion Bureau of Statistics.
* Shipments and quantities used by producers. In 1966, 1,009,323 tons of the total were shipped and 545,714 tons were used at the producing plants.
p Preliminary; e Estimated.

operations. High calcium quicklime constitutes the bulk of the total lime production in Canada but dolomitic and magnesian quicklimes and the hydrated forms of all types are produced as well.

Production equipment in the lime manufacturing industry represents a wide range of operating efficiency and a wide span in years. The general trend is towards a plant that can produce a lime of consistent quality under controllable conditions while keeping operating costs at a minimum. In most areas new kilns have been installed or adaptions have been made to existing units during recent years. What used to require a decision in favour of a rotary kiln or a vertical kiln is now further complicated by such new units as the calcimatic kiln featuring a circular rotating hearth, the Schmid-Hofer vertical kiln which features a parallel-flow, heat regeneration principle and the Corson calciner which uses an inclined, vibratory grate system and offers a high degree of control. There are many other new designs and modifications to existing designs. Hydration equipment has not changed greatly during recent years and conventional crushing and pulverizing equipment as well as conveying and packaging facilities are used. Quarrying techniques, in which heavy mining equipment is used, have kept pace with other comparable open-pit mining operations.

TABLE 2

Consumption of Lime
(producers' shipments by use)

	1965		1966	
	Short Tons	$	Short Tons	$
Chemical and Metallurgical				
Iron and steel plants	355,913	4,303,619	278,420	3,233,000
Pulp mills	204,956	2,490,442	171,688	2,056,000
Uranium plants	18,698	215,161	39,144	441,000
Nonferrous smelters	85,956	599,071	83,337	592,000
Sugar refineries	41,258	700,015	36,161	621,000
Cyanide and flotation mills	19,235	272,748	19,231	279,000
Glass works	4,318	43,701	3,901	45,000
Fertilizer plants	9,144	93,645	4,476	54,000
Tanneries	3,774	60,912	6,017	81,000
Water and sewage treatment	15,434	282,726	31,556	526,000
Other	619,010	7,126,748	647,542	6,751,000
Construction				
Finishing lime	85,092	1,922,713	81,994	1,708,000
Mason's lime	32,282	581,997	33,431	411,000
Sand-lime brick	28,530	327,231	32,734	414,000
Agricultural	19,081	226,984	13,321	193,000
Road stabilization	8,274	143,385	11,268	204,000
Other	69,449	743,210	60,816	731,000
Total	1,620,404	20,134,308	1,555,037	18,340,000

Source: Dominion Bureau of Statistics.

During 1967, 19 individual companies operated a total of 25 lime plants in Canada: 1 in New Brunswick, 5 in Quebec, 11 in Ontario, 4 in Manitoba and 4 in Alberta. A total of 98 kilns was maintained, 16 rotary and 82 shaft, affording a rated daily capacity of approximately 10,000 tons. Only 80 kilns with a production capacity of about 9,000 tons per day were operated during the year, 16 rotary and 64 shaft. The industry actually functioned at 44 per cent of the rated capacity of the units operated during 1967.

Lime is produced and used captively by sugar refineries, some steel manufacturers, chemical producers and the pulp and paper industry. When produced and used in the production of other chemicals or when recovered from sludge-burning operations and re-used in digesting liquors, it is not always possible to record the amounts accurately, and therefore such captive production statistics are not necessarily complete.

Exports of lime decreased to about 50 per cent of the 1966 quantity while imports were lower as well.

CONSUMPTION AND USE

The greatest single use for lime is as a flux in the production of steel. With the wide acceptance of the BOF (basic-oxygen-furnace) process of steel manufacture increased amounts will be used in this way. In Canada over 50 per cent of steel production is from mills using the BOF process. The pulp and paper industry continues to be the second largest user of lime, most of which is used for the preparation of cooking chemicals in pulp manufacture and for pulp bleaching. A.S.T.M. specifications covering the use of lime in the pulp and paper industry include the following: C 46-62 (Quicklime and Limestone for Sulphite Pulp Manufacture), C 433-63 (Quicklime and Hydrated Lime for Hypochlorite Bleach Manufacture) and C 45-25 (1961) (Quicklime and Hydrated Lime for Cooking of Rags in Paper Manufacture).

The uranium industry uses lime to control hydrogen-ion concentration 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 care and treatment of water supplies and the strong appeal for enforced anti-pollution measures should result in greater use of lime in the area of water and sewage treatment. A.S.T.M. specification C 53-63 refers to the use of quicklime and hydrated lime for water treatment.

In the construction industry slight increases are recorded in the amounts of lime used as mason's lime and in the production of sand-lime brick. A.S.T.M. specifications relating to the use of quicklime and hydrated lime for structural purposes are as follows: C 207-49 (1961) (Hydrated Lime for Masonry Purposes), C 141-61 (Hydraulic Hydrated Lime for Structural Purposes), C 6-49 (1961) (Normal Finishing Hydrated Lime), C 415-63 (Quicklime and Hydrated Lime for Sand-Lime Products), C 49-57 (Quicklime and Hydrated Lime for Silica Brick Manufacture), C 5-59 (Quicklime for Structural Purposes) and C 206-49 (1961) (Special Finishing Hydrated Lime). In general, calcium and magnesium oxides must be at least 95 per cent of the whole by weight and carbon dioxide must be no greater than 5 per cent at point of manufacture or 7 per cent if sampled elsewhere. For Type S lime, the unhydrated oxides as received shall not exceed 8 per cent while for Type N there is no requirement in this regard. Sieve analyses specifications allow a maximum of 0.5 per cent by weight retained on a No. 30 sieve and a maximum of 15 per cent retained on a No. 200 sieve.

TABLE 3

Lime Plant Operators 1967

Name of Firm	Plant Location	Type of Quicklime
New Brunswick		
Snowflake Lime, Limited	Saint John	High-calcium and dolomitic*
Quebec		
Aluminum Company of Canada, Limited	Wakefield[1]	Magnesian*
Dominion Lime, Ltd.	Lime Ridge	High-calcium*
Domtar Chemicals Limited	Joliette	High-calcium*
Quebec Sugar Refinery	St. Hilaire	High-calcium
Shawinigan Chemicals Limited	Shawinigan	High-calcium
Ontario		
The Algoma Steel Corporation, Limited	Sault Ste. Marie	High-calcium
Bonnechere Lime Limited	Grattan tp	High-calcium
Allied Chemical Canada, Ltd.	Anderdon tp	High-calcium
Canada and Cominion Sugar Company Limited	Chatham	High-calcium
Canadian Gypsum Company, Limited	Guelph tp	Dolomitic*
Cyanamid of Canada Limited	Niagara Falls	High-calcium
Cyanamid of Canada Limited	Beachville	High-calcium
Dominion Mangesium Limited	Haley	Dolomitic
Domtar Chemicals Limited	Hespeler	Dolomitic *
Domtar Chemicals Limited	Beachville	High-calcium*
The Steel Company of Canada, Limited	Ingersoll	High-calcium
Manitoba		
B.A.C.M. Limited	Inwood[2]	Dolomitic*
The Manitoba Sugar Company, Limited	Fort Garry	High-calcium
The Winnipeg Supply and Fuel Company, Limited	Spearhill	High-calcium
The Winnipeg Supply and Fuel Company Limited	Stonewall[3]	Dolomitic
Alberta		
Canadian Sugar Factories Limited	Picture Butte	High-calcium
Canadian Sugar Factories Limited	Taber	High-calcium
Steel Brothers Canada Ltd.	Kananaskis	High-calcium*
Summit Lime Works Limited	Crow's Nest, B.C.	High-calcium

* Hydrated lime produced also.
[1] Served notice the plant will close by February, 1968.
[2] Plant closed October, 1967.
[3] Plant closed early 1968. Modern replacement at Ft. Whyte.

A considerable amount of ground limestone, usually but wrongly termed "lime", is used as a soil conditioner to neutralize soil acidity but vast areas of farmland are not treated. The use of lime for this purpose is not a major market and varies considerably in quantity from year to year. Lime is used also as a soil stabilizer for highway construction, air terminal runway construction, and for site preparation for large building construction. This particular use in Canada has not yet reached the proportions it has in the United States.

Existing lime plants in Canada are capable of producing larger amounts of lime when the need arises. Those operations located near the major steel producing centres should be in a position to negotiate with these large-volume consumers as their requirements increase. The same applies to those operations close to pulp and paper plants. In each case the tendency for the consumer to produce and use lime captively is strong. Major amounts of lime will be used in water and sewage treatment and in soil stabilization procedures in the forseeable future. Producers of lime are cognizant of this expanding market and are gearing their plants to produce a consistent, good quality lime from Canada's well-distributed, high-quality raw materials.

PRICES

Quicklime is marketed in lump, pebble, crushed and pulverized form. It may be sold in bulk or in bags. Hydrated lime is normally shipped in bags. Prices vary with the type of product, method of shipment, amount sold, and supply and demand. In 1966 shipments of quicklime and hydrated lime averaged, respectively, $11.43 and $13.59 a ton at the plant.

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Limestone

D. H. STONEHOUSE*

Production of limestone in Canada has continued to increase steadily during recent years and is directly related to activities in the construction industry. The total value of construction in Canada reached an all-time high in 1966, having increased 13.5 per cent over the value for 1965. The increase was not so pronounced during 1967 as a levelling-off in the construction industry was evident – total value was $11.5 billion, compared to $11.2 billion for 1966.

Cement production, although it accounts for only about 15 per cent of total limestone consumption, was reduced during 1967 to 7.7 million tons from 9 million tons in 1966. This reduction occurred at a time when the production capacity of Canada's cement industry has been increasing – it is currently nearing 14.5 million tons per year. Limestone used in cement manufacture in 1967 is estimated at near 10 million tons. Within the cement industry, major changes are taking place with respect to materials handling and quality control. The general trend, especially in new plants, is to a computer-controlled operation.

The lime industry recorded less production during 1967 and used approximately 2.4 million tons of limestone. Both the cement industry and the lime industry are treated in detail in separate reviews.

The non-cement, non-lime uses for limestone, as shown in Table 1, account for well over 60 per cent of production. Only about 10 per cent of this quantity is shipped or used for non-construction purposes. Annual increases in production for non-cement, non-lime uses have been as great as 22 per cent, due mainly to expanding highway construction projects, and since 1960 a 75 per cent increase in production has been recorded.

Plants were operated in all provinces except Saskatchewan and Prince Edward Island in 1967, with 95 per cent of the limestone produced for non-cement, non-lime uses coming from two provinces, Ontario and Quebec.

For the most part, the import-export trade with respect to limestone is with the United States and results because of deposit location as well as because of chemical or physical properties associated with the raw material. Exceptions are whiting-grade material such as that imported from European countries and some chemical-grade limestone entering northwestern United States from British Columbia and Alberta, and Ontario from adjacent States. Compared to total production, tonnages traded are minor.

*Mineral Processing Division, Mines Branch.

TABLE 1

Limestone – Production, Trade, Consumption

	1965		1966p	
	Short Tons	$	Short Tons	$
Production[1]				
By province				
Quebec	35,473,875	36,461,581	39,052,084*	40,535,224*
Ontario	23,241,567	27,227,844	21,610,707	25,717,656
British Columbia	1,759,567	2,879,861	1,410,436	2,822,179
Manitoba	936,625	1,351,653	1,198,532	2,212,340
New Brunswick	366,390	821,743	233,138	684,568
Alberta	166,657	488,880	177,990	917,105
Newfoundland	11,985	89,887	–	–
Nova Scotia	222,167	652,556	316,275	969,689
Total	62,178,833	69,974,005	63,999,162	73,858,761
	1964		1965	
By type				
General[2]	56,909,844	62,919,534	62,003,833	69,708,082
Marl	110,046	221,194	175,000	265,923
Total	57,019,890	63,140,728	62,178,833	69,974,005
By use				
Metallurgical	2,876,659	3,498,967	2,359,530	2,766,531
Pulp and paper	543,328	1,335,197	339,773	1,047,287
Glass	75,896	265,439	82,639	279,821
Sugar refining	63,472	113,692	92,420	175,037
Other chemical uses	367,413	375,119	487,092	612,097
Pulverized for agricultural use	1,195,117	3,253,209	1,156,869	3,183,647
Pulverized for other uses	1,199,190	1,749,004	1,271,121	1,983,860
Road metal	28,364,591	28,800,655	39,441,850	39,630,232
Concrete aggregate	15,638,544	15,591,168	11,482,662	12,866,748
Rubble and riprap	687,808	740,592	683,948	774,496
Railroad ballast	1,897,360	1,715,206	2,145,647	2,332,488
Structural[3]	67,635	1,357,844	67,634	1,648,278
Other uses	4,042,877	4,344,636	2,567,648	2,673,483
Total	57,019,890	63,140,728	62,178,833	69,974,005
Exports	1965		1966	
Crushed limestone and refuse				
United States	1,098,048	1,576,299	1,150,165	1,939,000
Leeward and Windward Islands	25	650	–	–
Total	1,098,073	1,576,949	1,150,165	1,939,000
Stone, crude; not elsewhere specified				
United States	165,314	401,859	193,661	393,000
St. Pierre and Miquelon	–	–	5,163	45,000
Bahamas	–	–	1,202	4,000
Ceylon	–	–	245	4,000
Belgium and Luxembourg	–	–	80	4,000
Other countries	356	10,872	26	8,000
Total	165,670	412,731	200,377	458,000

TABLE 1 (Cont.)

Imports				
Stone, crushed, including stone refuse				
United States	1,488,273	3,384,959	1,437,105	3,571,000
Italy	4,796	97,973	5,157	65,000
Belgium and Luxembourg	61	1,564	86	2,000
Other countries	309	8,908	–	–
Total	1,493,439	3,493,404	1,442,348	3,638,000
Limestone flux and calcareous stone, used for manufacturing of lime and cement[4]				
United States	1,138,769	2,630,244	1,172,900	3,071,465
Consumption				
In production of cement	11,517,771		12,300,000^e	
In production of lime	2,927,691		2,700,000^e	
Miscellaneous	62,178,833		63,999,162	
Total	76,624,295		78,999,162	

Source: Dominion Bureau of Statistics.

1 Producers' shipments plus quantities used by producers. Does not include limestone produced for lime and cement but does include marl used for agricultural purposes. 2 Includes sedimentary limestone and minor coloured recrystallized limestone. 3 Includes building, monumental and ornamental stone as well as flagstone and curbstone. 4 US Department of Commerce, United States Exports of Domestic and Foreign Merchandise (Report FT 410). Values are in US dollars.

^{p} Preliminary; – Nil; * Includes marble; ^{e} Estimated.

DISTRIBUTION OF DEPOSITS

Limestones possessing the physical or chemical qualities required for use in the construction or chemical industries occur near the more heavily populated areas where they are required. In many centres in southern Ontario and Quebec the effects of urbanization are being felt in limestone operations as they are in the sand, gravel and crushed stone industries. Most of Canada's production is mined, processed and used in these areas although producing deposits occur in all other provinces except Saskatchewan and Prince Edward Island. Suitable and easily accessible deposits are not known in northwestern Ontario nor in eastern Alberta.

Marl is an unconsolidated form of limestone usually mixed with organic material and usually containing some silica. Where quality is good, quantity ample and a demand exists, this material, which occurs in all provinces, is recovered for agricultural applications.

USES

The uses for limestone are many and varied. The physical properties of a limestone, together with its location, quantity and availability, can make it the preferred stone for many applications in the construction industries. The chemical properties of a limestone determine its use in the cement, lime, chemical and metallurgical fields. Limestones consist mainly of calcium carbonate (calcite) or the double carbonate of calcium and magnesium (dolomite). Classification based on content of these constituents is generally accepted.

In Canada over 90 per cent of limestone quarried in 1965 was used in the many phases of the construction industry as road metal, concrete aggregate, railroad ballast, rubble and riprap, structural stone, terrazzo, stucco, fillers in construction products and as the basic raw material in the manufacture of cement and lime products. A calcium or high-calcium limestone is required for cement manufacture where a low magnesia content is essential. Both calcium and magnesian limestones are used to produce lime. Texture, hardness and colour are physical properties that are important in other construction applications.

In chemical applications the limestone or lime may or may not appear in the end product. Some major uses in the chemical field are: neutralization of acid waste liquors; manufacture of soda ash from sodium chloride brine; extraction of aluminum oxide from bauxite; production of ammonia, 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.

Limestones are used in the metallurgical industries as a fluxing material, which combines with impurities

TABLE 2

Limestone Consumption 1957–1966

Year	Cement Mfg.	Lime Mfg.	Miscellaneous*	Total
1957	8,741,863	2,562,740	32,686,552	43,991,155
1958	8,473,596	2,831,886	30,335,004	41,640,486
1959	8,175,733	3,062,152	36,691,804	47,929,689
1960	7,965,872	2,669,574	36,475,371	47,110,817
1961	8,145,376	2,592,831	38,220,418	48,958,625
1962	9,294,196	2,668,480	41,623,473	53,586,149
1963	9,384,412	2,703,709	51,021,396	63,109,517
1964	10,275,353	2,866,000[c]	57,019,890	70,161,243
1965	11,517,771	2,927,691	62,178,833	76,624,295
1966	12,300,000[e]	2,700,000[e]	63,999,162[p]	78,999,162

* Includes limestone used for metallurgical, chemical, agricultural and construction purposes.

[e] Estimated [p] Preliminary.

in the ore to form a fluid slag which can be separated from the metal. A calcium limestone is used in open-hearth operations whereas both calcium limestones and dolomitic limestones are used as a flux in the production of pig iron from iron ore in blast furnaces.

Limestone is used extensively as a filler and, where quality permits, as a whiting or whiting substitute. In such applications both physical and chemical properties must be considered. Specifications vary greatly depending on the particular use to which the material is put. 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 as well as a filler.

Agricultural limestone has been used for many years to correct soil acidity and to add calcium and magnesium to the soil. The amount used is not as great as it should be to maintain and improve soil conditions, however, through continued promotional efforts of agricultural departments, the use of agricultural limestone is increasing. Limestone and lime are used as soil stabilizers, particularly on highway construction projects.

Dolomitic limestone is the source of magnesium metal produced by Dominion Magnesium Limited, at Haley, Ontario. Dead-burned dolomitic limestone, for use as a refractory, is produced by Steetley of Canada Limited at Dundas, Ontario.

PRICES

Depending on the type, quality, degree of preparation, local supply and demand, and the quantity involved, limestone prices vary greatly. Screenings and refuse could be sold for 50 cents per ton, ground whiting substitute could bring \$13 to \$14 per ton. Transportation costs provide a major portion of the final price and make it undesirable to move the less expensive grades any great distance.

TARIFFS

	British Preferential (%)	Most Favoured Nation (%)	General (%)
CANADA			
Limestone, not further processed than crushed or screened	Free	Free	25
Flagstone and building stone, not hammered, sawn or chiselled	10	10	20

UNITED STATES

Limestone, crude, not suitable for use as monumental, paving, or building stone – 20¢ per short ton

Limestone, crude, broken or crushed, when imported to be used in the manufacture of fertilizer – free

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Lithium Minerals

J. E. REEVES*

The mine, concentrator and chemicals plant of Quebec Lithium Corporation remained inactive during 1967, but the company shipped products with a total lithia (Li_2O) content of about four hundred thousand pounds, valued at slightly more than one quarter million dollars. The products were the balance of stocks of lithium carbonate, lithium hydroxide monohydrate, chemical-grade spodumene concentrate and decrepitated spodumene concentrate.

The expected production of tantalite by Tantalum Mining Corporation of Canada (which is 40 per cent owned by Chemalloy Minerals Limited), from the large, nearly flat-lying lithium-bearing pegmatite on the north shore of Bernic Lake in southeastern Manitoba, may result in the production of some low-iron spodumene concentrate in the next few years. The tantalite concentrator which is expected to begin production early in 1969, will have an accommodation for spodumene recovery.

Growth in the use of lithium products continues to expand at a steady if undramatic pace. A continuing growth seems assured.

DOMESTIC OCCURRENCES

Lithium minerals, particularly spodumene, occur in several widely separated areas in Canada.

QUEBEC

The property of Quebec Lithium Corporation in Lacorne Township, north of Val d'Or, contains numerous parallel pegmatite dikes containing a large quantity of spodumene. Indicated reserves exceed 20 million tons of ore containing an average of 1.15 per cent Li_2O. These deposits are some of a large number of spodumene-bearing pegmatites associated with the Lacorne granitic batholith.

In several places to the north and west of Chibougamau, pegmatites with abundant spodumene have been found.

MANITOBA

Lithium-bearing pegmatites occur in the Winnipeg River-Cat Lake area. The deposit at Bernic Lake contains large quantities of low-iron spodumene and lepidolite, a small amount of amblygonite, an unusual concentration of the cesium mineral, pollucite, 2 million tons of mineable tantalite ore, and a small amount of beryl. There are 5 million recoverable tons of lithium-bearing material containing an average of more than 2 per cent Li_2O.

OTHER DOMESTIC OCCURRENCES

Many occurrences of spodumene-bearing pegmatites have been discovered in several areas of northwestern Ontario, most notably in the area south and southeast of Lake Nipigon. Pollucite has been identified in a spodumene pegmatite northeast of Dryden.

In the Northwest Territories to the north and east of Yellowknife, pegmatites containing spodumene, lesser amounts of amblygonite, minor amounts of other lithium minerals and beryl and columbite-tantalite have been described.

FOREIGN PRODUCTION

The United States is the principal producer and consumer of lithium minerals, chemicals and metal. It produces spodumene concentrate from vast reserves in pegmatites in North Carolina, lithium carbonate from the processing of brine (including the use of solar evaporation) at Silver Peak, Nevada, and dilithium sodium phosphate from the processing of brine at Searles Lake in southern California.

*Mineral Processing Division, Mines Branch.

Rhodesia is the principal source of petalite and lepidolite for various world markets. They have a low-iron content, and in the United States are consumed directly in glass and various other ceramic products. Rhodesia also produces spodumene, eucryptite and occasionally amblygonite. Low-iron spodumene concentrates from North Carolina and Manitoba may supplant some of the low-iron concentrates from Rhodesia in the future.

USES

Lithium is used mainly in the form of various chemical compounds, but also as low-iron mineral concentrates and to a small extent as the metal.

The ceramic industry is one of the main consumers of lithium chemicals, especially lithium carbonate, and the sole consumer of lepidolite, petalite and spodumene concentrates. These chemicals and concentrates are important primarily because of their content of lithia, a very strong flux, lithium carbonate being used when a high proportion of lithia is required. Petalite is a source of lithia with a low potash, soda and iron content. The use of lithia permits the development of low-temperature bodies that reduce the cost of refractories and fuel. It lowers the maturing temperature and increases the fluidity and gloss of glasses, glazes and enamels. It makes possible glasses that are harder and that have higher electrical, chemical and thermal resistance.

Another main use is in the manufacture of lubricating greases. Lithium stearate, derived from lithium hydroxide monohydrate, combines the best characteristics of sodium and calcium soaps and permits the greases to be effective over a wide range of temperatures, from -60°F to +320°F, and to be highly water resistant. Developed originally for use in aircraft, lithium greases have become of widespread importance.

Lithium chloride and lithium bromide are hygroscopic and are used for moisture absorption in air conditioning and refrigeration.

Lithium hydroxide monohydrate is added to the electrolyte in nickel-iron alkaline storage batteries to increase their life and output. The prospect of battery-powered automobiles offers a potentially promising long-range market.

Lithium chloride and fluoride are added to welding and brazing fluxes to remove the oxide film from aluminum and magnesium surfaces. Lithium hypochlorite is used as a bleaching agent.

To a small extent, lithium carbonate is added to the electrolyte in the Hall cell of aluminum smelters. The strong fluxing action of lithia reduces power requirements. The aluminum industry offers a potentially large market.

Lithium metal is used as a scavenger of oxygen, nitrogen and sulphur in copper and some brasses and bronzes, and as a reducing agent in the synthesis of such pharmaceutical products as vitamins and antihistamines. Butyl lithium is used as a catalyst in the production of synthetic rubber. Alloys of lithium and magnesium or aluminum have promise as light-weight and high-strength structural metals.

PRICES

In December 1967, producers in the United States announced increases in the prices of lithium carbonate, lithium chloride, lithium bromide and lithium fluoride, effective January 1, 1968. The price of lithium carbonate, in carlots or truckloads was increased by 2 cents a pound to 44 1/2 cents. The price of lithium hydroxide monohydrate was unchanged. Prices of many lithium compounds are quoted regularly in *Oil, Paint and Drug Reporter.*

TARIFFS

Tariffs in effect at the time of writing include:

	British Preferential (%)	Most Favoured Nation (%)	General (%)
CANADA			
Lithium compounds			
Of a class or kind not produced in Canada	free	15	25
Of a class or kind produced in Canada	15	20	25

UNITED STATES

Lithium compounds and salts –	9%
Lithium stearate –	1.3¢ a pound plus 9% ad val
Lithium metal –	22%

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Magnesite and Brucite

D.H. STONEHOUSE*

During 1967 the magnesia industry in Canada was based on two operations in the province of Quebec. One company mined a magnesite-dolomite rock for use in the manufacture of basic magnesia refractories, while another company mined a brucitic limestone from which both magnesia and lime were produced.

The recent increase in consumption of magnesia products in the pulp and paper manufacturing industries seems to have reached a plateau and until other operators convert to a magnesium-based pulping process or until new operations are created using this soluble base technique, the amount of magnesia so used should remain reasonably constant. The major portion of magnesia produced in Canada as well as that imported is used in the manufacture of basic refractory products.

Canadian production of dolomitic magnesite, brucite, dead-burned and calcined magnesia during 1967 was valued at $3.4 million, a decrease of nearly 13 per cent compared to 1966. Estimates of world production of crude magnesite** during 1966 indicate a total of 9.8 million tons. The largest single producer was the USSR with an estimated production of 3.2 million tons. Magnesia produced from brine and from sea-water constitutes a major proportion of the total US production, but the actual amount realized from these sources is not known.

Exports of crude refractory materials to the United States in 1967 amounted to 1.1 million tons, valued at $2.6 million, somewhat less than for 1966. Refractory magnesia, bricks and shapes imported by the United States from Canada were valued at $3.6 million but represented a comparatively small tonnage. Canadian imports of magnesia and magnesia products during 1967 were from the United States, Yugoslavia, Austria, Britain, Greece and West Germany. The amount of dead-burned and sintered magnesia imported was greater for 1967, but amounts of other products were decreased. Total value of imports was $5.4 million.

PRODUCTION

The two Quebec producers were Aluminum Company of Canada, Limited and Canadian Refractories Limited. The former marketed calcined magnesia and magnesium hydroxide, the latter ships a dead-burned magnesia.

At Wakefield, Quebec, Aluminum Company of Canada, Limited obtained a brucitic limestone from an open pit operation. The brucite was concentrated and reduced to magnesia, and lime was produced from the calcium carbonate portion of the ore. On October 20, 1967 the company announced that it would phase out its Wakefield operation during the period from January 1st to the end of February, 1968. The brucitic limestone deposits near Wakefield were discovered in 1939. During 1940 the then Bureau of Mines in Ottawa developed a commercial process for removal of the brucite granules from the limestone matrix. In 1941 Aluminum Company of Canada, Limited obtained the rights to the beneficiation process and erected a plant at Wakefield. Over the years, the company has maintained modern and efficient mining and milling equipment and, with secure markets for high-quality magnesia and lime, was

*Mineral Processing Division, Mines Branch.
**Source: US Bureau of Mines *Minerals Yearbook*, 1966.

TABLE 1

Magnesite and Brucite - Production and Trade, 1966-67

	1966		1967p	
	Short Tons	$	Short Tons	$
Production[1], Quebec				
Dolomitic magnesite and brucite	..	3,948,599	..	3,441,405
Exports				
Crude refractory materials[2]				
United States	1,302,245	2,682,000	1,114,162	2,605,000
Australia	116	8,000	-	-
Total	1,302,361	2,690,000	1,114,162	2,605,000
Imported by United States[3]				
Refractory magnesia including fused magnesia and dead-burned magnesia and dolomite	2,470	144,953	946	66,178
Magnesia, brick and other shapes	19,872	3,208,679	21,799	3,539,121
Imports				
Magnesia, dead-burned and sintered				
United States	21,625	1,743,000	31,128	2,523,000
Yugoslavia	7,235	475,000	4,138	275,000
Greece	722	57,000	2,204	167,000
Japan	1,102	91,000	772	59,000
Austria	4,133	292,000	-	-
Total	34,817	2,658,000	38,242	3,024,000
Magnesia, not elsewhere specified				
Britain	1,013	90,000	2,347	189,000
United States	1,728	269,000	1,920	249,000
Total	2,741	359,000	4,267	438,000
Magnesium oxide				
United States	1,114	396,000	968	367,000
Britain	85	46,000	26	17,000
Total	1,199	442,000	994	384,000
Dolomite, calcined				
United States	17,227	323,000	10,436	199,000
	Thousands of Units	$	Thousands of Units	$
Magnesite firebrick and other shapes				
United States	429	1,363,000	360	1,255,000
West Germany	11	15,000	66	68,000
Britain	285	268,000	26	36,000
Austria	-	-	10	20,000
Total	725	1,646,000	462	1,379,000

Source: Dominion Bureau of Statistics except where otherwise indicated.

1. Includes the value of brucitic magnesia shipped, and of dead-burned magnesia and a small quantity of serpentine used or shipped. Since 1963, some magnesium hydroxide has been shipped. 2. Mainly includes materials other than magnesia. 3. Not recorded separately in the official Canadian trade statistics. The figures shown are reported in United States imports of Merchandise for Consumption, the values being in United States dollars. These materials are also exported from Canada to other countries but the quantities and values are not available.

p Preliminary; .. Not available; - Nil.

assured of a continuing operation. The company's decision to close the plant came as a result of consistently poor recovery from a fairly low grade ore.

Because the Wakefield operation will be closed in early 1968 and may not be included in the next annual review, a brief description of the process by which the brucitic limestone was beneficiated is warranted. The elimination of waste material began in the quarry, where traditional mining methods were used to bring down quantities of ore and selective loading of material to trucks was practiced. Additional sorting was done in front of the secondary crusher which reduced the ore to less than 1 7/8 inches. Primary screening provided four size ranges which were calcined separately, thus assuring uniform calcination of the particles.

Two oil-fired rotary kilns, 7 1/2 feet x 152 feet, were used to calcine the ore at approximately 2100°F, with a recovery of 50 to 55 per cent of the feed by weight. Carbon dioxide from the limestone, water from the brucite, and some dust loss account for the balance. The granular form of the brucite ($Mg(OH)_2$) is not disturbed during calcination to magnesia (MgO). An initial separation of quicklime from magnesia was thus possible. Subsequent hydration has little effect on the granules of magnesia as well and this permitted the use of air separators to remove hydrated lime which is finer than 325 mesh. The magnesia granules were fed to a wet hydrator and passed to a series of three classifiers where adhering fine particles of lime were removed. Wet screening separated the larger, higher-purity particles from the fines, and the two fractions were dried separately in rotary driers and screened to provide various size-ranges. Major groups were formed, based on the magnesia content: over 90 per cent, about 85 per cent and about 75 per cent.

TABLE 2

Magnesite and Brucite Production*, 1958-67

1958	$2,529,161
1959	3,050,779
1960	3,279,021
1961	3,064,403
1962	3,431,873
1963	3,439,890
1964	3,569,619
1965	4,010,927
1966	3,948,599
1967p	3,441,405

Source: Dominion Bureau of Statistics.

*Brucitic magnesia shipped and dead-burned magnesia and a small quantity of serpentine used or shipped. Since 1963, some magnesium hydroxide has been shipped.

p Preliminary.

The high-purity material was passed over parallel air tables, one screen fraction to each table, yielding products containing 94 per cent magnesia. By further processing, using an autoclave, products containing 96 per cent magnesia were produced. Mixing of various grades could provide material to meet specific customer requirements.

Shipments were made in bulk or in bags by truck or rail. Besides magnesia, hydrated lime and quicklime, the company marketed various crushed stone products and limestone for use in the pulping industry and for agricultural purposes.

At Kilmar, in southwestern Quebec, Canadian Refractories Limited mines a magnesite-dolomite rock, which is beneficiated at the plant site by heavy media separation, dead-burning, crushing and sizing. Small quantities of the product are shipped to the United States but most of it goes to the company's plant at nearby Marelan, where it is used in the manufacture of basic refractories. The company put its third tunnel kiln into operation during 1966 – a unit 400 feet in length, oil-fired, automatically controlled, and operated at 3200°F. The new kiln is used primarily for "high-firing" of direct-bonded basic brick, mainly of high-purity magnesia and chrome content.

TABLE 3

Available Data on Consumption of Magnesia in Canada, 1966

(short tons)

Refractory brick, cements, mixes	77,071
Paper and paper products	26,437
Glass wool and fibre	6,105
Foundry	7,165
Other*	1,401
Total	118,179

*Includes: fertilizers, rubber production, ferrosilicon, sugar processing, etc.

Dead-burned dolomitic limestone, commonly referred to as dead-burned dolomite, contains much less magnesia than most basic refractories. It is produced near Dundas, Ontario, by Steetley of Canada Limited, but production and export statistics for this commodity are not available.

Magnesite deposits are known in British Columbia, the Northwest Territories, Saskatchewan, Ontario, Quebec, Nova Scotia and Newfoundland. Other than in Quebec, none is being exploited. Interest is still held in deposits in Deloro Township near Timmins, Ontario, and extensive beneficiation tests have been made on material from this area. Brucite has been found as brucitic limestone near Rutherglen, Ontario and has been noted also in other areas of Quebec and Ontario, in British Columbia and Nova Scotia.

Interest in the possibility of production of magnesia from sea-water has been evident from areas in the Atlantic Provinces.

TECHNOLOGY

The minerals magnesite ($MgCO_3$) and brucite ($Mg(OH)_2$) theoretically contain 47.6 and 69.0 per cent magnesia, respectively, and they may be converted to magnesia by calcination. Dolomite, sea-water, sea-water bitterns and some brines may also be processed to recover magnesia. Since 1954 there has been an appreciable increase in the United States in the recovery of this commodity from brines and sea-water. High-purity products are derived by the calcination of magnesium hydroxide or magnesium chloride resulting from treatment of these solutions.

Calcined and dead-burned magnesia are two semiprocessed products commonly used by industry. Calcined magnesia is chemically active and a product of mild calcination. Dead-burned magnesia forms during intense calcination and is chemically inactive. The mineralogical name periclase is applied in industry to dead-burned magnesia containing small amounts of iron and a minimum of 92 per cent magnesia. Other magnesium compounds such as the hydroxide, carbonate and chloride are also marketed.

Technical developments in the steel industry have led to increased use of magnesia-containing refractories, and because of higher temperatures attained with the use of oxygen, the demand for purer refractory grades is increasing. Magnesia has one of the highest melting points of any of the refractory oxides at 5070°F. A high-density refractory material is required to ensure longer life of furnace linings and to prevent penetration of the melt or slag. Pelletized material containing 98 per cent magnesia is being offered in the United States as a means of reducing the erosion of magnesia-based furnace linings in basic oxygen steel refining.

In many applications the life of a refractory is dependent on its resistance to abrasion – to date there is no standard ASTM abrasion test for refractories. The Abrasion Section in Committee C-8 on Refractories is investigating various tests with the aim of proposing a standard to cover the situation.

CONSUMPTION AND USES

Refractory uses accounted for 65 per cent of magnesia consumption during 1966. The pulp and paper industry used about 22 per cent of total reported consumption.

High-magnesia refractories are produced at four plants in Canada: Canadian Refractories Limited, Marelan, Quebec; General Refractories Company of Canada Limited, Smithville, Ontario; Refractories Engineering and Supplies Limited, Bronte, Ontario; and Norton Company, Chippawa, Ontario. Each plant, except that at Marelan, is dependent upon imported magnesia. Kaiser Refractories Division of Kaiser Aluminum & Chemical Corporation, Oakland, California announced it would construct a basic refractory brick plant at Oakville, Ontario for operation by early 1968.

Dead-burned magnesia is employed as an ingredient in such basic refractory products as bricks and shapes, hearth clinker, gunning and ramming mixes, cements and mortars. It has the ability to withstand the effects of basic slags for reasonable periods during metallurgical processing and is particularly popular as a refractory in steel and cement production.

Calcined magnesia is used as a raw material in the production of other magnesium compounds and occasionally in the production of the dead-burned product for use in refractories. It is a source of magnesium metal and an ingredient in magnesium-oxychloride and magnesium-oxysulphate cements, which are employed in floor construction and in composition board. Magnesia is also used to control acidity in chemical processing, as a constituent of manufactured fertilizers and in the production of heating elements, rayon, rubber, petrochemicals, magnesian chemicals, welding rod coatings, certain types of insulation and catalysts.

A significant recent development associated with the use of magnesia products has been the conversion of some major pulp and paper manufacturing operations to the Magnefite process based on magnesium bisulphite pulping. The change from a calcium- to a magnesium-based process results in a newsprint of increased strength, permitting greater use of jackpine wood pulp.

PRICES

Prices vary with product quality and product demand. The December 25, 1967 issue of *Oil, Paint and Drug Reporter* quotes the following United States prices per short ton.

Magnesia, dead-burned, standard grade, bulk, car lots, Chewela, Washington	$46.00
Magnesia, calcined, technical, heavy, car lots, f.o.b. Lunning, Nevada	
90%	53.00
93%	56.00
95%	61.00
Magnesia, calcined, chemical grade, powdered, bags, car lots, works	88.75

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Magnesium

W.H. JACKSON*

CANADIAN INDUSTRY

Primary magnesium is produced in Canada only by Dominion Magnesium Limited. The company has operated its mine and smelter at Haley, Ontario, since 1942. The basis of the operation is a dolomite of unusual purity, low in the alkali metals and silica. The dolomite is mined by open pit and calcined in a rotary kiln to produce dolime. Magnesium is recovered by the Pidgeon process wherein the dolime is mixed with ferrosilicon and some fluorite and charged in batches into retorts that are externally heated in electric furnaces. Under vacuum and at high temperature, the magnesium content is reduced and accumulates as crystalline rings called 'crowns' in the water-cooled head-sections of the retorts. The plant, which is a major source of employment in the Renfrew area, has 544 retorts in 16 furnaces and a magnesium production capacity of 11,300 tons a year.

The following grades and purities of magnesium are available: Commercial, 99.90 per cent; High Purity, 99.95 per cent; and Refined, 99.98 per cent. These are produced in 20-pound, 5-pound and 1-kilogram ingots, as billets from 4 to 20 inches in diameter, and as minus 4 mesh plus 50 mesh granules. Other magnesium products include master alloys, rods, bars, wire, structural shapes, and magnesium alloys to all specifications.

For Commercial-grade magnesium, the crowns are remelted and cast into ingot forms. This grade and the High Purity grade are suitable for magnesium-base and aluminum-base alloys. The Refined grade is of a purity not equalled from any other source and is particularly suited for uranium reduction and similar reductant applications where control of impurities is important.

Production data in Table 1, provided by the Dominion Bureau of Statistics, differs from the annual report of the company that lists production of magnesium crowns in 1967 at 9,981 tons and metal shipments at 9,776 tons. Shipments in 1967 compare favourably with the 7,555 tons shipped in 1966 when plant operations were interrupted by a strike. In 1967, two furnaces were shut down in June because of lower demand but production is expected to increase in 1968.

The main markets are Canada, United States, Australia and the Western European countries, Britain, West Germany and France. Only the dollar value of magnesium exports is recorded in Canadian foreign trade statistics. Imports from Canada into the United States reported by the US Department of Commerce, included 1,966 tons of magnesium metal or alloys and 732 tons of scrap for 1967. Exports of magnesium metal to the United States from Canada are possible through the Canada-United States Defence Production Sharing Act but commercial shipments are inhibited by the tariff. Scrap enters the United States free of duty. Possible changes as a result of the Kennedy Round of trade negotiations under the General Agreements on Tariffs and Trade will not greatly change the outlook for the sale of magnesium to the United States or Western Europe.

Canadian consumption of magnesium (Table 2) has more than doubled since 1960. Currently, the greatest demand is in the aluminum industry where it is used as an alloying agent to improve the properties of

*Mineral Resources Branch.

TABLE 1

Canada, Magnesium Production and Trade, 1966-67

	1966		1967p	
	Short Tons	$	Short Tons	$
Production (metal)	6,723	4,175,743	8,685	4,950,233
Imports				
Magnesium metal				
United States	1,903	1,458,000	1,430	1,105,000
Britain	2	4,000	57	38,000
USSR	1,102	575,000	2	1,000
Austria	4	5,000	4	5,000
Total	3,011	2,042,000	1,493	1,149,000
Magnesium alloys				
United States	285	878,000	189	777,000
Britain	45	32,000	17	26,000
Total	330	910,000	206	803,000
Exports				
Magnesium metal				
United States	..	1,134,000	..	1,526,000
Britain	..	951,000	..	1,371,000
Western Germany	..	893,000	..	324,000
France	..	286,000	..	282,000
Switzerland	..	15,000	..	39,000
Other countries	..	173,000	..	154,000
Total	..	3,452,000	..	3,696,000

Source: Dominion Bureau of Statistics.
pPreliminary; .. Not available.

aluminum alloys. Structural applications require fairly small tonnages but the increase from a very low level is encouraging. In common with magnesium industries in other countries, an increase in die-casting applications is the most likely field for expansion, based on the intrinsic properties of magnesium.

Demand in Canada is served partly by domestic shipments and partly by imports, exemplifying the international character of the industry and the competition within it. The small domestic industry must export a large proportion of its output under competitive conditions and at the same time must compete with foreign sources of supply for a substantial share of the domestic market.

Imports in 1966 were unusually high but in 1967 a return to a normal trading pattern was evident. Not listed in Table 1 are imports of sheet and plate that, it is worth noting, enter Canada free of duty on a Most Favoured Nation basis. There are no facilities in Canada for rolling sheet from magnesium.

TABLE 2

Canada, Magnesium Consumption, 1960 and 1966-67
(short tons)

	1960	1966	1967p
Consumption (metal)			
Castings	158	554	631
Extrusions[1]	230	572	571
Aluminum alloys	1,339	3,630	3,253
All other products[2]	472	431	599
Total	2,199	5,187	5,054

Source: Dominion Bureau of Statistics.
1 Includes a small amount of other wrought products.
2 Includes magnesium used as a reducing agent, for cathodic protection and in other alloys.
p Preliminary.

TABLE 3

Canada, Magnesium Production, Trade and Consumption, 1958-67

	Production	Imports		Exports	Con-sumption
	Metal (short tons)	Alloys (short tons)	Metal (short tons)	Metal $	Metal (short tons)
1958	6,796	..	..	2,871,991	711
1959	6,102	..	..	3,879,588	1,668
1960	7,289	..	..	3,232,805	2,199
1961	7,635	..	..	3,608,523	2,776
1962	8,816	..	..	3,967,932	3,614
1963	8,905	..	..	3,676,725	3,641
1964	9,353	187	1,594	3,951,386	3,762
1965	10,108	166	1,641	4,456,255	4,473
1966	6,723	330	3,011	3,452,000	5,187
1967P	8,685	206	1,493	3,696,000	5,054

Source: Dominion Bureau of Statistics.
P Preliminary; .. Not available.

TABLE 4

World Magnesium Production, 1965-67
(thousand short tons)

	1965	1966	1967P
United States	81.4	79.8	97.4
USSR	36.0e	40.0e	45.0e
Norway	29.1	31.2	31.4
Canada	10.1	6.7	8.7
Italy	7.0	7.2	7.0
Britain	6.1	4.1	4.1
Japan	8.8	5.8	7.4
France	3.1	3.8	4.6
China	1.0	1.0	1.0
W. Germany	0.5	0.2	NIL
Total	183.1	179.8	206.6

Source: American Bureau of Metal Statistics.
P Preliminary; e Estimated.

WORLD INDUSTRY

World production of magnesium (Table 4) increased from 102,500 tons in 1960 to 206,600 tons in 1967; production in the non-communist world was 74,000 tons in 1960 and 160,000 tons in 1967. The countries with significant increased production in the period were: Japan from 2,363 in 1960 to 7,438 tons in 1967, Norway from 11,373 to 31,400 tons, and United States from 40,070 to 97,406 tons. Primary smelting in Britain ceased in 1966. Secondary production adds to effective supply in Europe, United States and Japan but the total amount is not known with any certainty.

Table 5 shows estimates of capacity by country and company at the end of 1967. Further increases are in the planning stage with some of them being only tentative.

TABLE 5

World Magnesium Capacity, 1967

	Annual Capacity (short tons)
CANADA	
Dominion Magnesium Limited	11,300
FRANCE	
Societe Magnetherm	3,900
ITALY	
Societe Italiana per il Magnesio e Leghe di Magnesio, S.P.A.	7,000
JAPAN	
Furukawa Magnesium Company	6,600
Ube Kosan KK	2,000
NORWAY	
Norsk Hydro-Elektrisk	37,400
UNITED STATES	
Alamet Division of Calumet & Hecla, Inc.	9,200
The Dow Chemical Company	120,000
Titanium Metals Corporation	12,000
USSR	50,000

Norwegian capacity can be quickly increased to 39,000 tons annually; that of France is to be doubled. In Japan, Ube Kosan KK plans an increase of 3,000 tons a year. In Saudi Arabia, Petromin, the state-owned oil company, is negotiating for construction of a 20,000-ton-a-year plant based on sea-water and in Brazil the feasibility of a small plant is under consideration. Most of the announced expansion is in the United States. Dow Chemical Company, in addition to plans for the re-activation of 25,000 tons a year at Freeport, Texas, is working on design of a plant based on brines from Great Salt Lake in Utah. National Lead Company plans a 45,000-ton-a-year smelter based on the brines of Great Salt Lake. American Magnesium Company completed feasibility studies of a 30,000-ton-a-year smelter at Snyder, Texas, that would be based on brines containing 11.6 per cent magnesium chloride.

The United States is the largest producer and consumer of magnesium and is also a major exporter. Consumption of primary magnesium in 1967 was 98,000 tons. Primary production of 97,406 tons was supplemented by 18,150 tons of secondary production, imports of 7,638 tons of metal and 1,952 tons of scrap. Exports of magnesium and magnesium alloys were 13,170 tons. At the end of 1967 there was an excess of 55,338 in the United States government stockpile over the objective for conventional warfare of 90,000 tons, which was revised downwards from 145,000 tons in January 1967. Inventory at the end of 1967 was 145,388 tons compared with 152,033 tons in 1966. Further stockpile releases from inventory require Senate approval.

Canada and Norway are the two exporting countries without strong domestic markets. Production from Japan and Europe is consumed mainly in domestic markets.

USES

The main market for magnesium, and a steadily expanding one, is for alloying with aluminum. Its use as a reducing agent should also increase because of greater demands as uranium and titanium production each increase. Sacrificial anodes for corrosion protection,and incendiary devices are other uses that depend on the chemical properties of magnesium.

As a structural material, an extensive technology has been developed to utilize the properties of magnesium alloys and mill forms. Industry has been gradually accepting magnesium for its intrinsic properties of strength, lightness and rigidity. For many applications both zinc and aluminum are firmly established and market penetration by magnesium for those applications has been difficult except where finished products show a distinct advantage in cost or performance. Extrusions and sheet products of magnesium are available for a wide variety of applications. Die-castings are likely to show the best growth rate as new alloys have recently been developed. Also, an increase in the number and size of producers will improve the supply base and should cause manufacturers to re-assess the possibilities of magnesium in the design and engineering of products, particularly for the automotive market.

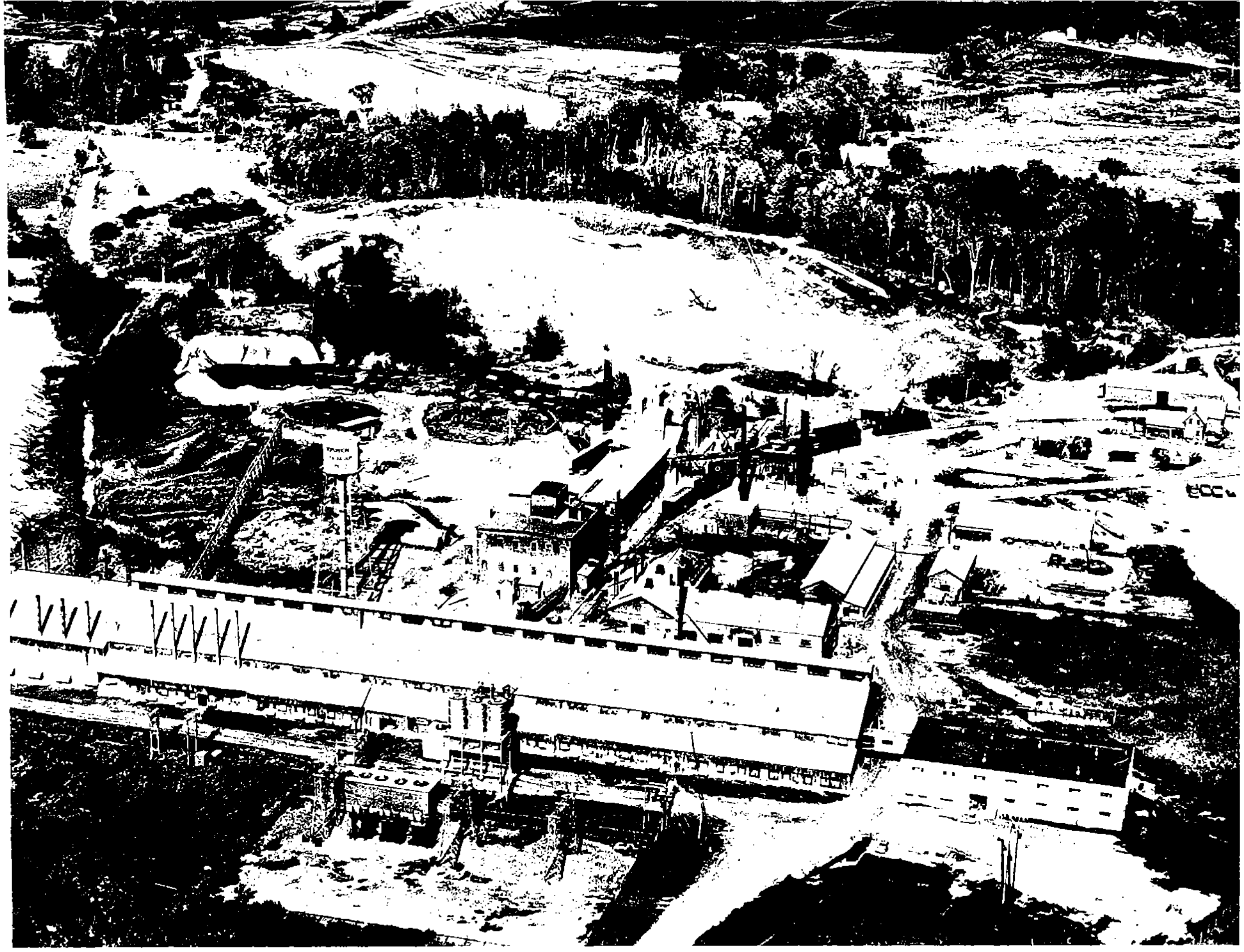
PRICES

The domestic quotation in Canada for Commercial-grade magnesium remained unchanged at 31 cents a pound, f.o.b. Haley. In the United States, the basic price of 35.25 cents was also unchanged but for aluminum smelters and alloyers, prices were in the order of 32 cents a pound. In West Germany, the competitive selling price was 25 to 27 cents (US) to major consumers and in Japan it was 34 cents. The general stability of magnesium prices over a period has had the effect of gradually improving the price differential between magnesium and other metals.

TARIFFS

	British Preferential %	Most Favoured Nation %	General %
CANADA			
Pure magnesium	free	15	25
Alloys of magnesium, ingots, pigs, sheets, plates, strips, bars, rods, tubes	5	10	25
Magnesium scrap	free	free	free
Sheet or plate, of magnesium or alloys of magnesium, plain, corrugated, pebbled, or with a raised surface pattern, for use in Canadian manufacture	free	free	25
UNITED STATES			
Magnesium, unwrought other than alloys; and magnesium waste and scrap (duty on waste and scrap suspended to June 30, 1969)		40% ad val	
Magnesium alloys, unwrought		16¢ per lb on magnesium content plus 8% ad val	

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.



CANADA'S ONLY PRODUCER OF PRIMARY MAGNESIUM: Dominion Magnesium's extraction plant in the foreground is the largest high-temperature, high-vacuum metallurgical works in the world. Mill and dolomite mine in background.

Manganese

G.P. WIGLE*

Canada imported 82,659 tons of manganese in ores and concentrates in 1967 valued at $5.2 million compared with 184,103 tons valued at $10.9 million in 1966. Imports of ferromanganese, silicomanganese, and spiegeleisen totalled 20,246 tons valued at $3.4 million compared with 51,049 tons valued at $6.7 million in 1966.

Ores of manganese are not produced in Canada but small amounts have been mined intermittently from sporadic occurrences in Nova Scotia, New Brunswick and British Columbia. Low-grade occurrences in the Atlantic Provinces have been examined but they are of no present economic importance. The large low-grade deposit near Woodstock, New Brunswick, is reported to contain 50 million tons grading 11 per cent manganese and 14 per cent iron.

WORLD PRODUCTION AND TRADE

Estimated world mine production of manganese ores was 19.4 million tons in 1967 compared with 20 million tons in 1966. Russia is the largest producer with an estimated output of 8.8 million tons in 1966. Brazil, Gabon, India and the Republic of South Africa each produced from 1.3 to 1.9 million tons in 1967, about the same as in 1966.

Seventy per cent of Canada's imports of manganese ores came from Ghana, Republic of the Congo (Kinshasa), Brazil, and Republic of South Africa; more than six other countries supplied the remainder. The principal supplier of ferromanganese was the Republic of South Africa.

The United States is the leading importer and consumer of manganese ores. The US Bureau of Mines, Mineral Industry Surveys reported imports of 2.1 million tons in 1967 and consumption of 2.3 million tons. Manganese ores were received from more than 20 countries. The leading suppliers in 1967 were Republic of the Congo (Kinshasa), Gabon, Brazil, Republic of South Africa, India and Ghana. United States imports of ferromanganese were 210,000 tons compared with 258,000 tons in 1966. The leading suppliers were the exporters of high-carbon ferromanganese including Belgium-Luxembourg, Republic of South Africa, France, West Germany, India and Britain. United States consumption of ferromanganese was 862,000 tons in 1967.

Russia is the only major industrial nation that is self-sufficient in manganese ore production and has very large reserves. Important manganese ore deposits are found in Republic of South Africa, India, Brazil, Gabon, Ghana, Guyana and Mainland China. Many other countries contribute to world production. Australian production of manganese ores more than doubled to 270,955 long tons in 1966 compared with 1965. Production in the first three months of 1967 was 114,166 long tons. Japan was the principal destination of Australian exports of manganese.

*Mineral Resources Branch.

TABLE 1

Canada, Manganese Trade and Consumption, 1966–1967

	1966		1967[p]	
	Short Tons	$	Short Tons	$
Imports				
Manganese, in ores and concentrates[1]				
Ghana	94,140	5,023,000	20,829	1,335,000
Congo-Kinshasa	6,672	382,000	13,612	817,000
Brazil	36,749	2,233,000	11,622	634,000
Republic of South Africa	8,128	337,000	11,117	504,000
Guyana	7,894	396,000	6,642	334,000
United States	6,136	1,018,000	6,097	829,000
USSR	–	–	5,395	370,000
India	10,227	480,000	4,666	180,000
Turkey	–	–	1,882	67,000
Mexico	2,406	210,000	603	47,000
Other countries	11,751	787,000	194	83,000
Total	184,103	10,866,000	82,659	5,200,000
Ferromanganese including spiegeleisen[2]				
Republic of South Africa	47,819	6,190,000	13,837	1,868,000
United States	1,035	190,000	2,036	545,000
Japan	99	29,000	123	35,000
France	83	42,000	48	22,000
Other countries	82	24,000	–	–
Total	49,118	6,475,000	16,044	2,470,000
Silicomanganese including silico spiegeleisen[2]				
United States	139	37,000	2,296	666,000
Republic of South Africa	1,792	245,000	1,342	198,000
USSR	–	–	564	64,000
Total	1,931	282,000	4,202	928,000
Exports				
Ferromanganese[2]				
United States	5,722	1,297,000	4,334	1,729,000
Colombia	–	–	5	1,000
Total	5,722	1,297,000	4,339	1,730,000
Consumption[2]				
Manganese ore				
Metallurgical grade	151,070	..	..	
Battery and chemical grade	1,466	..	..	
Total	152,536			

Source: Dominion Bureau of Statistics.
[1] Mn content. [2] Gross weight.
[p]Preliminary; – Nil; . . Not available.

TABLE 2

Iron Oxide – Production, Trade and Consumption, 1958-67
(short tons)

	Production (shipments natural)	Imports			Exports	Consumption*		
							Paint Industry	
		Natural and Synthetic	Ochres, Siennas, Umbers	Oxides, Fillers, Colours, etc.	Natural and Synthetic	Coke and Gas Industries	Natural and Synthetic	Orchres, Siennas, Umbers
1958	1,632	. .	680	4,923	2,401	237	1,826	158
1959	1,235	. .	833	6,103	2,624	100	1,889	138
1960	909	. .	615	4,908	2,523	. .	1,858	150
1961	808	. .	649	4,903	2,208	. .	1,755	130
1962	771	. .	. .	. .	1,865	. .	1,955	150
1963	978	. .	. .	. .	2,218	. .	2,009	168
1964	1,033	3,071	. .	. .	2,408	. .	2,178	191
1965	309	2,528	. .	. .	2,795	. .	1,965	250
1966	390	3,360	. .	. .	4,577	. .	. .	. .
1967p	700	6,391	. .	. .	4,944	. .	. .	. .

Source: Dominion Bureau of Statistics.
*Partial; pPreliminary; . . Not available.

reserves, located about 27 miles inland from Havre-St. Pierre, Quebec, in the Allard Lake – St. Urbain area. The orebody occurs within an anorthosite mass and consists of narrow dykes, irregular lenses and sill-like bodies in which hematite and ilmenite are intimately mixed. The ore, averaging about 87 per cent total oxides (titanium and iron), is beneficiated by classifying, screening and magnetic separation to about 93 per cent combined oxides, at the company plant at Sorel, Quebec. The concentrates are calcined in rotary kilns, cooled, mixed with powdered anthracite coal (20 per cent by weight) and smelted in open-arc electric furnaces to produce pig iron and a pigment-grade titania slag containing 70 to 72 per cent TiO_2, as well as metal-grade titania slag at 74 to 76 per cent TiO_2. With a recent expansion of plant capacity at Sorel, the company can produce 570,000 tons of titania slag per year, much of which is exported to the United States and Britain. Shipments are also made to two Canadian pigment-producing companies – Canadian Titanium Pigments Limited at Varennes, Quebec, and Tioxide of Canada Limited at Ville-de-Tracy, Quebec. The two plants have a combined capacity for production of more than 60,000 tons of refined titanium dioxide pigment per year.

Canadian Titanium Pigments Limited, a wholly-owned subsidiary of National Lead Company, New York, uses both the sulphate process and the chloride process to provide titanium dioxide pigment for domestic and export markets. Tioxide of Canada Limited is a wholly-owned subsidiary of British Titan Products Company Limited, London, England. Continental Titanium Corp. also mines ilmenite in the St. Urbain area of Quebec. The material is sold mainly as a heavy aggregate.

An increase in producers' shipments of titania slag is indicated by preliminary statistics for 1967. Imports of titanium dioxide and extended titanium dioxide pigments remained close to 1966 amounts, while exports of titanium dioxide increased to 1,756 tons from 1,334 tons in 1966.

USES AND SPECIFICATIONS

The use of titanium dioxide as a pigment is based on a number of characteristics, among which are its high refractive index or high opacity, its whiteness, and its chemical inactivity. The material must be ground to a very fine, uniform powder. When all properties are combined, the titanium dioxide pigment is far superior to other white pigments for use in paints, and is the strongest white pigment known.

Titanium dioxide pigment is available in three grades – rutile, anatase and extended grade. Rutile and anatase grades are nearly pure titanium dioxide, differing in hiding power because of different crystal structures. Extended titanium dioxide pigment contains 30-50 per cent titanium dioxide and an extender such as whiting. The non-pigmentary or "technical grade" titanium dioxide is made especially for titania porcelain enamels. It flows freely in the dry state and eliminates balling and sticking often associated with titanium dioxide pigments.

TABLE 3

Titanium Dioxide – Trade and Consumption

	1966		1967p	
	Short Tons	$	Short Tons	$
Production (Producers' shipments of titania slag, TiO_2 content)	. .	20,505,484	. .	23,704,420
Imports				
Titanium dioxide, pure				
United States	821	459,000	681	376,000
Britain	661	265,000	324	146,000
Spain	–	–	265	85,000
West Germany	109	43,000	259	107,000
Other countries	36	17,000	87	35,000
Total	1,627	784,000	1,616	749,000
Titanium dioxide, extended				
United States	9,774	1,856,000	9,763	1,860,000
Exports[1]				
Titanium dioxide				
United States	1,334	519,997	1,756	693,352
	1964		1965	
Consumption				
Refined titanium dioxide				
Industrial chemicals	41		39	
Other chemicals	536		601	
Linoleum and coated fabrics[2]	2,151		1,570	
Paint and varnish	22,812		22,884	
Paper	3,687		3,804	
Rubber	1,476		1,691	
Synthetic textiles	58		68	
Toilet preparations	24		27	
Other non-metallic products	965		806	
Total	31,750		31,490	
Extended titanium dioxide pigments				
Paints	8,788		8,193	
Estimated TiO_2 content	2,800e		2,340e	

Source: Dominion Bureau of Statistics.
[1]As reported by United States Imports for Consumption, FT125. Value $US
[2]Includes also asphalt roofing.
pPreliminary; eEstimated; . . Not available; – Nil.

As an extended pigment it is used in paints, papers, linoleum, rubber goods, textiles, ceramics and plastics. Specifications are based on tests similar to those used for all pigments.

PRICES

Canadian prices of titanium dioxide quoted in Canadian Chemical Processing of October 1967 were as follows:

anatase, dry milled, bags, car lots, delivered, East, per 100 lb	$22.50
anatase, regular, bags, car lots, delivered, East, per 100 lb	$25.00
rutile pigment, bags, car lots, delivered, East, per 100 lb	$27.00
calcium pigment, 30% TiO_2, bags, car lots, delivered, East, per 100 lb	$10.45 – $11.00
calcium pigment, 50% TiO_2, bags, car lots, delivered, East, per 100 lb	$16.25 – $16.55
non-pigment grades, bags, car lots, delivered, East, per 100 lb	$24.30 – $24.90

WHITING

PRODUCTION

Whiting is either finely ground calcium carbonate prepared from chalk, marble or limestone, or the precipitate from a solution or suspension containing lime. Whiting obtained from chalk differs physically from that obtained from the other sources in that the particles are more rounded and thus have greater surface area and greater absorptive capability. The tonnage of limestone processed for whiting in Canada is small. Use of more limestone for filler applications in which only whiting is now accepted will come with the acceptance of darker, off-white material and with the use of advanced techniques for obtaining a product with better physical characteristics.

Statistics relative to stone processed for whiting in Canada are incomplete, and the actual amount of

TABLE 4

Whiting – Production, Trade and Consumption

	1966		1967	
	Short Tons	$	Short Tons	$
Production				
Stone processed for whiting	. .	. .	. .	. .
Imports[1]				
Whiting				
United States	6,408	230,000	11,821	350,000
Britain	1,076	27,000	1,534	29,000
France	555	7,000	802	11,000
West Germany	5	1,000	20	2,000
Total	8,044	265,000	14,177	392,000
	1965		1966	
Consumption, available data				
Ground chalk, whiting and whiting substitute				
Paints and varnish	18,519		16,618	
Linoleum, oilcloth and floor tile	24,879		30,627	
Rubber goods	23,673		20,801	
Asbestos products	6,888		10,374	
Paper	4,722		33,057	
Gypsum products	3,845		11,357	
Roofing	5,858		15,780	
Foundry	2,617		3,035	
Fertilizers and poultry feed	1,811		1,299	
Miscellaneous chemicals	1,485		738	
Other uses	19,254		8,779	
Total	113,551		152,465	

Source: Dominion Bureau of Statistics.
[1]True and precipitated whiting only.
. . Not available.

TABLE 5

Whiting–Production, Imports and Consumption, 1958-67
(short tons)

	Production[1]	Imports[2]	Consumption[3]
1958	11,900	11,121	37,268
1959	11,633	10,322	64,933
1960	10,319	8,835	52,226
1961	14,301	8,408	62,442
1962	13,356	8,142	53,756
1963	16,195	9,789	65,082
1964	23,022	8,641	62,484
1965	40,593	9,089	113,551
1966	. .	8,044	152,465
1967	. .	14,177	. .

Source: Dominion Bureau of Statistics.
[1] Rock processed for whiting statistics. [2] Whiting only.
[3] Whiting and whiting substitute, includes some ground, off-white limestone.
. . Not available.

material produced for use as such is not known. Imports of true and precipitated whiting rose to 14,177 tons during 1967, 84 per cent of which came from the United States.

USES AND SPECIFICATIONS

The terms "whiting" and "whiting substitute" refer to the product derived from chalk and limestone respectively although the trend is toward accepting the term "whiting" as all-encompassing.

Because of wide variations in the raw materials and the methods of processing, products used as whiting cover a wide range of physical and chemical analyses. Each consumer sets his own standards for each application and is reluctant to change to a new or unproven product.

The finest grades of whiting are used in cosmetics and for dentifrices. Other uses, which absorb the largest part of production, are in paints, rubber, paper, linoleum, ceramics and putty. The physical properties required in each application relate to whiteness, particle size and shape, workability, and freedom from grit. High chemical purity is also important. Because of its extender qualities, whiting is used in cold water paints and in the lower-quality oil-base paints. However, its low opacity and high oil absorbency discourage more extensive use in paints. Precipitated whiting can be treated with a resin or stearate, coating the particles and enhancing its extender qualities in paints and inks.

ASTM Specification D 1199-66T pertains to chemical and physical requirements for calcium carbonate for use in pigments or as a filler.

PRICES

The following United States prices for the three main types of whiting were quoted in the *Oil, Paint and Drug Reporter* of December 25, 1967. They refer to one ton of bagged material, in a carlot, at the producing plant.

Calcium carbonate	
Natural, dry-ground, 325 mesh	$13.50 – $19.00
Natural, water-ground	
10 to 30 microns	22.00 – 23.00
Chalk, 325 mesh	36.00 – 38.00
Precipitated	
Dense	30.00 – 38.50
Ultrafine	117.50 – 167.50

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Molybdenum

G.P. WIGLE*

Production of molybdenum in Canada in 1967 increased for the eighth consecutive year and reached a new high of 21.2 million pounds valued at $37.9 million compared with 20.6 million pounds valued at $34.7 million in 1966. Canada's position in 1967 was second only to the United States among world producers of molybdenum. Canadian molybdenum mine capacity was increased by about five million pounds a year with the start of operations by British Columbia Molybdenum Limited at its mine near Alice Arm, British Columbia.

Exploration and development programs on molybdenum and copper-molybdenum properties were carried on in eastern and western Canada with most of the effort being concerned with large tonnage low-grade occurrences in British Columbia.

United States molybdenum output was reduced by the prolonged strike at copper operations, some of which produce byproduct molybdenum. The annual capacity of US primary and byproduct molybdenum producers was increased seven million pounds to about 100 million pounds with the start-up of the Urad mine, the second Colorado molybdenum producer developed by American Metal Climax, Inc. (AMAX).

The expansion of established molybdenum-producing mines and the advent of new producers brought further improvement in the supply situation. Prices for molybdenite (MoS_2) and molybdic oxide (MoO_3) were increased from US $1.55 and $1.75, respectively, to US $1.62 and $1.82 ($1.75 and $1.97 Canadian) a pound of contained molybdenum in January 1967.

PRODUCTION AND DEVELOPMENTS

CANADA

British Columbia Molybdenum Limited, a subsidiary of Kennecott Copper Corporation, started mill tune-up in November 1967 at its new 6,000-ton-a-day mine and concentrator near Alice Arm, British Columbia. This newest Canadian producer is expected to have an annual output of four to five million pounds of molybdenum, an increase of over 20 per cent in British Columbia molybdenum output.

Endako Mines Ltd. completed equipment installations in expanding its milling capacity so that daily mill throughput during December was 25,400 tons. Production for 1967 was 9.9 million pounds of molybdenum contained in molybdenite concentrates and 4.4 million pounds of molybdenum in molybdic oxide, from 6.8 million tons of ore milled. The company plans to maintain a minimum output of 12 million pounds of molybdenum a year. Ore reserves totalling 239 million tons of an average grade of 0.15 per cent MoS_2 (0.09% Mo) were reported at the year-end.

Brynnor Mines Limited, Boss Mountain Division, in the Cariboo District of central British Columbia, produced 3,130,000 pounds of molybdenum in molybdenite concentrates in 1967. The average daily milling rate was 1,286 tons and average grade of ore treated was 0.35 per cent molybdenum. Ore reserves above the adit level were reported at 2,475,000 tons averaging 0.28 per cent molybdenum.

*Mineral Resources Branch.

TABLE I

Canada, Molybdenum Production, Trade and Consumption, 1966-67

	1966		1967p	
	Pounds	$	Pounds	$
Production (shipments)[1]				
British Columbia	17,094,927	27,606,589	17,495,609	31,297,937
Quebec	3,501,117	7,064,004	3,728,298	6,575,733
Total	20,596,044	34,670,593	21,223,907	37,873,670
Exports[2]				
Molybdenum in ores and concentrates				
Britain			6,547,500	12,211,000
Japan			5,818,700	8,572,000
Netherlands			3,493,200	6,339,000
West Germany			2,021,700	3,591,000
France			1,836,600	3,394,000
United States			1,357,500	2,722,000
Italy			788,100	1,468,000
Belgium and Luxembourg			701,300	1,343,000
Sweden			569,600	1,024,000
Australia			261,600	362,000
Czechoslovakia			176,000	317,000
Other countries			220,900	399,000
Total			23,792,700	41,742,000
Imports				
Molybdic Oxide[3]				
United States	665,500	684,000	452,600	492,000
Ferromolybdenum				
United States[4]	522,800	667,039	316,692	426,350
Consumption (Mo content)				
Ferrous and Non-ferrous alloys	1,229,102	. .	. .	
Electrical and electronics	11,192	. .	. .	
Other uses[5]	21,093	. .	. .	
Total	1,261,387			

Source: Dominion Bureau of Statistics.
[1]Producers' shipments (Mo content)of molybdenum concentrates, molybdic oxide and ferromolybdenum.
[2]Not available as a separate export class prior to 1967. [3]Gross weight. [4]United States exports of ferromolybdenum (gross weight) to Canada reported by the US Bureau of Commerce, Exports of Domestic and Foreign Merchandise (Report 410). Value in US currency. Imports of ferromolybdenum are not available separately in official Canadian Trade Statistics. [5]Chiefly pigment uses.
pPreliminary; . .Not available.

Red Mountain Mines Limited, near Rossland in south central British Columbia, milled 438 tons a day averaging 0.42 per cent MoS_2 to produce 757,000 pounds of molybdenum in molybdenite concentrates. The milling rate was increased to 490 tons a day in the second half of the year.

Bethlehem Copper Corporation Ltd. carried out a major mill expansion program and made flowsheet modifications but did not produce any byproduct molybdenite at its Highland Valley copper operation in 1967.

TABLE 2

Canada, Molybdenum Production, Trade and Consumption, 1958-67
(pounds)

	Production[1]	Exports	Imports			Consumption[7]
			Calcium Molybdate[4]	Molybdic Oxide[5]	Ferro-molybdenum[6]	
1958	888,264	1,892,200[2]	135,333	304,822	196,000	519,124
1959	748,566	3,748,300[2]	75,987	305,762	164,366	928,505
1960	767,621	..	236,936	656,062	230,600	1,042,077
1961	771,358	..	46,648	266,399	211,779	1,135,610
1962	817,705	..	103,274	328,424	131,358	1,261,380
1963	833,867	..	148,402	258,765	125,869	1,306,193
1964	1,224,712	..	..	490,500	271,605	1,261,454
1965	9,557,191	..	..	759,500	398,460	1,702,589
1966	20,596,044	..	..	665,500	522,800	1,261,387
1967[p]	21,223,907	23,792,700[3]	..	452,600	316,692	..

Source: Dominion Bureau of Statistics.
[1]Producers' shipments (Mo content) molybdenum concentrates, oxide and ferromolybdenum. [2]Molybdenum concentrates and oxide (gross weight). [3]Mo content, ores and concentrates. [4]Gross weight, including vanadium oxide and tungstic oxide. [5]Gross weight. [6]U S exports to Canada reported in United States Exports of Domestic and Foreign Produce, gross weight. [7]Mo content of molybdenum products, reported by consumers.
[p]Preliminary; . .Not available.

TABLE 3

Molybdenum Production in
Ores and Concentrates, 1965-67
(Mo content, thousands of pounds)

	1965	1966	1967
United States	77,372	90,532	87,554
Canada	9,557	20,596	21,224
Chile	7,943	10,445	10,655
Peru	1,484	1,669	1,900
South Korea	448	659	..
Japan	611	623	..
Norway	498	485	..
Mexico	108	230	..
Philippines	170	110	..
Total (estimate)	98,200	125,300	123,300
USSR[e]	13,700	14,300	..
Total (estimate)	112,000	140,000	137,000

Sources: Dominion Bureau of Statistics; US Bureau of Mines, Minerals Yearbook; Company annual reports. Several other countries produce small amounts of molybdenum.
[e]Estimate; . .Not available.

Brenda Mines Ltd. continued development of its large low-grade copper-molybdenum property in the Peachland area, and proceeded with production plans. Noranda Mines Limited, managing the project, reported that the property will be brought into production in 1969 at an initial rate of 24,000 tons a day at an estimated expenditure of $60 million. Open-pit material in excess of 100 million tons was reported to average 0.19 per cent copper and 0.087 per cent molybdenite. Brenda's annual production of molybdenum could amount to nine million pounds.

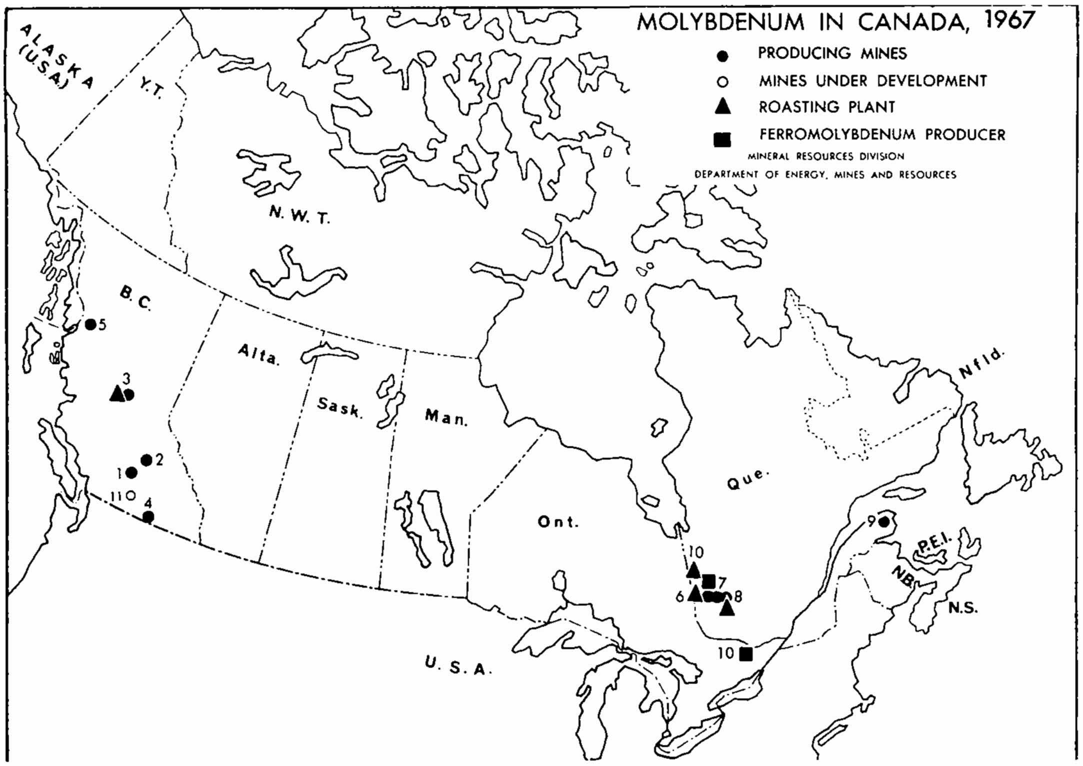
Lornex Mining Corporation Ltd. carried on an extensive program of sampling and pilot-plant test work on material from open-pit and underground testing of its large low-grade copper-molybdenum property in the Highland Valley. The program was designed to determine the feasibility of operation at a rate of 30,000 tons or more a day. Drill-hole information was reported to indicate over 300 million tons averaging about 0.4 per cent copper and 0.03 per cent molybdenite.

Highmont Mining Corp. Ltd. proceeded with a bulk-sampling program on its large low-grade copper-molybdenum property adjoining and east of Lornex. It was reported that Highmont estimated from drill-hole results that its east zone contains 72 million tons averaging 0.25 per cent copper and 0.06 per cent molybdenite.

In Quebec, production was interrupted in October 1967 at Canada's oldest operating molybdenum producer by a fire that destroyed plant buildings of Molybdenite Corporation of Canada Limited at Lacorne. This company's production for the 12 months ending September 30, 1967, was 600,895 pounds of molybdenum and 127,591 pounds of bismuth. Reconstruction of the buildings was started immediately and production was expected to resume by the end of 1968.

Preissac Molybdenite Mines Limited, and Anglo-American Molybdenite Mining Corporation, both in the Lake Preissac area near Val d'Or, Quebec, produced molybdic oxide and molybdenite concentrates. Gaspé Copper Mines, Limited recovered 489,424 pounds of byproduct molybdenum at its copper operations at Murdochville.

Masterloy Products Limited converted molybdenite concentrates from various producers to molybdic oxide at a roasting plant at Duparquet,



PRODUCING MINES

(numbers refer to numbers on map)

1. Bethlehem Copper Corporation Ltd. (no molybdenum production in 1967)
2. Brynnor Mines Limited (Boss Mountain)
3. Endako Mines Ltd.
4. Red Mountain Mines Limited
5. British Columbia Molybdenum Limited
6. Preissac Molybdenite Mines Limited
7. Anglo-American Molybdenite Mining Corporation
8. Molybdenite Corporation of Canada Limited
9. Gaspé Copper Mines, Limited

MINES UNDER DEVELOPMENT

11. Brenda Mines Ltd.

PROCESSING PLANTS

3. Endako Mines Ltd.
6. Preissac Molybdenite Mines Limited
8. Molybdenite Corporation of Canada Limited
10. Masterloy Products Limited (roaster and ferro-alloy plants)

Quebec. Masterloy also produced 88 tons of ferromolybdenum at its plant near Ottawa, Ontario.

UNITED STATES AND CHILE

The United States is the largest producer of molybdenum and since 1925 has produced more than half the world supply. The United States Bureau of Mines estimated domestic production for 1967 at 87.5 million pounds of molybdenum compared with 90.5 million pounds in 1966. A reduction in output was caused by a prolonged strike at copper operations that produce byproduct molybdenum. The United States production rate prior to the strike was about 95 million pounds a year.

The Climax, Colorado, mine of Climax Molybdenum Company, a division of American Metal Climax, Inc. (AMAX), is the largest single producer of molybdenum with an annual output of nearly 60 million pounds. AMAX developed and brought into production its second Colorado molybdenum producer, the Urad mine near Empire, in August 1967. The new mine is equipped to produce about seven million pounds of molybdenum a year. Another AMAX project near the Urad, the Henderson deposit, is being developed for production in the 1970s at a proposed rate of 50 million pounds a year. The Henderson orebody is estimated to contain 300 million tons of ore grading 0.49 per cent molybdenite (MoS_2).

The Questa, New Mexico, mine of Molybdenum Corporation of America produced 9.4 million pounds of molybdenum in 1967.

Duval Corporation is developing a large open-pit copper mine in Pima County, Arizona. Production plans include an annual yield of 12 million pounds of byproduct molybdenum.

In Chile, plans were made to increase byproduct molybdenum recovery to about 25 million pounds a year by 1970 as part of its program for expanded copper production.

CONSUMPTION AND USES

About 68 per cent of United States molybdenum consumption was in the form of molybdic oxide followed by ferromolybdenum (22%), and molybdenum powder (5%). Molybdenum is used in lesser amounts in ammonium, calcium and sodium molybdate, in purified molybdenum disulphide as an additive in lubricants, and in molybdenite concentrates added to steel when sulphur is also to be added. The steel and iron industries have always been the principal consumers of molybdenum which is an important additive in high-speed and other tool steels, in speciality and stainless steels, and in grey and malleable castings. Molybdenum metal and molybdenum-base alloys are used in high-temperature applications, thermocouples, electronics, missile parts and in structural components of nuclear reactors.

TABLE 4

United States Consumption of Molybdenum, by Use, 1965-67
(thousands of pounds of contained molybdenum)

	1965	1966	1967
Steel			
High-speed	2,814	3,652	2,840
Other alloys including stainless	29,725	30,311	25,128
Hot-work and other tool	1,313	1,275	1,011
Grey and malleable castings	3,335	3,419	2,757
Rolls (steel mill)	2,400	2,420	1,271
Welding rods	292	311	267
High-temperature alloys	1,846	3,064	3,750
Molybdenum metal wire, rod, sheet and other	1,904	2,479	1,462
Chemicals			
Catalysts	1,975	1,968	1,530
Pigments and other colour compounds	1,001	1,060	775
Miscellaneous[1]	2,016	2,365	3,568
Unspecified	–	–	1,525
Total	48,621	52,324	45,884

Source: US Bureau of Mines Minerals Yearbook, 1966; US Bureau of Mines Mineral Industry Surveys, 1967.
[1]Includes magnets, other special alloys, lubricants, packings, forging billets.

Small additions of molybdenum promote uniform hardness, hardenability and toughness in steel, steel castings and cast iron. The addition of molybdenum can be made in the oxide form or in the form of ferromolybdenum. It is a straightforward operation and losses are small. Molybdenum raises the strength of low-and high-alloy steels at elevated temperatures. It improves the corrosion resistance of chromium-nickel stainless steels giving a superior product for the handling of corrosive chemicals. Because of low coefficient of expansion and retention of rigidity, a number of molybdenum-uranium alloys have been chosen for use as fuel elements in nuclear reactors. Some of these alloys contain as much as 10 per cent molybdenum.

The petroleum and chemical industries use molybdenum as a catalyst, and in many steel components of process equipment and containers. The glass industry uses molybdenum products in process equipment that is exposed to high temperatures and corrosion. It is also used in the production of pigment colours for printing inks, lacquers and paints noted for their permanence and brilliance. The intermediate compounds of molybdenum used in the chemical and associated industries are the molybdates and molybdic oxide. Molybdenum compounds are used in small amounts to replace molybdenum deficiencies in certain soils.

Dominion Bureau of Statistics, Industry Division, Ottawa – Consumption of Molybdenum and Tungsten 1966 – lists Canadian consumers of molybdenum and its intermediate products. Among the important users are:

In Nova Scotia: Sydney Steel Corporation, Sydney

In Quebec: Crucible Steel of Canada Ltd., Sorel; Dominion Engineering Works, Limited, Lachine; Canadian Steel Foundries Division of Hawker Siddeley Canada Ltd., Montreal; Sorel Steel Foundries Limited, Sorel.

In Ontario: The Algoma Steel Corporation, Limited, Sault Ste. Marie; Atlas Steels Division of Rio Algom Mines Limited, Welland; Dominion Foundries and Steel, Limited, Hamilton; Fahralloy Canada Limited, Orillia; The Steel Company of Canada, Limited, Hamilton.

In Manitoba: Amsco Joliette Division of Abex Industries of Canada Ltd., Selkirk.

In Alberta: Irving Industries (Foothills Steel Foundry Division) Ltd., Edmonton

In British Columbia: A-I Steel and Iron Foundry (Vancouver) Ltd., Vancouver; Cae Machinery Ltd., Vancouver.

PRICES

Metals Week of December 25, 1967, quoted molybdenum prices in the United States as follows:

	US \$ per lb
Molybdenum concentrates, contained Mo, 95% MoS_2, f.o.b. shipping point, cost of containers extra	1.62
Molybdic trioxide, contained Mo, f.o.b. shipping point:	
bags	1.81
cans	1.82
Ferromolybdenum, contained Mo, packed, f.o.b. shipping point, 0.12-0.25% C, per lb Mo, lots 5,000 lb:	
lump	2.11
powder	2.17
Molybdenum powder, carbon-reduced, f.o.b. shipping point	3.35

TARIFFS

	British Preferential	Most Favoured Nation	General
CANADA			
Molybdenum ores and concentrates	free	free	free
Ferromolybdenum	free	5%	5%
Calcium Molybdate and molybdic oxide	free	free	5%

UNITED STATES	1967	1968
Molybdenum ores and concentrates	24¢ per lb on Mo content	21¢ per lb on Mo content
Ferromolybdenum	20¢ per lb on Mo content plus 6% ad valorem	18¢ per lb on Mo content plus 5% ad valorem

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Natural Gas

J.W. FRASER*

Development of the Canadian gas industry in 1967 was highlighted by a sharp upswing in the level of exports, approval of a second major pipeline to eastern Canada and a near-record expansion of gas processing capacity. After several years of modest increases, export sales increased over 18 per cent to 1,406 million cubic feet per day, contributing $123.6 million to export earnings in Canada's balance of payments. At the same time, domestic sales increased over 9 per cent to 1,913 million cubic feet per day having a value of $454.7 million. To meet the rising demand for gas and for processed byproducts, the year's expansion of gas processing capacity was the second highest in the history of the Canadian industry. Despite the record production levels, however, total Canadian marketable gas reserves were again increased, and now represent over 28 years' supply based on the 1967 rate of gross new production after allowing for processing shrinkage.

Uncertainty regarding approval of a second major transmission line via the United States to eastern Canada and regarding increased exports to the Pacific northwest area of the United States tended to delay the development of reserves and the expansion of pipeline systems in some areas. However, when approval for the second line to eastern Canada was received in mid-year, Trans-Canada Pipe Lines Limited acted quickly to put the first phase of the project in operation for the winter heating season. Westcoast Transmission Company Limited and its major American customer, El Paso Natural Gas Company, submitted several proposals to Canadian and United States authorities during the year in an attempt to have new contracts approved for increased exports to Pacific Coast markets but final approval was not received until early in 1968.

PRODUCTION

Net new production of natural gas in 1967, excluding reinjected gas and gas flared and wasted, totalled 1,471,716 million cubic feet, or an average of 4,032 million cubic feet daily. This amounted to an increase of 9.7 per cent, somewhat greater than the rate of increase for 1966.

Table 1 lists the gross production from the main gas fields in Canada which produced over 10,000 million cubic feet during 1967. At some fields, such as Harmattan-Elkton and Harmattan East, most of the production is reinjected into the producing formation to maintain reservoir pressure, after liquid hydrocarbons and sulphur have been stripped from the raw gas. At Carson Creek, limited sales of residue gas were started in 1967 although most of the processed gas is still reinjected. The cycling operation at Lookout Butte was discontinued during the year, and the gas from the field is now treated at Pincher Creek and becomes part of the sales gas from that plant.

Table 3 lists gross new production on a provincial basis. Net new production, after allowing for field waste and flaring, and reinjection into producing fields, is also shown. The volume reduction resulting from the removal of liquid hydrocarbons and sulphur at gas processing plants is shown as processing shrinkage.

Alberta production in 1967 included adjustments to prior years amounting to 1,139 million cubic feet.

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*Mineral Resources Branch.

Note: Throughout this review, Mcf = thousand cubic feet

TABLE 1

Canadian Natural Gas Fields Producing 10 Million Mcf or More, 1966-67
(numbers in brackets refer to map location)

	1966 (Mcf)	1967 (Mcf)
Alberta		
Crossfield (1)	93,566,356	115,635,338
Westerose South (2)	69,511,819	76,793,307
Waterton (11)	57,274,233	64,512,150
Windfall (5)	62,520,718	63,028,004
Edson (19)	45,992,578	59,096,699
Cessford (4)	56,149,266	55,230,818
Medicine Hat (10)	52,159,947	55,123,311
Pine Creek (6)	54,115,976	49,245,144
Harmattan-Elkton (8)	38,878,055	48,331,291
Homeglen-Rimbey (9)	47,566,646	45,364,302
Harmattan-East (8)	42,087,563	43,060,763
Pembina (7)	42,206,628	42,468,168
Carstairs (12)	39,420,827	36,532,893
Gilby (9)	26,286,249	28,605,404
Provost (15)	29,016,953	28,394,452
Wildcat Hills (20)	19,696,705	28,301,138
Nevis (14)	26,118,160	28,008,321
Carson Creek (13)	27,034,280	27,108,367
Hussar (16)	23,680,934	24,013,522
Jumping Pound (17)	22,499,566	22,884,162
Minnehik-Buck Lake (23)	16,809,865	22,377,189
Sylvan Lake (2)	18,858,212	19,227,732
Pincher Creek (3)	22,862,500	18,717,091
Kaybob (25)	11,190,249	16,945,140
Olds (12)	14,481,933	14,722,740
Westlock (21)	12,258,371	14,718,753
Wimbourne (12)	15,818,533	14,180,248
Bindloss (26)	14,331,601	13,815,253
Lookout Butte (27)	12,897,100	13,694,813
Worsley (24)	13,709,708	13,320,360
Fort Saskatchewan (21)	10,870,798	13,299,225
Turner Valley (18)	18,159,342	13,264,850
Leduc-Woodbend (22)	12,575,043	11,904,389
Crossfield East (1)	10,589,314	12,586,930
Okotoks (29)	10,745,945	11,545,017
Wayne-Rosedale (28)	11,873,898	11,394,576
Countess (16)	11,662,736	10,229,172
Judy Creek (13)	8,749,208	10,041,705
British Columbia		
Clarke Lake (35)	42,622,967	67,053,152
Laprise Creek (30)	19,493,628	27,223,352
Jedney (30)	18,362,633	20,599,214
Nig Creek (32)	15,920,031	18,771,552
Rigel (34)	12,861,494	15,817,043
Beg (33)	11,869,563	10,741,001
Saskatchewan		
Coleville-Smiley (36)	14,321,074	12,394,632

Source: Provincial government reports. Volumes shown are gross production figures measured at pressure base of 14.65 psia, standard pressure for provincial government statistics.

Production from Alberta excludes withdrawals from the Bow Island and Lloydminster fields since these are storage fields only and no longer produce new gas.

EXPLORATION AND DEVELOPMENT

ALBERTA

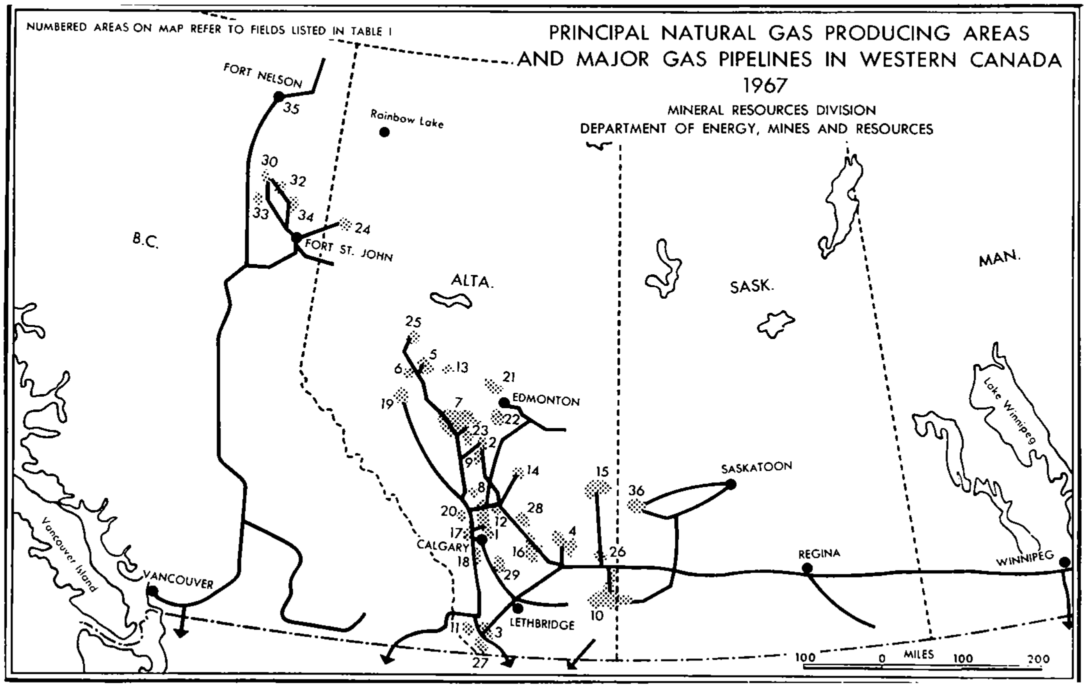
New reserves were developed in several areas of the province as the result of widespread exploratory and development drilling during 1967. In northwestern Alberta, the concentrated search for oil in Middle

TABLE 2

Pressure Maintenance Injection and Storage of Natural Gas in Canada, 1966-67
(Mcf)

	1966 Input	1967P Input
Alberta		
Beaver Crossing	791	–
Bow Island	1,677,777	–
Carson Creek	27,672,902	25,030,836
Carstairs	2,095,734	1,967,305
Crossfield	10,424,495	8,485,142
Duhamel	104,848	143,584
Gilby	–	183,474
Golden Spike	7,291,140	8,834,430
Harmattan-East	36,753,974	39,041,355
Harmattan-Elkton	32,056,301	33,201,715
Joarcam	–	1,061,941
Judy Creek	139,000	1,387,844
Jumping Pound	2,274,104	428,582
Leduc-Woodbend	3,841,347	2,186,622
Lookout Butte	12,124,509	9,315,190
Pembina	12,643,094	9,720,529
Rainbow	154,598	1,223,676
Rainbow South	–	106,715
Rowley	–	41,436
Turner Valley	4,488,450	1,318,208
Viking Kinsella	1,714,102	4,847,758
Waterton	–	6,111,453
Westerose South	741,470	8,159,788
Windfall	56,406,697	57,107,181
Total (14.65 psia)	212,605,333	219,904,764
Volume (adjusted to 14.73 psia)	211,457,264	218,717,278
Ontario	49,511,188	45,500,420
Saskatchewan (14.73 psia)	2,199,551	3,819,560
Total, Canada (14.73 psia)	263,168,003	268,037,258

Source: Provincial government reports.
P Preliminary; – Nil.



Devonian pinnacle reefs resulted in several gas discoveries, including a number of potential multiple-zone producers in the Rainbow Lake area. The team of Banff Oil Ltd. and Mobil Oil Canada, Ltd. registered several triple zone gas discoveries along the west edge of the Rainbow South field, while other gas discoveries were made in the West Rainbow area by Central-Del Rio Oils Limited and Canadian Superior Oil Ltd. The British American Oil Company Limited and Canadian Superior were also successful in the Zama Lake area. Substantial reserves have been indicated in the gas cap of many oil discoveries and in non-associated accumulations in overlying formations. Large volumes of gas will be required for pressure maintenance schemes in the Rainbow-Zama area but surplus reserves may be marketed by 1971 if proposed pipeline connections are approved by regulatory authorities.

In the historic Turner Valley area, southeast of Calgary, two Mississippian discoveries generated interest, particularly because their sour gas potential will help meet increased sulphur demand. Major reserves were indicated in a large structure paralleling the Turner Valley field by the drilling of Columbian IOE Quirk 6-5-21-4W5, an exploratory test located 6 miles west of the present field limits. The discovery well is reported to have tested up to 2 million cubic feet per day of sour, wet gas from about 120 feet of total pay section in two zones in the Mississippian. A step-out well, one and a half miles southeast, encountered a similar section and further development is proceeding along the prospective northwest-southeast trend. The other Mississippian discovery was made on the eastern side of the Turner Valley field. Baysel et al. Black Diamond 4-13-20-2W5, located 4 miles east of the field, discovered 106 feet of net pay which tested over 7 million cubic feet daily of sour, wet gas. The areal extent of the discovery had not been outlined at year end.

Deep drilling resulted in two Leduc reef gas discoveries in the Chedderville-Strachan area, approximately 85 miles northwest of Calgary, but data on the wells have not been released. Pinnacle Chedderville 16-19-37-7W5 is reported to have discovered sour, wet gas in the Leduc formation. An earlier well, 11 miles west, Stampede B.A. Strachan 6-33-37-9W5, is also reported to have discovered a thin pay zone of sour, wet gas in the D-3 reef. Discoveries of sour, wet gas are becoming increasingly attractive targets for exploration as the demand for sales gas, sulphur and LPG continues to mount.

In central Alberta, exploratory and development drilling was carried out to meet current and future contract demands. Development in the area east of Lesser Slave Lake was stimulated by the announced plans of Trans-Canada Pipe Lines Limited to take gas

TABLE 3

Canada, Production of Natural Gas, 1966-67
(14.73 psia)

	1966[r]		1967[p]	
	Mcf	$	Mcf	$
Gross new production				
New Brunswick	97,403		97,686	
Quebec	3,000		55,259	
Ontario	15,537,395		14,155,130	
Saskatchewan	65,882,249		61,839,433	
Alberta	1,552,726,765		1,454,772,782	
British Columbia	199,304,474		245,610,506	
Northwest Territories	704,453		625,491	
Total, Canada	1,834,255,739		1,777,156,287	
Waste and flared				
Saskatchewan	16,003,889		11,811,407	
Alberta	52,559,659		54,622,016	
British Columbia	11,150,767		12,252,628	
Northwest Territories	658,215		584,902	
Total, Canada	80,372,530		79,270,953	
Reinjected				
Saskatchewan	10,598		52,245	
Alberta	209,475,982		218,344,437	
British Columbia	2,563,434		7,890,852	
Total, Canada	212,050,014		226,287,534	
Net new production				
New Brunswick	97,403	92,600	97,686	83,127
Quebec	3,000	340	55,259	7,247
Ontario	15,537,395	5,940,000	14,155,130	5,378,731
Saskatchewan	49,867,762	5,974,000	49,975,781	5,996,091
Alberta	1,090,691,124	146,215,000	1,181,806,329	162,279,035
British Columbia	185,590,273	19,390,000	225,467,026	24,801,373
Northwest Territories	46,238	19,400	40,589	17,116
Total, Canada	1,341,833,195	177,631,340	1,471,597,800	198,562,720
Processing shrinkage				
Saskatchewan	2,110,186		2,290,954	
Alberta	128,750,125		150,256,306	
British Columbia	6,053,423		6,646,766	
Total, Canada	136,913,734		159,194,026	
Net new supply, Canada	1,204,919,461		1,312,403,774	

Source: Dominion Bureau of Statistics.
[r] Revised; [p] Preliminary.

from the Marten Hills area by the fall of 1969 provided adequate reserves are proven up. Several companies participated in field development and exploratory drilling in the Marten Hills, Calling Lake and Pelican areas. To the southeast in the Lac La Biche-Craigend area, new reserves were developed in the Lower Cretaceous by Chieftain Development Co. Ltd. and Blue Crown Petroleums Ltd. In the Big Bend area, south of Marten Hills, Canadian Delhi Oil Ltd. drilled two multiple zone Blairmore and Wabamun gas discoveries.

Development of shallow reservoirs was extensive in southern Alberta. One of the larger programs was that carried out by Canadian Pacific Oil and Gas Limited to develop the Cretaceous Second White Specks reservoir in the Alderson area.

TABLE 4

Canada, Production, Trade and Total Sales of Gas, 1957-67
(Mcf)

	Production	Imports	Exports	Sales in Canada
1957	220,006,682	30,550,944	15,731,072	159,893,877
1958	337,803,726	34,716,151	86,971,932	202,057,485
1959	417,334,527	11,962,811	84,764,116	278,226,823
1960	522,972,327	5,570,949	91,045,510	320,701,484
1961	655,737,644	5,574,355	168,180,412	370,739,542
1962	946,702,727	5,575,466	319,565,908	412,061,509
1963	1,111,477,926	6,877,438	340,953,146	451,598,298
1964	1,327,664,338	8,046,365	404,143,095	504,503,388
1965	1,442,448,070	15,673,069	403,908,528	573,016,494
1966	1,341,833,195	43,550,818	426,223,806	635,508,883
1967^p	1,471,597,800	52,871,671	505,164,622	697,586,005

Source: Dominion Bureau of Statistics.
^{p} Preliminary.

TABLE 5

Canada, Liquids and Sulphur Recovered from Natural Gas, 1957-67

	Propane (barrels)	Butane (barrels)	Condensate/ Pentanes Plus (barrels)	Sulphur (long tons)
1957	1,111,355	747,709	1,121,440	89,916
1958	1,123,797	748,972	1,094,653	165,116
1959	1,690,114	1,424,452	2,259,413	261,015
1960	2,064,623	1,536,621	2,460,649	404,591
1961	2,875,823	2,157,309	5,444,034	487,679
1962	3,671,683	2,744,044	10,802,436	1,035,988
1963	4,353,871^r	3,273,625^r	21,759,526	1,281,999
1964	7,615,121^r	5,656,888^r	25,275,285^r	1,472,583
1965	10,371,256	6,957,833	27,864,189	1,589,586
1966	12,643,278	8,230,620	29,354,168^r	1,729,455
1967^p	14,171,019	9,347,535	30,741,399	2,168,646

Sources: Dominion Bureau of Statistics and provincial government reports.
^{p} Preliminary; ^{r} Revised.

One hundred and eleven successful exploratory wells and 174 successful development wells were drilled in 1967, compared to 121 exploratory and 136 development wells successfully drilled in 1966. Producing wells increased by 120 to 1,647 out of a total of 2,065 capable of production.

BRITISH COLUMBIA

The pace of exploratory drilling in northeastern British Columbia was tempered by the uncertainty regarding the approval of the gas export applications filed by Westcoast Transmission Company. As a result, both the number of wells and total footage drilled dropped somewhat below the 1966 level.

In the Beaver River region near the Yukon-B.C. border, 100 miles northwest of Fort Nelson, Pan American Petroleum Corporation followed up its major gas discovery drilled in 1961, with a successful test 2 miles to the southwest. Limited information released on the new test, Pan Am Beaver c-45-K-94-N-16, indicates a thick pay section in the

TABLE 6

Canada, Wells Drilled, by Province, 1966-67

	Oil		Gas		Dry		Total	
	1966	1967	1966	1967	1966	1967	1966[r]	1967[p]
Western Canada								
Alberta	641	648	257	283	735	659	1,644	1,590
Saskatchewan	540	421	34	44	594	500	1,109	965
British Columbia	45	50	51	43	116	93	214	186
Manitoba	26	43	–	–	35	44	57	87
Yukon and Northwest Territories	–	–	–	2	28	38	28	40
Sub-total	1,252	1,162	342	372	1,508	1,336(a)	3,052	2,870(a)
Eastern Canada								
Ontario	11	6	44	59	89	81	122	146
Quebec	–	–	–	–	8	–	8	–
Atlantic Provinces	–	–	–	–	3	4	4	4
Sub-total	11	6	44	59	100	86(b)	134	151(b)
Total, Canada	1,263	1,168	386	431	1,608	1,422	3,186	3,021(a,b)

Source: Canadian Petroleum Association.
[r]Revised; [p] Preliminary; – Nil.
(a) Includes 2 westcoast offshore wells.
(b) Includes 1 eastcoast offshore well.

TABLE 7

Footage Drilled in Canada for Oil and Gas, by Province, 1966-67

	Exploratory		Development		All Wells	
	1966	1967	1966	1967	1966	1967
Alberta	4,149,247	3,812,265	4,095,797	3,929,662	8,245,044	7,741,927
Saskatchewan	1,920,943	1,808,695	2,352,123	1,704,293	4,273,066	3,512,988
British Columbia	687,455	626,144*	345,120	384,692	1,032,575	1,010,836
Manitoba	75,747	71,529	68,123	142,131	143,870	213,660
Northwest Territories	121,620	128,944	–	–	121,620	128,944
Total, western Canada	6,955,012	6,447,577	6,861,163	6,160,778	13,816,175	12,608,355
Ontario	155,954	141,110	88,777	78,136	244,731	219,246
Quebec	9,677	–	–	–	9,677	–
Atlantic Provinces	14,384	24,296**	–	–	14,384	24,296
Total, eastern Canada	180,015	165,406	88,777	78,136	268,792	243,542
Total, Canada	7,135,027	6,612,983	6,949,940	6,238,914	14,084,967	12,851,897

Source: Canadian Petroleum Association.
– Nil.
* Includes 19,887 feet drilled off the westcoast.
** Includes 15,106 feet drilled off the eastcoast.

Middle Devonian Nahanni formation had been penetrated and tested extensively, but no indication of the well's potential is available.

In the Shekilie area, 40 miles southeast of the Kotcho Lake pool, a successful step-out was drilled to a gas discovery made in 1966. The new well, Pacific Sinclair Shekilie b-46-A-94-I-16, located two and one half miles north of the discovery, is reported to have tested 10.2 million cubic feet of gas daily from the Devonian, Slave Point formation.

Approximately 50 miles northeast of the Kotcho Lake pool, Chevron Standard Limited drilled a Middle Devonian discovery, Chevron N. Helmet a-54-B-94-P-10. The well is reported to have been cased after testing over 7 million cubic feet per day. Further development will probably be deferred until market demands warrant pipeline extensions to the area.

A number of gas discoveries were drilled adjacent to the producing Triassic fields in the area northwest of Fort St. John but no major new fields were discovered. Wells capable of production in the province amounted to 611 at the end of 1967, an increase of 41 over 1966.

The exploratory program of Shell Canada Limited off Canada's west coast, which was started in 1962, reached the drilling phase during 1967. The first well, Shell Anglo Prometheus d-43-G-92-C-12, was located approximately 15 miles off Barkley Sound on the west coast of Vancouver Island. It was abandoned at a depth of 7,662 feet. A second attempt, Shell Anglo Pluto a-37-L-92-C-13, was drilled 18 miles to the northwest and was also abandoned at a depth of 12,225 feet. At year end, a third well, Shell Anglo Zeus 1-65, was drilling approximately 10 miles southwest of the second location. Gas shows were reported from some of the wells, but the accumulations are not of commercial size. The initial drilling program is expected to involve the drilling of eight to ten wells over a two-year period.

In a test case advanced by the Province of British Columbia the Supreme Court of Canada in November ruled that the Federal Government had exclusive ownership and jurisdiction over offshore minerals and other natural resources. At present, most companies have obtained both federal and provincial permits to cover offshore acreage, pending resolution of the question of ownership. At the end of 1967, acreage off British Columbia under federal government permits amounted to slightly more than 15 million acres, a drop of 3 million from 1966.

TABLE 8

Canada, Estimated Year-End Marketable Reserves of Natural Gas, 1966-67
(millions of cubic feet)

	1966	1967
Alberta	35,135,103	36,890,431
British Columbia	7,265,690	7,752,745
Saskatchewan	729,278	728,967
Eastern Canada	202,704	202,210
Northwest Territories	117,320	107,698
Total	43,450,095	45,682,051

Source: Canadian Petroleum Association.

SASKATCHEWAN AND MANITOBA

Exploratory and development drilling, directed primarily to the development of gas reserves, was confined to the established gas prone areas in the western areas of Saskatchewan and accounted for 44 completions out of the total of 465 oil and gas wells completed in the province during the year. Under agreement with Saskatchewan Power Corporation, North Canadian Oils Limited initiated a program to develop a large block of acreage in the northeast section of the Hatton pool. Operating gas wells increased to 251 from 217 in 1966, and wells capable of production increased to 383 from 345.

In northern Manitoba, on the west shore of Hudson Bay, the Sogepet Kaskattama Province No. 1 well, suspended in the fall of 1966, was completed in the spring of 1967 at a total depth of 2,941 feet. Although no commercial production was obtained, the thickness of the sedimentary section penetrated was encouraging. Seismic and magnetic surveys were completed in the Hudson Bay area during the year. Acreage under permits totalled 53.8 million acres, a slight increase over 1966. There were no gas discoveries in Manitoba during the year and the province remains a non-producer of natural gas.

NORTHWEST TERRITORIES AND THE YUKON

Forty wells, all exploratory, were drilled in the Yukon and Northwest Territories, an increase of 12 over 1966, while total footage drilled increased about five per cent to 128,944 feet. In the Northwest Territories, thirty miles northeast of the Beaver River area of British Columbia, the Pan American Pointed Mountain P53-60.30-123.43 Middle Devonian gas discovery was completed early in the year and capped in February. A follow-up well, Pan Am Pointed Mountain K-45, was started late in the year and was still drilling at year end. The general Beaver River-Pointed Mountain region is expected to be a major supply area for Westcoast Transmission and a considerable amount of the exploratory activity in the Yukon and Northwest Territories has been in this area.

EASTERN CANADA

Although the total number of wells drilled in Ontario increased slightly over 1966, total drilled footage declined, indicating a trend to drilling shallower wells. Interest was concentrated on Lake Erie and by mid-year virtually all rights under Canadian waters, totalling about 3.1 million acres, had been filed on or taken under permit. The activity in Canadian waters prompted state authorities in Pennsylvania and New York to post lake acreage for lease for the first time early in 1968, but similar plans for Ohio acreage have been delayed for one year, pending the drafting of regulations.

In the western end of the lake, between Pelee Point and Pelee Island, Atlas Explorations Limited made a discovery in the Silurian Guelph formation at Atlas Lake Erie No. 1, which is reported to have an absolute open flow potential of 7.4 million cubic feet per day from a 58-foot pay zone. North and south limits of the pool were established and further delineation will be carried out in 1968. Pan American Petroleum Corporation and The Consumers' Gas Company pooled approximately 1.3 million acres in the lake and carried out an exploratory program which resulted in two Silurian gas discoveries in the central portion of Canadian waters south of Port Burwell.

For Ontario as a whole, 68 exploratory tests were drilled, resulting in 14 gas discoveries. Three of these were in the Silurian Salina-Guelph formation. The remainder were in the Clinton-Cataract formation, including six drilled in Lake Erie. Of 67 development wells drilled, 51 were successful. Of these, 45 were gas wells, all in the Silurian. Nine were completed in the Salina-Guelph, and 36 in the Clinton Cataract. Eleven were drilled in Lake Erie.

In the evaluation of acreage off Canada's east coast, one well was drilled by Mobil Oil Canada, Ltd. on Sable Island, 190 miles east of Halifax, Nova Scotia. Mobil Sable Island #1 F-67, was drilled to 15, 106 feet, but was abandoned. Only non-commercial gas shows were encountered. Other companies carried out extensive magnetic, seismic and geological surveys both on and offshore to evaluate permits. Federal permits in the east coast area covered almost 151 million acres at the end of 1967, a substantial increase from 124.6 million acres in 1966. Four shallow tests were drilled in the Chaleur Bay region of New Brunswick by Hudson's Bay Oil and Gas Company Limited. In Quebec, a group of companies with Sun Explorations of Quebec Ltd. as operator, spudded an exploratory test late in the year in the Matapedia region, approximately 200 miles northeast of Quebec City on the south shore of the St. Lawrence River.

RESERVES

Proved remaining marketable reserves of gas in Canada increased to 45,682 billion cubic feet during 1967, according to the annual estimates compiled by the Canadian Petroleum Association. This represents a net increase of 2,232 billion cubic feet for a growth rate of 5.1 per cent during the year, considerably lower than the 7.7 per cent rise recorded in 1966. The net increase for Canada was made up of 604 billion cubic feet attributed to new discoveries drilled during the year, and 2,844 billion cubic feet increase resulting from extensions and revisions of reserves in known pools, less the year's production of 1,216 billion cubic feet. On a provincial basis, Alberta accounted for 79 per cent of the total 1967 increase, showing an increase in reserves of 1,755 billion cubic feet. The only other major increase was recorded in British Columbia, where reserves climbed by 487 billion cubic feet. Marketable reserves decreased slightly in the Northwest Territories, Saskatchewan and Ontario.

NATURAL GAS PROCESSING

Raw gas, as it is produced at the wellhead, generally contains liquid hydrocarbons and other compounds such as hydrogen sulphide which must be removed to meet consumer and pipeline requirements and to comply with provincial conservation regulations. For example, about 86 per cent of the gas produced in Alberta in 1967 was treated in gas processing plants at or near the producing field before being delivered to transmission lines. In recent years, a strong demand has built up for the natural gas liquids and sulphur which are extracted during processing. As a result, there has been a trend to install 'deep-cut' facilities in new and existing plants, to remove a higher percentage of the liquid hydrocarbons from the raw gas than did some of the earlier plants. The overall rapid growth in processing facilities is illustrated by the fact that since 1961 propane capacity has increased more than four times to about 52,000 barrels daily in 1967, butane capacity has increased threefold to 36,000 barrels daily, and pentanes plus capacity has almost tripled to 120,000 barrels daily.

Equally impressive has been the development of plants to recover elemental sulphur from the hydrogen sulphide in raw gas. World demand for elemental sulphur has outstripped the available supply, raising prices to levels which make sulphur recovery economically attractive. As the result of processors' efforts to capitalize on this market, the sulphur recovery capacity of Canadian plants has risen from 3,000 long tons daily in 1961 to 9,500 long tons daily in 1967, ranking Canada second only to the United States in terms of annual production capacity of elemental sulphur.

Expansion of gas processing facilities in 1967 was the second highest in the history of the Canadian industry, with daily raw gas input capacity being increased by 1,189 million cubic feet, raising total Canadian capacity to 7,687 million cubic feet daily. Most of the increase resulted from expansion of existing plants, although five new plants were built in Alberta. Alberta now has 102 plants, British Columbia has four, Saskatchewan has seven and Ontario has four.

The largest single addition to input capacity was at the Pacific Petroleums, Ltd. plant at Empress, Alberta

TABLE 9

Canada, Natural Gas Processing Plant Capacities, by Fields, 1967
(millions of cubic feet a day)

Main Fields Served	Raw Gas Capacity	Residue Gas Produced
Alberta		
Acheson	6	5
Alexander, Westlock	36	35
Black Butte	10	10
Bonnie Glen, Wizard Lake	36	30
Boundary Lake South	25	22
Braeburn	16	15
Carbon	155	150
Caroline	5	5
Carson Creek	100	reinj.
Carstairs (2 plants)	315	264
Cessford (7 plants)	210	202
Chigwell (2 plants)	12	10
Countess	22	21
Crossfield (2 plants)	290	199
East Crossfield	39	35
Edson	309	280
Enchant	5	5
Ferrier	8	7
Ghost Pine	86	85
Gilby (7 plants)	99	93
Golden Spike	45	reinj.
Harmattan-Elkton, Harmattan-East	246	reinj.
Harmattan-Elkton (2 plants)	47	19
Homeglen-Rimbey, Westerose	422	357
Hussar (2 plants)	100	95
Innisfail	15	10
Judy Creek, Swan Hills	85	62
Jumping Pound	200	160
Kaybob	70	68
Kessler	6	5
Leduc-Woodbend	35	31
Lone Pine Creek	30	24
Minnehik-Buck Lake	70	63
Morinville, St. Albert	25	24
Nevis, Stettler (2 plants)	125	104
Okotoks	30	13
Olds	50	38
Oyen	3	3
Paddle River	30	28
Pembina, Pembalta System (9 plants)	91	74
Pembina (4 plants)	62	56
Pincher Creek	204	145
Prevo	5	4
Princess (3 plants)	19	19
Provost (3 plants)	105	99
Redwater	11	8
Retlaw	7	7
Samson	3	3
Savanna Creek	75	63
Sedalia	5	5
Sibbald	6	5
Sylvan Lake	28	26
Sylvan Lake, Hespero	50	43
Three Hills Creek	10	9
Turner Valley	100	85
Waterton	270	170
Wayne-Rosedale (3 plants)	57	54
Wildcat Hills	96	83
Willesden Green	9	8
Wilson Creek	15	10
Wimborne	55	43
Windfall, Pine Creek	215	132
Wintering Hills	20	20
Wood River	5	5
Worsley	55	52
Pipeline at Ellerslie*	70	66
Pipeline at Empress**	1,500	1,460
Saskatchewan		
Cantuar	25	24
Coleville, Smiley	60	59
Dollard	2	2
Smiley	4	3
Steelman	38	30
British Columbia		
Fort St. John	395	300
Boundary Lake (2 plants)	27	24
Clarke Lake	365	300
Ontario		
Port Alma	16	16
Corunna (2 plants)	5	5
Becher	1	1

Source: Natural Gas Processing Plants in Canada (Operators' List 7), January 1968, Department of Energy, Mines and Resources.

* Plant reprocesses gas owned by Northwestern Utilities Limited.

** Plant reprocesses gas owned by Trans-Canada Pipe Lines Limited.

where capacity was raised from 1,000 million to 1,500 million cubic feet daily. A major addition to sulphur recovery capacity resulted from the expansion of the Petrogas Processing Ltd. plant at Balzac, Alberta from 870 long tons daily to 1,940 long tons daily. Expansion of facilities to increase natural gas liquids production was completed at plants at Jumping Pound, Waterton, Buck Lake, Carstairs, Judy Creek and Hussar in Alberta and at Fort Nelson in British Columbia. Sulphur recovery capacity was also increased at several of these plants. New plants were built at Ghost Pine, Wilson Creek, Gilby, Caroline and Ferrier. Projects under way or planned indicate that new plant construction in 1968 will exceed the 1967 level.

TRANSPORTATION

Expansion of the gas pipeline system in Canada was concentrated mainly in the distribution, utility and gathering sectors during 1967. Delay in obtaining approval for the Great Lakes transmission line to eastern Canada, and difficulties in reaching an acceptable price for gas exports to the northwestern United States resulted in reductions in the planned expansion programs of the major transmission pipelines. A new facet was added to the transportation network with the start of regular deliveries of liquefied natural gas by refrigerated tank trucks for use in the gas system of the town of Squamish, B.C.

Construction of the first phase of the Great Lakes Gas Transmission Company Limited pipeline project was begun immediately after approval was obtained for the United States section from the Federal Power Commission in June, 1967, in order to provide additional gas supplies to the Ontario market in time for the 1967-68 winter season. Gas storage fields in central Michigan were thereby connected to underground storage facilities in the Dawn storage area near Sarnia, Ontario by the construction of 157 miles of new pipeline in the United States and a 14-mile link in Canada. Both lines are 36-inch pipeline. By year end, 113 million cubic feet of gas per day were being

TABLE 10

Gas Pipeline Mileage in Canada, 1964-67

	1964	1965[r]	1966[r]	1967[p]
Gathering				
New Brunswick	6	6	6	6
Quebec	–	–	–	1
Ontario	1,043	1,102	1,167	1,163
Saskatchewan	389	560	684	714
Alberta	3,071	3,120	2,957	3,342
British Columbia	409	418	460	513
Total	4,918	5,206	5,274	5,739
Transmission				
New Brunswick	13	13	13	13
Quebec	25	25	112	121
Ontario	3,365	3,390	3,479	3,558
Manitoba	731	919	956	1,022
Saskatchewan	3,081	3,288	3,629	3,911
Alberta	4,776	5,020	5,165	5,370
British Columbia	1,319	1,551	1,580	1,660
Total	13,310	14,206	14,934	15,655
Distribution				
New Brunswick	33	33	33	33
Quebec	1,263	1,295	1,361	1,417
Ontario	12,297	12,699	13,315	13,737
Manitoba	1,178	1,354	1,344	1,443
Saskatchewan	1,637	1,740	1,789	1,914
Alberta	3,383	3,487	3,623	3,806
British Columbia	3,843	4,053	4,264	4,466
Total	23,634	24,661	25,729	26,816
Total, Canada	41,862	44,073	45,937	48,210

Source: Dominion Bureau of Statistics.
[p] Preliminary; [r] Revised; – Nil.

supplied to Canadian customers. In the second phase, to be completed in 1968, 814 miles of 36-inch pipeline will be laid from Emerson, Manitoba via the Straits of Mackinac to connect with the existing line in Michigan. A 44-mile, 10-inch lateral will be extended to serve Sault Ste. Marie in Canada. Expansion of the Trans-Canada system in western Canada and Ontario will be necessary to handle the increased gas volumes.

Other expansion completed by Trans-Canada in 1967 included construction of 19 miles of 36-inch loop near Dryden, in northwestern Ontario, to provide additional capacity for an 80-mile, 8-inch lateral constructed by Northern and Central Gas Company Limited from Vermilion Bay to Bruce Lake Mines Ltd. in the Red Lake area. Throughput capacity was improved by internal sandblasting of 430 miles of line in Manitoba and Saskatchewan, and additions and improvements to a number of compressor stations in the system.

Although Westcoast Transmission Company Limited did not receive approval to increase exports until early in 1968, some expansion of the system was completed in 1967. Forty-one miles of the main line in northern British Columbia were looped with 36-inch pipe and 66 miles of 12- to 24-inch laterals were added northeast of Fort Nelson, to connect the Yoyo, Kotcho Lake and Sierra fields. In addition, more than 100,000 horsepower was added to existing compressor capacity. Expansion and northward extension of the system to the Beaver River area is anticipated to meet expected demand increases in British Columbia and the United States.

Total mileage of The Alberta Gas Trunk Line Company system increased by 91 miles to 2,094 miles as the company expanded the Plains and Foothills Divisions to tie in several new gas fields and new gas processing plants at Morrin, Vulcan and Wilson Creek. Compressor capacity was increased by the addition of 15,500 horsepower at Princess and Turner Valley. Elsewhere in Alberta, Canadian Industrial Gas & Oil Ltd. completed a 46-mile transmission line from the Bittern Lake field to Edmonton. Gas gathering systems were installed in a number of producing fields, two of the largest installations being a 110-mile system laid by Canadian Pacific Oil and Gas Limited in the Alderson field, and a 98-mile system constructed in the East Crossfield field by Pan American Petroleum Corporation. A number of smaller gathering systems and expansions to distribution systems were completed during the year.

Saskatchewan Power Corporation extended gas service to new areas of the province by laying 280 miles of main lines and laterals. Installation of local distribution mains and services accounted for an additional 127 miles of small diameter pipeline.

In Manitoba, Greater Winnipeg Gas Company extended its transmission line 36 miles north from Selkirk to service the town of Gimli.

In southern Ontario, Union Gas Company of Canada, Limited laid 37 miles of 34-inch line in its continuing program to complete a second transmission line paralleling the existing 26-inch main transmission line from the Dawn storage area to the connection with Trans-Canada northwest of Toronto. Only 18 miles of loop will be required to finish the second line. Union also laid 200 miles of distribution mains and laterals in general expansion of its system throughout southwestern Ontario.

Northern and Central Gas Company Limited added 135 miles of pipeline to its distribution system in serviced areas, in addition to the construction of the new lateral to the Bruce Lake Mines. Additions to The Consumers' Gas Company network in southern Ontario totalled 237 miles.

MARKETS AND TRADE

The increasing importance of export markets for Canadian natural gas producers was well illustrated by the relative growth experienced by domestic and export sales in 1967. Domestic sales continued the firm upward trend of the past few years, increasing by more than 9 per cent to 1,913 million cubic feet per day. Exports, however, rose 18.9 per cent, double the domestic increase, as increased shipments to the California and Montana markets raised total export sales to 1,406 million cubic feet per day.

Probably the most significant development on the domestic marketing scene was the granting of approval by the Federal Power Commission for construction of a major gas transmission line through the United States from Emerson, Manitoba to Sarnia, Ontario. Great Lakes Gas Transmission Company Limited, owned jointly by Trans-Canada Pipe Lines Limited and American Natural Gas Company of Detroit, will construct and operate the line which, by 1970 will provide an additional 677 million cubic feet per day of western Canadian gas to eastern Canadian markets. The line will also provide for anticipated exports of 170 million cubic feet per day by 1971. Although the FPC decision is being challenged in the courts by a competing company in the United States, the first phase of the project was completed in late 1967. This consisted of a pipeline from gas storage fields near Austin, Michigan to Ontario to provide supplemental gas to the Ontario market. Barring a reversal of the FPC decision, the complete system from Emerson to Sarnia, and a smaller lateral to Sault Ste. Marie, will be finished late in 1968.

The requirement for additional gas supplies in the eastern Canadian market was demonstrated by the growth experienced in the past year. Sales in Ontario accounted for a larger share of the total Canadian market, increasing to about 40 per cent from 38 per cent in 1966, and, at the same time, showed the highest growth rate at over 16 per cent. The Quebec market although relatively small, attained the second highest growth during 1967. The western Canadian provinces, led by Alberta, accounted for about 54 per cent of total Canadian sales, and showed varying rates of growth.

Provision of substantial new capacity through the Great Lakes system should materially aid gas marketing in eastern Canada. Although alternate supplies will be made available by the second line, Union Gas Company is seeking approval to increase imports from Panhandle Eastern Pipeline Co. from the present level of 23.5 billion cubic feet annually to 60.5 billion cubic feet by 1974. The contract has still to be approved by regulatory bodies in the United States and Canada, and will be opposed by Trans-Canada.

The competitive position of United States gas in Canada was improved by the removal of the 3 cents per thousand cubic feet Canadian import duty in mid-1967 as a result of the Kennedy Round of tariff negotiations. Imports increased over 21 per cent in 1967, amounting to 145 million cubic feet daily. Almost all of the imports are to southern Ontario, and in 1967, these included temporary imports by Trans-Canada from Michigan to meet requirements pending approval and construction of the Great Lakes pipeline.

The sharp 18 per cent jump in exports, following relatively small increases in recent years, resulted mainly from the implementation of authorized export increases to the California market by Alberta and Southern Gas Co. Ltd., and smaller increases to the Montana market by Montana Pipe Line Company. Applications for additional substantial increases in two contracts were under consideration at year end.

Westcoast Transmission Company Limited had applied to Canada's National Energy Board in 1966 for permission to increase exports to its main customer, El Paso Natural Gas Company, as the first phase in the implementation of a long-term contract between the two companies. Westcoast's first application, approved by the NEB in April 1967, basically provided for replacement of the original 1954 contract for 300 million cubic feet daily, by a new contract for 500 million cubic feet daily at a higher basic price, with provision for price escalation. El Paso presented a similar application to the FPC in the United States, but in August the FPC ruled that the original contract could not be changed, and also ruled that the additional 200 million cubic feet daily could be imported but only at a price comparable to that charged to Westcoast's major Canadian customers. Following further unsuccessful attempts by El Paso to have the FPC decision modified, Westcoast made another application to NEB essentially in line with the terms of the FPC decision. This was rejected by the NEB in late December 1967. A final compromise proposal, accepted by the FPC and the NEB by mid-February 1968, provided for additional exports of 202.3 million cubic feet daily at a price of 33.34 cents per thousand cubic feet in Canadian funds in the period to November 1972, after which it will be increased to 34.46 cents.

An FPC investigation into the general question of the gas supply for California has delayed a decision by United States authorities on an application by Pacific Gas Transmission Company to increase imports from

TABLE 11

Canada, Sales of Natural Gas, by Province, 1967p

	Mcf	$	Average $/Mcf	Number of Customers Dec. 31/67
New Brunswick	62,023	185,586	2.99	1,975
Quebec	36,799,397	36,765,542	1.00	215,202
Ontario	279,348,880	235,218,716	0.84	741,166
Manitoba	41,735,643	27,465,902	0.66	110,131
Saskatchewan	68,553,582	30,788,050	0.45	130,514
Alberta	196,741,379	63,450,926	0.32	278,154
British Columbia	74,982,533	60,847,283	0.81	212,015
Total, Canada	698,223,437	454,722,005	0.65	1,689,157
Previous Totals				
1963	451,598,298	287,584,177	0.64	1,397,138
1964	504,503,388	327,982,720	0.65	1,459,619
1965	573,016,494	369,307,232	0.64	1,569,539
1966	635,514,622	416,212,202	0.65	1,626,783

Source: Dominion Bureau of Statistics.

p Preliminary.

TABLE 12

Canada, Supply and Demand of Natural Gas
(MMcf)

	1966[r]		1967[p]	
Supply				
Gross new production		1,634,257		1,777,275
Field waste and flared		– 80,373		– 79,271
Reinjected		–212,050		–226,288
Net new production		1,341,834		1,471,716
Processing shrinkage		–136,914		–159,194
Net new supply		1,204,920		1,312,522
Removed from storage	35,485		47,768	
Placed in storage	–52,550		–52,639	
Net storage		– 17,065		– 4,871
Total net domestic supply		1,187,855		1,307,651
Imports		44,607		70,463
Total supply		1,232,462		1,378,114
Demand				
Exports		431,818		513,219
Domestic Sales				
Residential	195,261		204,741	
Commercial	324,532		358,945	
Industrial	115,722		134,537	
		635,515		698,223
Field and Pipeline Use				
In production	91,652		85,490	
Pipeline	70,351		83,758	
Other	2,781		1,002	
Line pack changes	366		– 362	
Total field, etc. use		165,150		169,888
Gas unaccounted for		– 21		– 3,216
Total demand		1,232,462		1,378,114
Total domestic demand		800,641		864,840
Average daily demand		2,194		2,369

Sources: Dominion Bureau of Statistics and provincial government reports.
[p] Preliminary; [r] Revised.

Alberta and Southern Gas Co. Ltd. for the California market. Additional licenses granted by the NEB in June 1967 approved a maximum export increase of 236 million cubic feet daily for Alberta and Southern, to be implemented in two equal increments in November, 1968 and November, 1969. All of this increase would go to California, except for about 20 million cubic feet daily for the Montana market.

The FPC investigation consolidated the hearing on the Pacific Gas Transmission application with a concurrent application by El Paso to supply California with gas by pipeline from the southwestern United States. The hearings are to consider the whole question of gas supply for California in relation to such considerations as whether there is an adequate market for the proposed increases, whether the FPC should permit importation of the proposed gas without limitation, whether it is preferable that other markets along the route of either pipeline should receive the gas other than the markets in the application, and finally, whether there are more preferable alternative means available to meet the requirements of the customers to be served.

COMPOSITION AND USES OF NATURAL GAS

Marketed natural gas consists chiefly of methane (CH_4) but small amounts of other combustible hydrocarbons such as ethane (C_2H_6) and propane (C_3H_8) may also be present. Methane is nonpoisonous and odourless but a characteristic odour is usually introduced into marketed natural gas as a safety measure. The heat value of natural gas averages about 1,000 British thermal units per cubic foot of gas.

Raw natural gas, as it exists in nature, may vary widely in composition. Besides the usually predominant methane, varying proportions of ethane, propane, butane and pentanes plus may be present. Water vapour is a normal constituent. Hydrogen sulphide, although not present in some Canadian natural gas, is commonly so abundant as to be an important source of sulphur. Other nonhydrocarbon gases which may be present, usually in small amounts are carbon dioxide, nitrogen and helium.

The most important use of natural gas is as a fuel for space and water heating. Gas is now extensively used in cooking and is becoming common as a fuel for air conditioners, incinerators, dishwashers and laundry equipment. In industrial areas, such as southwestern Ontario, natural gas has been a boon to such industries as automobile plants, steel plants, metal-working firms, glass factories and food-processing industries. For example, in metallurgical processing, the clean, easily controlled flame of natural gas enables the desired temperatures to be attained in rolling, shaping, drawing and tempering steel. The constituents of natural gas have become major sources of raw material for the petrochemical industry. Ethane, seldom removed from natural gas at the field processing plant, is an important petrochemical feedstock that is sometimes recovered from pipeline gas. Natural gas supplies basic raw material for ammonia, plastics, synthetic rubber, insecticides, detergents, dyes and synthetic fibres such as nylon, orlon and terylene. Important future uses may include gas fuel-cells and power-generator systems driven by gas turbines. Canada has recently become one of the world's largest producers of elemental sulphur, a byproduct recovered in the processing of sour gas (hydrogen sulphide bearing) from fields in western Canada.

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Nepheline Syenite

J.E. REEVES*

In 1967, production of nepheline syenite in Canada continued to rise sharply; shipments exceeded 400,000 short tons for the first time, nearly 10 per cent greater than in 1966. Exports increased almost 17 per cent. Although well over 90 per cent of exports were shipped to the United States, small amounts were sent to many other countries. With the growing acceptance of nepheline syenite by many industries, with the improvement of products and with the diversification of markets, the continued growth of the Canadian nepheline syenite industry seems assured.

DOMESTIC PRODUCERS

The only source of nepheline syenite in Canada is the large Blue Mountain deposit in Methuen Township, northeast of Peterborough, Ontario. Two companies control the deposit, quarry the rock and operate dry processing plants. The principal product is relatively coarse, glass-grade nepheline syenite, but fine-ground, high-quality grades and lower-quality byproducts with a comparatively high iron content are also produced. During 1967, Industrial Minerals of Canada Limited expanded its plant capacity by 200 tons of product a day, to about 800 tons a day. The plant of International Minerals & Chemical Corporation (Canada) Limited has a capacity of about 700 tons of product a day.

OTHER DOMESTIC OCCURRENCES

Nepheline-bearing rocks occur in many places in Canada, but, apart from the Blue Mountain nepheline syenite, none is known that can be beneficiated sufficiently to yield a high-quality feldspathic raw material suitable for the ceramic industry.

In the Bancroft area of southeastern Ontario a discontinuous band of nepheline gneiss and nepheline pegmatite, in some places containing a relatively high nepheline content, extends for many miles. From 1937 to 1942, small quantities of these rocks were mined in several parts of the area, but the products proved unsuitable for use in glass and various other ceramic ware. A variable nepheline content, and an excess of iron-bearing minerals in the rocks precluded the production of uniform-quality products.

Nepheline syenite occurs in several places in southern British Columbia, notably in national parkland in the Ice River area near Field and in the vicinity of Big Bend on the Columbia River.

Nepheline is common in the alkaline rock complexes in northern Ontario and southern Quebec but is nowhere of known commercial significance.

FOREIGN PRODUCTS

Nepheline-bearing ceramic raw materials are also being produced in Norway and the USSR. On Stjernøy, an island off the northern coast of Norway, the Norsk Nefelin division of Christiania Spigerwerk mines and processes nepheline syenite similar in appearance to the Blue Mountain rock and markets high-quality grades for glass, ceramic ware and porcelain enamels in Britain and various countries in continental western Europe. In 1967, a total of about 70,000 tons was produced, and a new plant with a capacity of 150,000 tons a year was being built.

*Mineral Processing Division, Mines Branch.

TABLE 1

Nepheline Syenite – Production, Exports and Consumption 1966-67

	1966		1967	
	Short Tons	$	Short Tons	$
Production (shipments)	366,696	4,109,744	401,601	4,752,875
Exports				
United States	242,206	2,754,000	282,381	3,138,000
Britain	6,313	105,000	8,057	120,000
Netherlands	463	10,000	5,125	53,000
Italy	831	11,000	3,918	64,000
Australia	1,129	26,000	2,255	48,000
Puerto Rico	2,953	43,000	2,150	31,000
Belgium and Luxembourg	2,234	52,000	1,736	42,000
Venezuela	6,043	70,000	530	6,000
Greece	72	2,000	359	6,000
Peru	510	11,000	343	7,000
Other countries	870	14,000	759	17,000
Total	263,624	3,098,000	307;613	3,532,000

	1965	1966
Consumption (available data)		
Glass	37,076	38,351
Whiteware	7,608	9,243
Glass fibre	3,129	3,547
Mineral wool	675	252
Porcelain enamel	352	299
Paint	139	273
Other	1,685	720
Total	50,664	52,685

Source: Dominion Bureau of Statistics.

TABLE 2

Production and Exports 1958-67
(short tons)

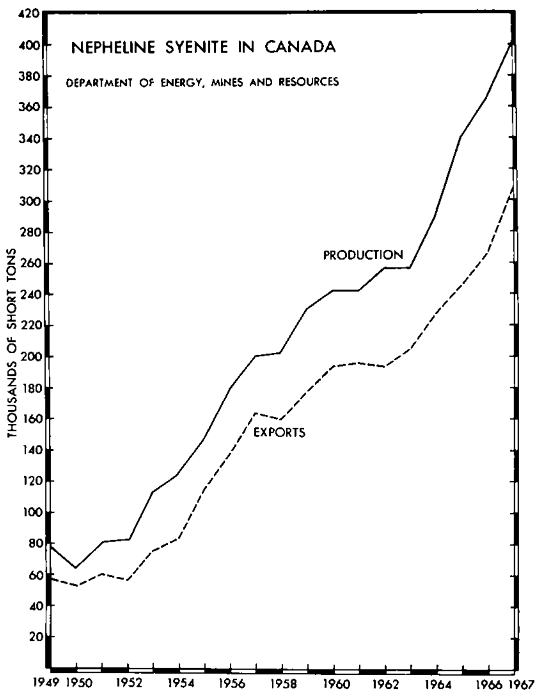
	Production	Exports
1958	201,306	160,081
1959	228,722	178,120
1960	240,636	193,298
1961	240,320	194,598
1962	254,418	193,658
1963	254,000	203,262
1964	290,300	226,971
1965	339,982	247,200
1966	366,696	263,624
1967	401,601	307,613

Source: Dominion Bureau of Statistics.

At Kirovsk in the Kola Peninsula, the Soviet Union mines an apatite-nepheline rock associated with the Khibinsk alkaline rock complex and produces a nepheline concentrate for use in the manufacture of green glass and as a source of aluminum. It also mines nepheline syenite in Siberia for processing at the alumina plant at Achinsk.

TECHNOLOGY

Nepheline syenite is a quartz-free rock consisting essentially of nepheline (a sodium aluminum silicate) and feldspar (sodium and potassium aluminum silicates). The Blue Mountain deposit contains approximately 50 per cent soda feldspar, 20 to 25 per cent of both nepheline and potash feldspar and small quantities of the iron-bearing minerals magnetite, biotite and hornblende. The comparatively little mineralogical variation in parts of the deposit and the relative ease with which iron-bearing minerals are removed by high-intensity, dry magnetic separation make the consistent production of high quality products possible. The deposit on Stjernøy is also uniform mineralogically, consisting of about 55 per cent perthite (a mixture of potash and soda feldspar), 30 to 35 per cent nepheline and minor amounts of other minerals, including the iron-bearing minerals magnetite, biotite, pyroxene and hornblende. A dry magnetic process is also used. In Canada, the nepheline syenite is mined in open quarries; in Norway, it is mined underground.



Ground and beneficiated nepheline syenite is commercially valuable to the ceramic industry because of its comparatively high alumina and alkali content and its relatively low melting temperature. Canadian products contain between 23 and 24 per cent alumina (Al_2O_3), about 10 per cent soda (Na_2O) and 5 per cent potash (K_2O), and a maximum of 0.08 per cent iron (expressed as Fe_2O_3). Norwegian nepheline syenite contains more than 24 per cent Al_2O_3, about 9 per cent K_2O and 8 per cent Na_2O, and about 0.08 per cent Fe_2O_3. Nepheline concentrate from the Kola Peninsula has a high alumina and alkali content – about 29 per cent Al_2O_3, 11 per cent Na_2O and 9 per cent K_2O – but too high an iron content – 3 to 4 per cent Fe_2O_3 – for anything but coloured glass.

USES AND SPECIFICATIONS

The glass industry is the dominant consumer of nepheline syenite, accounting for nearly three quarters of the total consumption in Canada. Nepheline syenite is important as a source of alumina and alkalis and because it lowers the melting temperature of the glass batch. All Canadian producers of container and flat glass have substituted nepheline syenite for feldspar. The particle size specification is minus 30 plus 200 mesh, US Standard. For clear glass, the iron content, expressed as Fe_2O_3, must be less than 0.1 per cent.

Nepheline syenite is used to a smaller extent in the whiteware industry as both a body and glaze ingredient. Because of its lower fusion temperature, many Canadian manufacturers of sanitaryware, wall tile and pottery have substituted it for feldspar. The particle size must be mainly minus 325 mesh and the iron content less than 0.1 per cent Fe_2O_3.

Because of its relatively low fusion temperature, fine-ground nepheline syenite is used as a frit ingredient for porcelain enamels. Specifications are similar to those for whitewares.

Small but increasing quantities of fine-ground nepheline syenite are being used as a filler in plastics and foam rubber and as an extender pigment in paints. Because the refractive index of nepheline syenite is nearly the same as that of the vinyl resins, it can be used in polyvinyl chloride plastics with little effect on the plastic's transparency. Its very fine particle size (the finest grade is essentially 10 microns), high reflectance and low oil absorption are useful properties in the manufacture of plastics and paints.

Lower-grade, lower-priced byproducts are used to some extent in glass fibre, in glaze for brick and tile, in the body and glaze of sewer pipe and in ground-coat enamels – in all of which the higher iron content is of little importance. Some crude is used in the manufacture of mineral wool.

PRICES

Canadian Chemical Processing of October 1967 quoted prices of nepheline syenite, in bags and car lots, f.o.b. works, of $12 to $29 a short ton, a modest increase over the year before. Early in 1968, the price of glass grade in bulk, f.o.b. plant, was increased by $1 to $11 a short ton.

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Nickel

A.F. KILLIN*

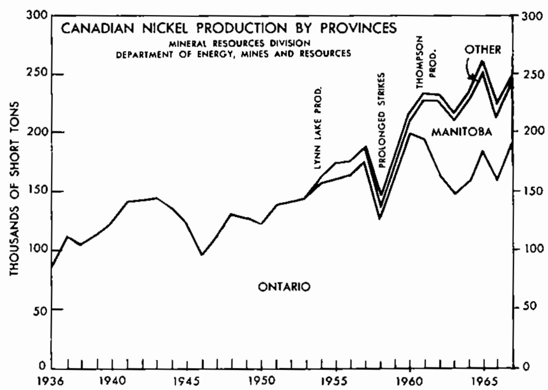
Sustained demand, a continued shortage of supply and a rise in price were the highlights of the year in the nickel industry. The inability of the industry to expand production quickly limited supplies that in turn, brought about a slow-down in consumption. At 412,500 tons, consumption in non-communist countries in 1967 was 2,500 tons less than in 1966. Non-communist world production is estimated at 340,000 tons. No further releases from the United States stockpile were made and the shortfall between production and consumption was satisfied by draw-down of company inventories and purchases from communist-bloc countries.

Production in Canada increased to 250,180 tons valued at $467,196,178 from 223,610 tons valued at $377,479,471 in 1966.

Consumption of nickel in Canada** increased 500 tons to 10,500 tons in 1967. Exports of the three major products decreased 3,404 tons to 246,525 tons valued at $419,980,000. Exports in concentrates and matte at 83,662 tons and in oxide sinter at 34,204 tons were 76 tons and 573 tons higher and exports of nickel in anodes, cathodes, shot, etc., at 128,659 tons were 4,053 tons lower than in 1966.

CANADIAN OPERATIONS AND DEVELOPMENTS

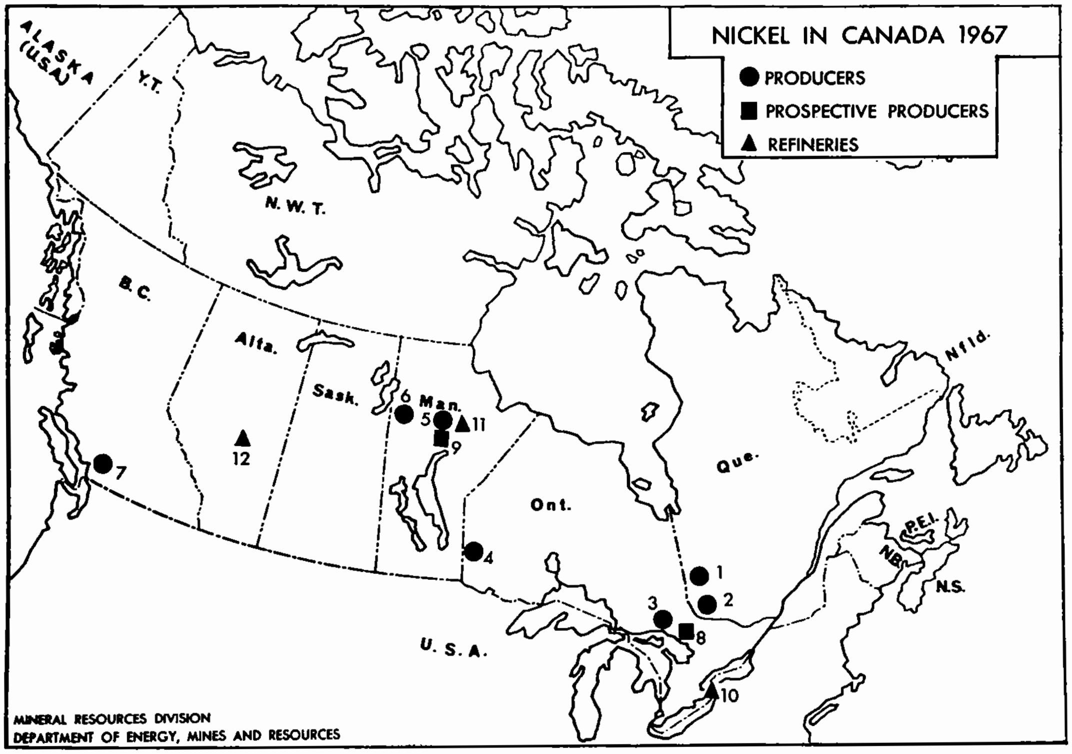
Two of the world's largest nickel-producing companies are The International Nickel Company of Canada, Limited (Inco) and Falconbridge Nickel Mines, Limited. In 1967 they produced about 90 per cent of Canada's output and nearly 68 per cent of the production in the non-communist world. There are six other nickel-producing companies in Canada, only one of which refines metal.



QUEBEC

Two small mines produced 1,679 tons of nickel valued at $3,170,330 in Quebec in 1967, a decrease of 2,296 tons and $3,643,373 from 1966. Most of the decline is attributed to a lower rate of mining and lower grade at the operation of Marbridge Mines Limited. This company, owned by Falconbridge Nickel Mines, Limited and Marchant Mining Company

*Mineral Resources Branch.
**Estimate by The International Nickel Company of Canada, Limited.



PRODUCERS

(numbers refer to numbers on map)

1. Marbridge Mines Limited

2. Lorraine Mining Company Limited

3. Sudbury area
   Falconbridge Nickel Mines, Limited (6 mines, 1 smelter)
   The International Nickel Company of Canada, Limited (10 mines, 2 smelters) Kidd Copper Mines Limited

4. Consolidated Canadian Faraday Limited

5. The International Nickel Company of Canada, Limited (Thompson mine and smelter)

6. Sherritt Gordon Mines, Limited

7. Giant Mascot Mines Limited

PROSPECTIVE PRODUCERS

8. Sudbury area
   Falconbridge Nickel Mines, Limited (Strathcona and Longvac South mines)
   The International Nickel Company of Canada, Limited (5 mines)

9. Thompson area
   The International Nickel Company of Canada, Limited (3 mines)

REFINERIES

10. The International Nickel Company of Canada, Limited (Port Colborne)

11. The International Nickel Company of Canada, Limited (Thompson)

12. Sherritt Gordon Mines, Limited (Fort Saskatchewan)

Ltd., operated a mine and mill near Malartic. Ore reserves and grade have been decreasing and the mine was on a salvage basis. A bulk concentrate was shipped to the Falconbridge smelter. Lorraine Mining Company Limited, near Belleterre, continued mining and exploration at its nickel-copper mine. Bulk concentrate from the 500-ton-a-day mill was shipped to the Sudbury, Ontario, smelter of The International Nickel Company of Canada, Limited.

New Quebec Raglan Mines Limited continued diamond drilling on its extensive nickel-copper property in the Wakeham Bay – Cape Smith area of the Ungava Peninsula. An exploration shaft was collared and supplies and equipment assembled at the camp and service area. Shaft sinking to allow underground exploration of the Raglan West and Raglan East zones was scheduled for 1968.

TABLE 1

Nickel – Production, Trade and Consumption, 1966-67

	1966		1967p	
	Short Tons	$	Short Tons	$
Production[1]				
All forms				
Ontario	160,214	269,461,584	190,684	354,904,736
Manitoba	57,812	98,447,063	55,543	104,827,800
British Columbia	1,594	2,731,869	2,112	3,987,456
Quebec	3,975	6,813,703	1,679	3,170,330
Saskatchewan	15	25,252	162	305,856
Total	223,610	377,479,471	250,180	467,196,178
Exports				
Nickel in ores, concentrates, matte and speiss				
Britain	44,364	74,094,000	45,939	84,508,000
Norway[2]	37,167	59,467,000	30,328	48,806,000
Japan	1,605	1,765,000	7,264	11,147,000
United States	450	629,000	120	177,000
Netherlands	–	–	11	11,000
Total	83,586	135,955,000	83,662	144,649,000
Nickel in oxide sinter				
United States	18,931	27,420,000	22,106	35,847,000
Britain	4,929	7,081,000	4,837	7,692,000
West Germany	2,690	4,230,000	2,653	4,687,000
Italy	1,087	1,713,000	1,657	2,904,000
Sweden	2,000	3,136,000	1,215	2,121,000
Australia	562	807,000	958	1,497,000
France	1,473	2,313,000	561	972,000
Belgium and Luxembourg	1,532	2,382,000	158	273,000
Mexico	69	113,000	36	67,000
Other countries	358	566,000	23	40,000
Total	33,631	49,761,000	34,204	56,100,000
Nickel and nickel alloy scrap				
United States	919	604,000	1,144	1,147,000
Japan	14	19,000	304	786,000
Netherlands	56	116,000	224	513,000
Britain	95	127,000	195	479,000
West Germany	–	–	106	215,000
France	53	81,000	17	29,000
Other countries	46	63,000	23	64,000
Total	1,183	1,010,000	2,013	3,233,000

TABLE 1 (Cont'd)

	1966		1967p	
	Short Tons	$	Short Tons	$
Exports (Cont.)				
Nickel anodes, cathodes, ingots, rods				
United States	101,700	156,962,000	104,045	176,124,000
Britain	20,248	29,978,000	17,487	28,886,000
France	1,392	2,254,000	1,604	2,951,000
Australia	571	915,000	1,342	2,439,000
Japan	1,624	2,752,000	1,208	2,787,000
India	257	432,000	1,064	2,164,000
Brazil	354	583,000	380	718,000
Mexico	244	404,000	319	667,000
Argentina	293	505,000	229	436,000
West Germany	3,205	5,219,000	213	545,000
Italy	607	995,000	188	371,000
Sweden	924	1,511,000	135	228,000
Other countries	1,293	2,171,000	445	915,000
Total	132,712	204,681,000	128,659	219,231,000
Nickel and nickel-alloy fabricated materials, n.e.s.				
United States	3,446	6,770,000	3,258	7,453,000
France	4	17,000	516	980,000
India	68	114,000	176	371,000
Britain	36	75,000	122	273,000
Japan	59	101,000	110	231,000
West Germany	89	143,000	75	201,000
Mexico	20	36,000	39	66,000
Italy	9	35,000	37	162,000
Other countries	145	461,000	107	329,000
Total	3,876	7,752,000	4,440	10,066,000
Imports				
Nickel in ores, concentrates and scrap				
French Oceania	5,646	6,608,000	5,261	6,113,000
United States	12,247	14,989,000	4,477	3,725,000
Britain	8,704	1,464,000	4,359	1,506,000
West Germany	73	80,000	99	114,000
Australia	–	–	75	44,000
Other countries	7	1,000	44	41,000
Total	26,677	23,142,000	14,315	11,543,000
Nickel anodes, cathodes, ingots, rods				
Norway	10,789	18,470,000	9,507	18,460,000
United States	18,097	29,110,000	48	143,000
Other countries	30	73,000	2	2,000
Total	28,916	47,653,000	9,557	18,605,000

TABLE 1 (Cont'd)

	1966		1967p	
	Short Tons	$	Short Tons	$
Imports (Cont.)				
Nickel alloy ingots, blocks, rods and wire bars				
United States	718	2,246,000	660	2,090,000
West Germany	20	62,000	10	37,000
Other countries	. .	1,000	1	3,000
Total	738	2,309,000	671	2,130,000
Nickel and nickel alloy fabricated materials, n.e.s.				
United States	1,731	5,922,000	2,220	8,237,000
West Germany	156	746,000	409	1,957,000
Britain	95	327,000	86	288,000
Japan	–	–	61	217,000
Other countries	10	41,000	22	119,000
Total	1,992	7,036,000	2,798	10,818,000
Consumption[3]	8,608			

Source: Dominion Bureau of Statistics.
[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, oxide and salts) as reported by consumers.
p Preliminary; – Nil; . . Less than one ton; n.e.s. Not elsewhere specified.

ONTARIO

Nickel production in Ontario increased 19 per cent to 190,684 tons valued at $354,904,736. Most of the increased production was obtained from the mines and plants of Inco and Falconbridge.

Inco operated nine underground mines, one open-pit mine, four mills, two smelters, a copper refinery and an iron ore recovery plant in the Sudbury area. The company continued its expansion in the Sudbury basin and plans to bring into production the Kirkwood mine (1970), the Coleman and Little Stobie mines (1969) and the Copper Cliff South mine (1971). At the producing mines, preparations for expanded production were being made by shaft sinking and development. The 22,500-ton-a-day mill at the Frood-Stobie mine was completed in November and production of a bulk nickel-copper concentrate was started. A start was made on the modification of the Levack mill circuit to allow the daily production of 1,500 tons of pyrrhotite concentrate. The pyrrhotite will be processed in the iron ore plant. Replacement of the multi-hearth roasters in the smelter with fluid-bed roasters continued. Inco had two major exploration projects in hand in 1967. At the North Range property in the Sudbury area, shaft sinking was started on a low-grade deposit. In northwestern Ontario, near Fort William–Port Arthur, the initial phase of shaft sinking was completed at the company's Shebandowan property, and underground development and exploration started.

Falconbridge operated six mines, three mills and a smelter in the Sudbury area. The company was preparing the Strathcona (1968) and Longvac South (1969) mines for production and was building a 6,000-ton-a-day mill at the Strathcona mine. Plant improvements at Falconbridge will allow the smelter to treat the increased production, and output capacity will be raised to 100 million pounds of nickel a year. The Strathcona mill will produce a nickel-copper concentrate and a pyrrhotite concentrate. An iron ore reduction plant is planned that will produce pre-reduced iron pellets containing about 90 per cent iron and 1.5 per cent nickel. Sulphur dioxide from the plant will be recovered and processed.

Kidd Copper Mines Limited continued operation at its mine, leased from Aer Nickel Corporation Limited, in the Worthington offset. A bulk nickel-copper concentrate was shipped to Falconbridge for smelting. Extensive diamond drilling from the bottom 950-foot level was being done to explore for extensions of the ore zone at depth.

At Werner Lake in northwestern Ontario, Consolidated Canadian Faraday Limited, of which Metal Mines Limited, the former operator at Werner Lake, is now a part, continued production at about 600 tons of ore a day. A bulk nickel-copper concentrate was sold to Inco.

Surface diamond drilling and underground exploration by an adit and ring drilling was carried out on the Pardee Township property of Great Lakes Nickel Corp. Limited. Indicated reserves were 40 million tons averaging 0.40 per cent copper and 0.20 per cent nickel. Feasibility studies on the economics of production were being made.

MANITOBA

There were two nickel mines, two mills, a smelter and a refinery operating in Manitoba in 1967 and three new mines were being developed. Output in 1967 was 55,543 tons valued at $104,827,800, a decrease of 2,269 tons in production but an increase of $6,380,737 in value from 1966. Most of the decrease in production was attributed to decreased output at the Lynn Lake mine of Sherritt Gordon Mines, Limited.

TABLE 2

Nickel – Production, Trade and Consumption, 1958-67
(short tons)

	Production[1]	Exports				Imports[2]	Consumption[3]
		In Matte etc.	In Oxide Sinter	Refined Metal	Total		
1958	139,559	67,659	1,393	85,168	154,220	2,155	4,099
1959	186,555	65,657	4,157	102,111	171,925	1,857	4,059
1960	214,506	73,910	13,257	108,350	195,517	1,762	4,861
1961	232,991	92,938	18,022	133,504	244,464	4,304	4,935
1962	232,242	77,410	11,120	121,712	210,242	7,494	5,322
1963	217,030	83,392	15,208	109,156	207,756	10,973	5,869
1964	228,496	74,766	35,800	128,330	238,896	10,444	6,899
1965	259,182	82,327	40,956	135,197	258,480	12,172	8,924
1966	223,610	83,586	33,631	132,712	249,929	28,916	8,608
1967p	250,180	83,662	34,204	128,659	246,525	9,557	8,767

Source: Dominion Bureau of Statistics.
[1] Refined metal and nickel in oxide and salts produced plus recoverable nickel in matte and concentrates exported. [2] Nickel in bars, rods, strips, sheets and wire; nickel and nickel-silver in ingots; nickel chromium in bars. [3] To 1959, producers' domestic shipments of refined metal; after 1959, consumption of nickel, all forms (refined metal, oxide and salts) as reported by consumers.
p Preliminary.

TABLE 3

Producing Companies, 1967

Company and Location	Mill Capacity (tons ore/day)	Ore Produced 1967 (1966) (short tons)	Grade (%) Ni	Grade (%) Cu	Developments
Quebec					
Lorraine Mining Company Limited, Belleterre	400	192,532 (186,363)	0.45	0.92	Underground exploration by development and diamond drilling.
Marbridge Mines Limited, Malartic	350 Milled at Canadian Malartic Gold Mines Limited	79,201 (128,500)	1.77	. .	Routine mining of remaining ore reserves.

TABLE 3 (Cont'd)

Company and Location	Mill Capacity (tons ore/day)	Ore Produced 1967 (1966) (short tons)	Grade (%) Ni	Cu	Developments
Ontario					
Consolidated Canadian Faraday Limited, Werner Lake Division, Gordon Lake	750	214,536 (211,228)	1.17	0.58	Formerly Metal Mines Limited. Development of known orebodies. Surface and underground exploration for new ore occurrences.
Falconbridge Nickel Mines, Limited, Falconbridge, (Falconbridge, East, Hardy, Fecunis, Onaping and North mines)	3,000 (Falconbridge) 1,500 (Hardy) 2,400 (Fecunis)	2,093,507 (2,101,000)	1.50	0.76	Routine mining and development of known orebodies. Preparation for mining at the Strathcona and Longvac South mines.
The International Nickel Company of Canada, Limited, Copper Cliff (Creighton, Frood-Stobie, Levack, Garson, Murray, Crean Hill, MacLennan, Totten, Copper Cliff North mines and Clarabelle open pit)	30,000 (Copper Cliff) 12,000 (Creighton) 6,000 (Levack) 22,500 (Frood-Stobie)	16,953,760 (14,625,200)	. .	. .	Sinking continued at the Creighton No. 9, Totten No. 2 and Stobie No. 9 shafts and development continued at the Copper Cliff South, Copper Cliff North, Coleman, Kirkwood and Little Stobie mines. Shaft sinking and underground development were continued at the company's Shebandowan property. The Frood-Stobie mill started production in October.
Kidd Copper Mines Limited, Aer Nickel mine, Worthington	1,000	. . (Tune up)	. .	. .	Routine mining. Exploration by diamond drilling below the 950-foot level.
Manitoba					
The International Nickel Company of Canada, Limited, Thompson, Thompson mine	6,000	1,982,201 (2,900,000)	. .	. .	Preparation of the Birchtree mine for production in 1968. Stripping of overburden from Pipe orebody. Shaft sinking at Soab mine. Construction of Pipe-Thompson railroad.
Sherritt Gordon Mines, Limited, Lynn Lake	3,500	1,071,490 (1,205,318)	. .	. .	Extensive exploration and development of the O and N zones. Indications of new orebodies will be investigated.
British Columbia					
Giant Mascot Mines Limited, Hope	1,250	333,546 (331,579)	0.86	0.31	Surface and underground exploration for new orebodies and for extensions to known orebodies. Geological, geochemical and geophysical surveys at surface in the mine area.

Source: Company reports.

. . Not available.

TABLE 4

Prospective Producing Companies* 1967

Company and Location	Type of Ore	Mill Capacity (tons of ore/day)	Production to Start	Destination of Concentrates
Ontario				
Falconbridge Nickel Mines, Limited, Sudbury				
Strathcona mine	Ni,Cu	6,000	1968	Own Smelter
Longvac South Mine	Ni,Cu	–	1969	Own Smelter
The International Nickel Company of Canada, Limited, Copper Cliff				
Copper Cliff South mine	Ni,Cu	4,000 (milled at Copper Cliff)	1970	Own Smelter
Coleman mine	Ni,Cu	..	1969	Own Smelter
Frood-Stobie expansion	Ni,Cu	22,500	1968	Own Smelter
Kirkwood mine	Ni,Cu	..	1968	Own Smelter
Little Stobie mine	Ni,Cu	6,000 (milled at Stobie Mill)	1969	Own Smelter
Manitoba				
The International Nickel Company of Canada, Limited Thompson				
Birchtree mine	Ni	..	1968	Thompson Smelter
Soab mine	Ni	..	1968	Thompson Smelter
Pipe Lake mine	Ni	..	1969	Thompson Smelter

Source: Company reports.
* Includes only companies with announced production plans.

Inco continued production at the Thompson mine and was preparing the Birchtree and Soab mines for production in 1968. Overburden was being dredged from over the Pipe orebody and open-pit production is scheduled for 1970. A 45-mile railway was being built from Thompson to transport ore from the Soab and Pipe mines. The smelter and refinery at Thompson were being expanded to treat the ore from the new mines.

Sherritt Gordon's Lynn Lake mine produced less ore in 1967 resulting in a lower output of nickel and copper in concentrates. Production started in the B open pit in the third quarter and exploration of the N zone above the 3,000-foot level continued. Matte was imported from New Caledonia for treatment at the company's Fort Saskatchewan, Alberta, refinery and Sherritt Gordon had contracted to toll-refine 11,000 tons of concentrate a year from the Kambalda, Australia, mine of Western Mining Corporation Limited.

Falconbridge Nickel Mines continued its exploration at the Wabowden Lake property of Bowden Lake Nickel Mines Limited. An extensive low-grade nickel deposit has been indicated by diamond drilling from the surface.

BRITISH COLUMBIA

All the 2,112 tons of nickel valued at $3,987,456 produced in British Columbia in 1967 was from the mine of Giant Mascot Mines Limited near Hope. Giant Mascot increased production, grade and ore reserves in the year and was continuing an extensive surface and underground exploration program.

Silver Standard Mines Limited continued exploration of the E & L property south of the Iskut River in northwestern British Columbia. A road was built from the airstrip to the proposed site of an adit crosscut. Underground exploration was scheduled for 1968.

WORLD DEVELOPMENTS

World production in 1967 was estimated by the United States Bureau of Mines at 479,300 tons, an increase of 4,300 tons from 1966. There were no authorizations for release of nickel from United States stockpiles in the year. Table 5 lists world production by countries.

TABLE 5

World Production of Nickel
(short tons)

	1966	1967[p]
Canada	242,788	240,000
USSR	105,000	110,000
New Caledonia	66,900[e]	68,000
Cuba	30,200[e]	30,000
United States	13,237	13,300
Other non-communist countries	16,875	18,000
Total	475,000	479,300

Source: United States Bureau of Mines.
[e] Estimate; [p] Preliminary.

Although Canadian production is expected to increase by about 100,000 tons by 1970, world consumption is increasing at a steady rate and new sources of supply will be required. The world's greatest nickel reserves are contained in lateritic ores occurring in tropical and semi-tropical areas. It is reasonable to assume that increased production will be obtained from nickel laterites and, to this end, deposits are being explored in Guatemala, New Caledonia, Venezuela, Colombia, Indonesia, the British Solomon Islands Protectorate, Brazil, the Dominican Republic, Australia and the Republic of the Philippines. Sulphide nickel deposits have also been discovered in Australia and production from one of these, at Kambalda, started in 1967.

AUSTRALIA

Production of nickel in Australia began in June 1967 when concentrates were obtained from the Kambalda mill of Western Mining Corporation Limited. The Kambalda mine is in Western Australia about 35 miles south of Kalgoorlie. Three orebodies have been discovered on the north shore of Lake Lefroy. A 350-ton-a-day mill was built to treat ore from the Lunnan shoot, the first of the orebodies to be developed for mining. Some of the concentrates will be shipped to the Sherritt Gordon refinery at Fort Saskatchewan, Alberta, Canada, and the remainder to the Sumitomo Metal Mining Co. Ltd. at Niihama, Japan. The Kambalda discovery has stimulated exploration in the area and a number of companies are exploring for deposits including: The International Nickel Company of Canada, Limited, Conwest Exploration Overseas Limited, The Anaconda Company, Cominco Ltd., Selection Trust, Conzinc Riotinto of Australia Ltd., and Great Boulder Goldmines Ltd.

Lateritic nickel ores occur in Western Australia about 900 miles northeast of Perth, at Greenvale in north Queensland and also north of Rockhampton in Queensland. These deposits are being sampled and explored by a number of companies.

BRITISH SOLOMON ISLANDS PROTECTORATE

Inco continued exploration of lateritic nickel deposits on the islands of Santa Ysabel, San Gorge and Choiseul. An airstrip was built on San Gorge and bulk samples of the lateritic ore sent to Canada for metallurgical testing.

BRAZIL

Brazil currently ranks tenth among world nickel producers. The two major producers are Morro do Niquel S.A. at Pratapolis (Minas Gerais) and Companhia Niquel do Brazil S.A. at Liberdade. Both companies make ferronickel. Average annual production is 1,200 tons of contained nickel.

DOMINICAN REPUBLIC

Falconbridge built a larger pilot plant for metallurgical testing of ore from its lateritic nickel deposit. A decision on the establishment of a commercial operation is expected in 1968.

GUATEMALA

Exploraciones y Explotaciones Mineras Izabal, S.A. (Eximbal), a majority-owned subsidiary of Inco, continued development work on the deposits near Lake Izabal. Negotiations were being made with the Guatemalan government for permission to build a plant capable of producing 25,000 tons of nickel a year.

GREECE

Société Minière et Métallurgique de Larynma-Larco produced ferronickel for sale in Europe. Production of electrolytic nickel and steel was scheduled to start in 1968.

THE REPUBLIC OF INDONESIA

The Sulawesi Nickel Development Cooperation Co. (Sunideco) a joint venture of Japanese nickel smelting companies, operated mines in the Pomala district of Sulawesi (Celebes) Island. The lateritic ore was shipped to Japan for smelting. In fiscal year 1967 (April 1967 – March 1968) a contract for 190,000 tons of ore was signed between the Indonesian Government and Sunideco.

In 1967 the Government of the Republic of Indonesia invited proposals from interested companies to develop the nickel deposits of Sulawesi. Inco was the successful bidder and has scheduled a program of exploration and metallurgical testing as a preliminary to development.

JAPAN

There was no production of nickel ore in Japan. Lateritic ores were imported from New Caledonia and Indonesia for the manufacture of ferronickel and nickel sulphide concentrates from Australia and Canada for the production of electrolytic nickel. Two Japanese companies produced electrolytic nickel and ferronickel and three companies produced only ferronickel. Tokyo Nickel Company, owned by Inco (40%), Mitsui and Company (10%) and Shimura Kako Co., Ltd. (50%), started the production of nickel oxide sinter 75 in March. The plant at Matsuzaka, about 300 miles southwest of Tokyo is operated on matte purchased from Inco; its capacity is 415 tons of oxide sinter a month.

Four Japanese nickel producers have formed a consortium with Société Le Nickel to build a nickel oxide plant at Tsuruga in northern Japan. The plant will have a capacity of 5,000 tons of oxide a year. The four Japanese companies are Nippon Mining Co. Ltd., Sumitomo Metal Mining Co. Ltd., Taiheiyo Nickel Co. and Nippon Yakin Kogyo K.K.

NEW CALEDONIA

Société Le Nickel is the largest nickel producer in New Caledonia, operating mines, electrical generating plants and a smelter for the production of ferronickel and nickel matte. Capacity of the plant was increased to 42,000 tons of contained nickel a year in 1967. The French government has granted Le Nickel and Kaiser Aluminum & Chemical Corporation the right to mine nickel ore and produce ferronickel in New Caledonia. Two companies will be established, New Caledonia Nickel Company to mine the ore and produce the ferronickel and Kaiser Le Nickel Corporation to market the product in the United States. Planned capacity is 33 million pounds of contained nickel a year.

Inco has entered into an agreement to obtain a 40 per cent equity in a new company formed to explore, mine and smelt nickel ore in New Caledonia. The company will be owned by Inco and a consortium of French companies and banks. These will include the French government mining agency, Bureau de Recherches Géologiques et Minières, and Ugine-Kuhlmann, Schneider, Chatillon, CAFL, Banque de Paris, Banque Nationale de Paris, Cie Financière du Suez and Banque d'Indochine. Exploration of low-grade lateritic deposits in New Caledonia was scheduled to start in 1968 and, if successful, a mining plant and smelter is scheduled to be built to produce 50 million to 100 million pounds of nickel a year.

RHODESIA

Anglo American Corporation of South Africa, Limited has purchased the Trojan nickel mine at Bindura. Geological investigation has discovered another orebody at Shamva. The company plans to develop the two mines and build a smelter and refinery. Annual production is scheduled at 17 million pounds of nickel by late 1969.

Near Gatooma, Rio Tinto (Rhodesia) Limited was exploring and developing the Empress mine. Present plans call for production of 720,000 tons of ore a year averaging 0.81 per cent nickel and 0.62 per cent copper by 1972.

VENEZUELA

Société Le Nickel was negotiating with the Venezuelan government to explore and, if feasible, to develop the lateritic nickel deposits at Loma de Hiero, Aragua State.

CONSUMPTION AND USES

Resistance to corrosion, pleasing appearance and suitability as an alloying agent are the chief advantages in almost all of the uses of nickel. Stainless steel was the largest single outlet for nickel followed closely by nickel plating and high-nickel alloys. Stainless steel use increased in the field of rapid transit and railway car manufacture, in fertilizer and food processing machinery and in architectural applications. High-nickel alloys are used in chemical, marine, electronic, nuclear and aerospace applications.

Consumption in 1967 was estimated at 825,000,000 pounds, some 5 million pounds less than in 1966. Consumption decreased 14 per cent in the United States and rose 5 per cent in Europe and the United Kingdom, 37 per cent in Japan and 5 per cent in Canada.

Tables 6 and 7 list the consumption of nickel by use and by countries in 1966 and 1967.

TABLE 6

Nickel Consumption by Use, 1966-67
(millions of pounds)

	1966	1967e
Stainless steels	296	309
Nickel plating	132	125
High-nickel alloys	124	121
Constructional alloy steels	97	90
Iron and steel castings	78	77
Copper and brass products	33	31
Other	72	72
Total	832	825

Source: The International Nickel Company of Canada, Limited.
eEstimated.

TABLE 7

Nickel Consumption by Country, 1966-67
(millions of pounds)

	1966	1967e
United States	412	353
Europe* and Britain	305	320
Japan	80	110
Canada	20	21
Other	15	22
Total	832	825

Source: The International Nickel Company of Canada, Limited.
eEstimated; *Excluding communist countries.

PRICES

Nickel prices were again raised in 1967 after an increase of 7 1/2 cents (US) a pound in 1966. Sherritt Gordon Mines, Limited raised its refined nickel powder price to 98 cents (US) a pound on September 15. Effective October 1, International Nickel and Falconbridge raised the price of electrolytic cathodes to 94 cents (US) a pound from 85.25 cents. The Canadian price was raised to 101.5 cents (Can.) a pound. There was a free market price for nickel that ranged up to $2.00 a pound.

PRICES, 1967

	Canada		United States	
	Jan. 1– Sept. 31	Oct. 1– Dec. 31	Jan. 1– Sept. 31	Oct. 1– Dec. 31
	(cents a pound)			
Inco, electrolytic, f.o.b. Port Colborne, Ont. and Thompson, Man.	92.15	101.5	85.25	94
Falconbridge, electrolytic f.o.b., Thorold, Ont.	92.15	101.5	85.25	94
Sherritt Gordon, briquettes, f.o.b., Niagara Falls, Ont., and Fort Saskatchewan, Alta.	92.15	105.0*	85.25	98*
Nickel oxide sinter 75(Ni-Co content) points in Ontario (freight allowed)	87.80	95.50		
Points outside of Ontario (less freight allowance of 1.25¢ a pound)	87.80	95.50		
Buffalo, N.Y., or other established US points of entry				
Nickel oxide sinter 75			81.00	88.50
Nickel oxide sinter 90			81.25	89.00

Source: *Metals Week*.
* Effective September 15.

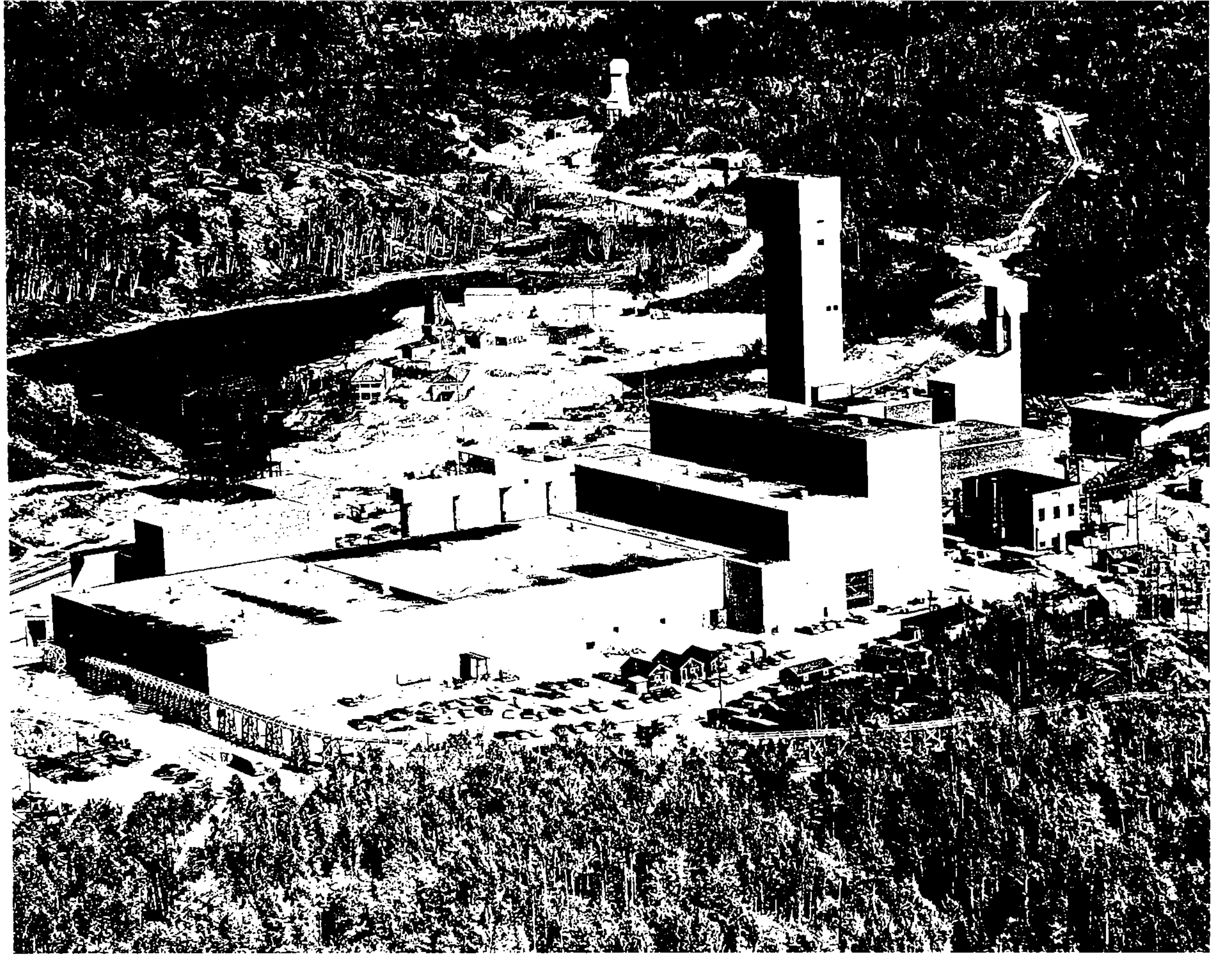
TARIFFS

	British Preferential (%)	Most Favoured Nation (%)	General (%)
CANADA			
Nickel and alloys consisting of 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
Rods, consisting of 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	10
Metal, alloy strip or tubing, not being steel strip or tubing, consisting of not less than 30% by weight of nickel and 12% by weight of chromium, for use in Canadian manufactures	free	free	20
Anodes of nickel	5	7 1/2	10
Nickel, and alloys containing 60% by weight or more of nickel, in Canadian manufactures (expires June 30, 1968)	free	free	free
Nickel or nickel alloys, namely: matte, sludges, spent catalysts and scrap, and concentrates other than ores, for recovery of the nickel or attendant byproducts (expires June 30, 1968)	free	free	free
Articles of iron, steel or nickel, or of which iron, steel or 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	10	10	20
Ferronickel	free	5	5

UNITED STATES

Ore, matte, and oxide	free
Unwrought, waste and scrap, (duty suspended until June 30, 1967)	1.25¢ lb
Electroplating anodes, wrought and cast of nickel	10% ad val

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT) that was convened in 1964 to consider reductions in tariffs submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968 and final reductions on January 1, 1972.



ANOTHER MINE FOR THE WORLD-FAMOUS SUDBURY BASIN: Falconbridge's Strathcona mill and mine headframes on the north rim of the Basin. This mine and another under development are scheduled for production in late 1968 — bringing to eight the number of Sudbury mines operated by the company.

Petroleum

W.G. LUGG*

Encouraged by increased demand for crude oil and petroleum products, Canada's oil industry again expanded its operations to record levels and continued to play a vital role in the nation's economy. Due in part to the disruption of crude oil supplies from the Middle East, production of crude oil and natural gas liquids rose to a new high of 1,111,000 barrels daily in 1967, surpassing the 1966 volume by more than 9 per cent. This gain was comprised mainly of increased exports to the United States, partly because of the closure of the Suez Canal, although domestic demand did rise slightly. Canadian crude oil producers supplied 58 per cent of Canada's crude oil requirements in 1967. If imports, exports and stock changes are considered, Canada's petroleum industry met the equivalent of 84 per cent of domestic requirements. Imports of crude oil and products, amounting to 631,000 barrels a day, surpassed the demand for domestic crude oil in 1967. Exports of crude oil to the United States increased 22 per cent to 412,000 barrels a day – part of this large increase being due to shortages which developed on the west coast of the United States because of the disruption in traditional supplies of Middle East oil.

The Rainbow Lake-Zama Lake areas of northwestern Alberta continued to be an area of major exploratory interest, although the boom experienced in the past two years slackened to some extent. Exploratory effort in the remainder of the western Canadian sedimentary basin was maintained at a high level during the past year but the industry fell behind the previous year in total number of wells drilled and new oil discoveries confirmed. The Great Canadian Oil Sands Limited project near Fort McMurray, Alberta was officially opened in September, 1967 and although at year end the plant was experiencing some operating problems, it was expected to reach full production in 1968.

Recoverable crude oil and natural gas liquids reserves increased by almost a half billion barrels despite record levels of production in 1967. Some progress was again made in experimental steam secondary recovery projects, notably in the Cold Lake area of east-central Alberta where the producing sands are thick enough to provide a high oil recovery to injected stream ratio. The pipeline sector of the industry showed a sharp upturn in construction during 1967 as did the refinery industry with several major additions to plant facilities. One small new refinery came on stream at Prince George, British Columbia.

PRODUCTION

Net production of Canadian crude oil and natural gas liquids increased by 9.5 per cent in 1967, a substantial gain over all previous levels. Total output of liquid hydrocarbons was 404.6 million barrels, an average of 1,109,000 barrels a day. Crude oil output alone amounted to 960,000 barrels daily. Field and gas plant production of natural gas liquids totalled 149,000 barrels a day, including 84,000 barrels of condensate and pentanes plus, and 65,000 barrels of propane and butane.

Total liquid hydrocarbon production increased 14 per cent in Alberta, 18 per cent in British Columbia, 7 per cent in Manitoba and declined slightly in Saskatchewan, Ontario and the Northwest Territories.

*Mineral Resources Branch.

TABLE 1

Production of Crude Oil by Province and Field, 1966-67
(number in parentheses gives location of field on the accompanying map)

	1966		1967p	
	Barrels	Bbl/Day	Barrels	Bbl/Day
Alberta				
Pembina (1)	37,838,589	103,667	37,917,696	103,884
Swan Hills (4)	20,526,026	56,235	22,755,379	62,344
Golden Spike (2)	13,579,674	37,204	16,531,040	45,292
Redwater (3)	15,374,988	42,124	16,513,241	45,243
Judy Creek (4)	9,884,281	27,081	12,121,899	33,211
Rainbow (14)	2,565,305	7,028	9,612,232	26,335
Swan Hills South (4)	8,860,426	24,275	8,674,398	23,765
Bonnie Glenn (2)	7,373,031	20,201	8,668,531	23,749
Leduc-Woodbend	8,104,503	22,204	8,044,500	22,041
Fenn-Big Valley	5,692,806	15,597	6,250,692	17,125
Mitsue (16)	4,315,098	11,823	4,917,398	13,473
Wizard Lake (2)	4,169,738	11,424	4,813,963	13,189
Nipisi	2,759,159	7,559	4,478,040	12,269
Virginia Hills (4)	4,501,737	12,334	4,420,202	12,111
Sturgeon Lake South (9)	3,455,280	9,466	3,660,337	10,029
Willesden Green	3,043,627	8,338	3,396,679	9,306
Kaybob (10)	2,807,395	7,692	2,950,021	8,083
Carson Creek North (4)	2,599,517	7,122	2,714,011	7,435
Zama	–	–	2,669,469	7,314
Snipe Lake (12)	2,892,290	7,924	2,668,924	7,313
Joarcam (7)	2,493,600	6,832	2,548,126	6,982
Acheson (2)	2,327,818	6,377	2,467,912	6,762
Westerose (2)	1,631,692	4,470	2,219,403	6,081
Medicine River (13)	1,836,718	5,033	2,042,232	5,595
Harmattan-East (6)	1,890,532	5,179	1,886,411	5,168
Innisfail (6)	1,797,974	4,926	1,873,903	5,134
Wainwright (17)	1,810,154	4,959	1,847,953	5,063
Joffre (5)	1,721,893	4,717	1,760,206	4,823
Bantry (18)	1,605,859	4,399	1,743,919	4,778
Kaybob South (10)	1,705,172	4,672	1,735,569	4,755
Harmattan-Elkton (6)	1,542,734	4,226	1,565,903	4,291
Gilby (5)	1,314,415	3,602	1,479,116	4,053
Clive	754,443	2,067	1,478,227	4,050
Stettler (8)	1,319,480	3,615	1,349,225	3,697
Rainbow South (14)	362,209	993	1,345,916	3,687
Simonette (15)	1,173,048	3,214	1,112,333	3,047
Sundre	1,064,093	2,915	1,059,526	2,904
Turner Valley (11)	1,017,775	2,788	1,006,584	2,758
Other fields and pools	15,626,354	42,812	17,242,333	47,239
Total	203,339,433	557,094	231,543,449	634,378
Total value	$524,005,719		$613,126,177	

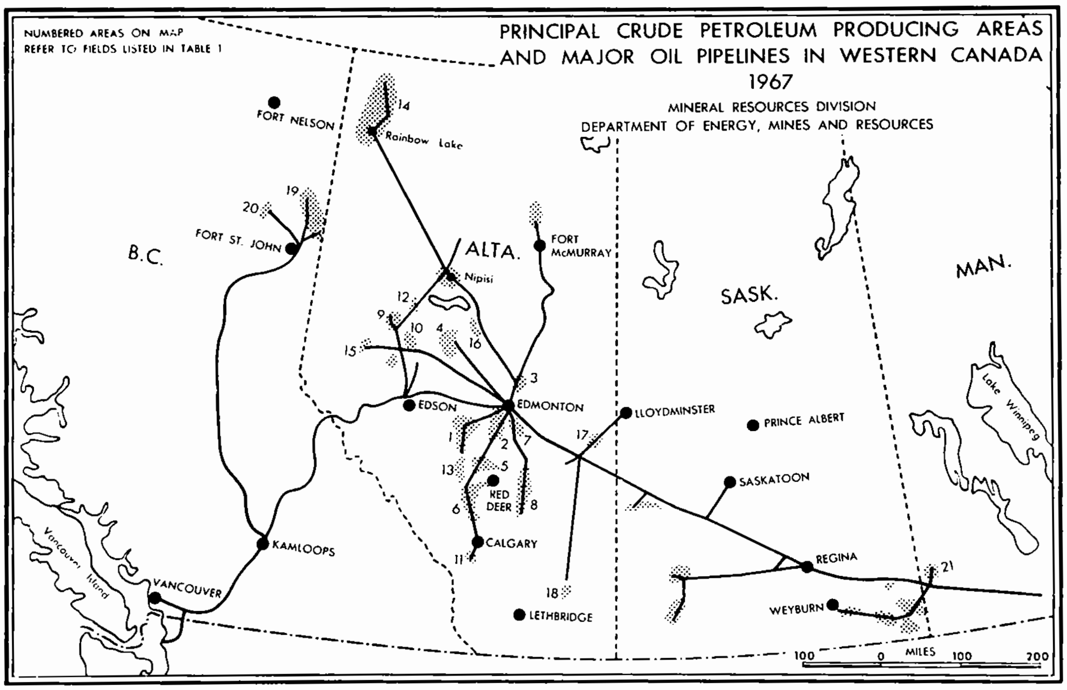
TABLE 1 (continued)

	1966		1967p	
	Barrels	Bbl/Day	Barrels	Bbl/Day
Saskatchewan[1]				
Total unit and non-unit areas	93,218,119	255,392	92,538,966	253,531
Total value	$212,723,748		$211,174,248	
British Columbia				
Boundary Lake (19)	5,710,838	15,646	6,643,759	18,202
Peejay (19)	3,796,316	10,401	5,144,321	14,094
Milligan Creek (19)	3,475,633	9,523	3,558,644	9,750
Other fields and pools	3,688,541	10,105	4,306,251	11,797
Total	16,671,328	45,675	19,652,975	53,843
Total value	$ 36,726,936		$ 40,803,579	
Manitoba				
North Virden-Scallion (21)	2,356,616	6,456	2,608,866	7,148
Virden-Roselea (21)	1,171,252	3,209	1,270,585	3,481
Other fields and pools	1,702,844	4,665	1,705,924	4,673
Total	5,230,712	14,330	5,585,375	15,302
Total value	$ 12,956,474		$ 13,940,358	
Ontario	1,323,781	3,626	1,240,159	3,397
Total value	$ 4,236,099		$ 3,908,318	
Northwest Territories	752,585[2]	2,061	677,937[2]	1,857
Total value	$ 842,895		$ 779,775	
New Brunswick	6,836	18	8,837	24
Total value	$ 20,508		$ 26,511	
Total, Canada	320,542,794	878,196	351,247,698	962,320
Total value	$791,512,379		$883,758,966	

Sources: Dominion Bureau of Statistics and Provincial government reports.
[1] Saskatchewan lists production by formations rather than by fields.
[2] Excludes stock reinjected into the reservoir.
p Preliminary; – Not reported.

Alberta production accounted for 66.0 per cent of the total Canadian output of crude oil, Saskatchewan contributed 26.3 per cent, British Columbia 5.6 per cent, Manitoba 1.6 per cent and Ontario, the Northwest Territories and New Brunswick together, 0.5 per cent. All provinces except Alberta were producing crude oil at near capacity rates. The Alberta Oil and Gas Conservation Board estimated that the year-end daily crude oil output capacity of the province was 1.5 million barrels, which means that only about 42 per cent of the province's capability was being utilized at the end of 1967.

The gradual implementation of the new prorationing regulations, in Alberta which are to become fully operative in 1969, is beginning to affect the production allowables of many of the province's oil fields. The new regulations favour the large reserves per acre, high production potential pools, such as Swan Hills, Golden Spike and Redwater. These pools, as shown in Table 1, have had their allowable pool production consistently raised since the changes in the prorationing regulations began to take effect in 1965. Although aggregate production of crude oil in Alberta has increased over 23 per cent in the past three years,



the low reserves per acre fields, such as Pembina, have not increased their output and in some instances have appreciably declined from their 1965 levels of production.

Output from the Rainbow and Rainbow South fields increased sharply in the past year and this trend will become more pronounced in 1968 as pipeline facilities are extended to the many recently discovered pools within the same general area. The Zama field came into production in 1967 and contributed over 7,000 barrels of crude oil daily to provincial totals. This output should increase substantially next year as many new pools within the expanding field limits are brought into production and pipeline facilities are extended. The production rate of the large reserve Mitsue field increased only slightly during the past year. However, the operating company is planning to install a large waterflood project in 1968, which should substantially boost the field production allowable. Production from the Great Canadian Oil Sands Athabasca tar sands project in 1967 was modest but maximum rated output of 45,000 barrels a day of synthetic crude oil should be attained in the coming year.

RESERVES

In the face of record level of production, Canada's recoverable reserves of liquid hydrocarbons at the end of 1967 had increased by 497 million barrels to a new high of 9,548 million barrels. This total was comprised of 8,169 million barrels of crude oil and 1,379 million barrels of natural gas liquids, representing a 24 year supply at the 1967 rate of production. According to the estimate of the Canadian Petroleum Association, 209 million barrels of the gross additions to reserves were attributable to 1967 discoveries, 596 million barrels to revisions of previous estimates and 98 million barrels to extensions of existing fields. Net production for the year was set at 401 million barrels by the Canadian Petroleum Association.

Alberta increased its liquid hydrocarbons reserves by 427 million barrels, which is 86 per cent of the total Canadian reserves increase. Estimates of reserves of bitumen from the Athabasca oil sands of Alberta as well as asphaltic crude oil from the heavy gravity crude belt of east central Alberta are not included in provincial reserves calculations. Official estimates of recoverable oil in place in the oil sands are placed at 415 billion barrels. Unofficial reserves in the heavy gravity belt have been set as high as 80 billion barrels. Extractive technology is not sufficiently advanced at the present time to permit a reasonable estimate of recoverable oil from the latter accumulations.

The Canadian Petroleum Association estimated Saskatchewan's recoverable reserves of liquid hydrocarbons at 725 million barrels at the end of 1967 – a

TABLE 2

Production of Natural Gas Liquids by Province, 1966-67

	1966		1967[p]	
	Barrels	Bbl/day	Barrels	Bbl/day
Alberta				
Propane	11,557,891	31,665	12,872,669	35,267
Butane	7,387,586	20,240	8,365,508	22,919
Pentanes plus	27,360,178	74,959	28,568,987	78,272
Condensate	734,734	2,013	819,817	2,246
Other natural gas liquids	956,359	2,620	1,045,085	2,863
Total	47,996,748	131,497	51,672,066	141,567
Saskatchewan				
Propane	751,072	2,058	885,292	2,425
Butane	342,061	937	393,909	1,079
Pentanes plus	251,056	687	295,980	811
Total	1,344,189	3,682	1,575,181	4,315
British Columbia				
Propane	334,315	916	413,058	1,131
Butane	500,973	1,372	588,118	1,612
Pentanes plus	974,564	2,670	1,016,045	2,783
Condensate	39,571	108	40,570	111
Total	1,849,423	5,066	2,057,791	5,637
Canada				
Propane	12,643,278	34,639	14,171,019	38,824
Butane	8,230,620	22,550	9,347,535	25,609
Pentanes plus	28,585,798	78,317	29,881,012	81,866
Condensate	774,305	2,121	860,387	2,357
Other natural gas liquids	956,359	2,620	1,045,085	2,863
Total	51,190,360	140,247	55,305,038	151,519
Returned to formation	1,179,468	3,231	1,089,100	2,983
Total net production	50,010,892	137,016	54,215,938	148,536

Source: Provincial government reports.
[p] Preliminary.

4.5 per cent increase over 1966. Almost all of the increase in Saskatchewan's reserve position resulted from revisions and extensions to existing fields. New discoveries accounted for only three million barrels of additional reserves to the provincial total. British Columbia increased its recoverable reserves by 16 per cent in 1967, mainly by greater use of pressure maintenance or secondary recovery schemes. Manitoba's recoverable reserves rose to 66 million barrels – a gain of 14 per cent from 1966; all of this increase was due to revisions and extensions of existing fields.

EXPLORATION AND DEVELOPMENT

ALBERTA

Aggregate exploratory and development drilling footage declined for the third successive year during 1967. This downtrend was due to several contributing factors, the increasing use of wider well spacing in oil field development being the principal cause. The lack of significant discoveries in the deeper formations has also contributed to the downtrend. Drilling statistics show development drilling declined 4 per cent to 3.9 million feet and exploratory drilling decreased 10 per

TABLE 3

Value of Natural Gas Liquids by Province, 1966-67
($ thousands)

	1966	1967P
Alberta	94,117	102,305
Saskatchewan	2,417	2,412
British Columbia	3,374	3,900
Total, Canada	99,908	108,617
Volume (thousand bbl)	47,921	52,198

Source: Dominion Bureau of Statistics and provincial government reports.

P Preliminary.

cent to 3.7 million feet. Although the provincial aggregate drilling footage was down 6 per cent to 7.7 million feet, Alberta still accounted for 60 per cent of the Canadian total.

Exploratory effort continued to be concentrated in northwestern Alberta but recent cut-backs in estimated proven reserves for several of the established pools in the Rainbow Lake field, combined with the smaller size of the pools discovered in the Zama Lake field, have led to some slackening of activity in this region. The same Middle Devonian producing horizons that occur in the nearby Rainbow Lake pools were encountered at Zama, but the productive zones are thinner and more limited in areal extent. Maximum pay thickness at Zama Lake is about 300 feet whereas at Rainbow Lake it is over 800 feet. Also, rapid pressure declines as production progresses in many of the pools at Zama Lake suggest that the reservoirs are much smaller than originally considered. Some of the details of the Zama Lake discovery wells were released from the confidential list during the past year. Information made available by Hudson's Bay Oil and Gas Company Limited and other companies show that the best well drilled to date in this area has 228 feet of productive oil section and 73 feet of natural gas pay. The oil occurs in the Zama Lake member and Keg River formation of Middle Devonian age. The gas production was obtained from the Bistcho formation of similar age. A discovery of major interest was made by the well Banff – CDR, Black Creek Rainbow 11-17-110-9W6 in that it considerably enlarged the potential productive limits of the Rainbow Lake field area. Based on revised interpretations of the regional geology, companies are expanding their exploratory drilling outwards from the Rainbow-Zama area to adjacent regions in British Columbia and Alberta.

There has been a revival in drilling activity in southern Alberta during 1967. Although most of the pools found in southern Alberta are not large, the favourable economics of exploring for and operating them is such that exploration funds are being transferred from some of the more active areas of the north. Several discoveries were reported in 1967, most

TABLE 4

Crude Oil -- Production, Trade and Refinery Receipts, 1957-67
(barrels)

	Production[1]	Imports[2]	Exports[2]	Refinery Receipts[3]		
				Domestic	Imported[4]	Total
1957	181,848,004	111,905,371	55,674,228	126,914,237	111,905,372	238,819,609
1958	165,496,196	104,038,800	31,679,429	134,513,998	107,444,741	241,958,739
1959	184,778,497	115,288,643	33,362,234	151,507,774	116,342,270	267,850,044
1960	189,534,221	125,559,631	42,234,937	149,259,745	126,824,208	276,083,953
1961	220,848,080	133,249,113	65,222,523	157,182,263	133,225,748	290,408,011
1962	244,115,152	134,517,707	91,580,232	173,606,596	135,364,821	308,971,417
1963	257,661,777	147,720,870	90,875,816	186,157,830	146,586,964	332,744,794
1964	274,626,385	143,530,957	101,258,926	199,456,597	143,946,481	343,403,078
1965	296,418,914	144,184,281	108,010,297	208,581,343	144,000,656	352,581,999
1966	320,542,794	146,076,898	123,691,342	220,196,625	158,546,823	378,743,448
1967P	351,287,792	170,784,980	150,344,567	224,569,817	163,148,797	387,718,614

Source: Dominion Bureau of Statistics.

[1] Crude Petroleum and Natural Gas Production (DBS). Alberta field condensate is excluded from the statistics for 1960, 1961 and 1962. [2] Trade of Canada (DBS). [3] Receipts at refineries are reported in Refined Petroleum Products (DBS). Refinery receipts include condensate and pentanes plus. [4] Imported includes some partly processed crude.

P Preliminary.

TABLE 5

Reserves of Crude Oil, 1966-67

Province or Region	At end of 1967 (thousand barrels)	Per Cent of Total		Net Change Since 1966 (thousand barrels)
		1966	1967	
Alberta	7,030,049	86.3	86.0	+ 309,549
Saskatchewan	725,603	8.9	8.9	+ 28,818
British Columbia	294,246	3.4	3.6	+ 30,462
Northwest Territories	47,848	0.6	0.6	+ 723
Manitoba	66,016	0.7	0.8	+ 7,686
Eastern Canada	5,162	0.1	0.1	– 65
Total	8,168,924	100.0	100.0	377,173

Source: Canadian Petroleum Association.

TABLE 6

Reserves of Liquid Hydrocarbons at end of 1967

	Natural Gas Liquids (thousand barrels)	Crude Oil Plus Natural Gas Liquids (thousand barrels)	Per Cent of Total
Alberta	1,326,126	8,356,175	87.5
Saskatchewan	10,973	736,576	7.7
British Columbia	41,769	336,015	3.5
Other areas	–	119,026	1.3
Total	1,378,868	9,547,792	100.0

Source: Canadian Petroleum Association.
– Nil.

of them being in Cretaceous sandstone members of limited reserve potential. The more important of these were, Brett et al. Bantry 6-6-19-12 W4 which flowed 300 barrels a day of oil from the Bantry sandstone and Empire State-Liberty, Taber South 6-15-6-17 W4 which recovered commercial quantities of oil in the Taber sandstone.

In other areas of Alberta there were no significant discoveries made this year. Exploration in the folded belt of the Foothills has diminished primarily due to the unpredictable distribution of porosity in the reservoir rocks. Normally porous horizons which underlie the Alberta Plains often lose much of their effective porosity in the disturbed region to the west.

Most oil field development took place in northwestern Alberta this year and by the end of 1967 three new fields were officially designated there by the Alberta Oil and Gas Conservation Board. These are the Rainbow, Rainbow South and Zama fields. All consist of a series of small pools, the reservoirs being buried pinnacle and atoll reefs, many of which are less than 1 square mile in areal extent. At the present time, 120 Keg River, 29 Muskeg and 11 Sulphur Point oil pools have been defined both within and outside the official field limits. In addition, thirty 'wet' gas reservoirs had been outlined by the end of 1967. The boundaries of the fields are still not fully defined and with further development, the Rainbow and Zama fields may soon be merged as a single area.

One of the main areas of oil field development elsewhere in Alberta was the Hamilton Lake pool. This field's limits were expanded to include several more sections and by year's end the Viking 'A' and 'E' pools had been joined. In north-central Alberta the Nipisi Gilwood 'A' pool continued to be expanded to the northwest and finally merged with the Gilwood 'B' pool. Other main development areas in central Alberta included the Crimson Lake and Willesden Green Cardium fields.

Although laboratory and field pilot experiments seeking the most effective ways of producing heavy oil deposits continued in 1967, a number of thermal

TABLE 7

Wells Completed and Footage Drilled

	1955		1960		1966		1967	
	No.	Footage	No.	Footage	No.	Footage	No.	Footage
WESTERN CANADA								
British Columbia[1]								
New Field Wildcats	34	194,014	60	365,818	68	333,941	25	176,313
Other Exploratory	2	13,020	11	55,749	66	353,514	89	449,831
Development	–	–	72	331,740	80	349,631	74	384,692
	36	207,034	143	753,307	214	1,037,086	188	1,010,836
Alberta								
New Field Wildcats	307	1,773,980	338	2,078,876	503	2,533,364	473	2,380,983
Other Exploratory	105	436,941	223	1,171,079	321	1,585,255	297	1,431,282
Development	1,208	6,219,810	1,131	7,125,856	820	4,180,415	820	3,929,662
	1,620	8,430,731	1,692	10,375,811	1,644	8,299,034	1,590	7,741,927
Saskatchewan								
New Field Wildcats	312	1,182,727	113	468,507	358	1,415,454	390	1,553,602
Other Exploratory	50	179,511	28	99,203	80	313,332	81	255,093
Development	550	1,873,040	461	1,795,968	671	2,427,774	494	1,704,293
	912	3,235,278	602	2,363,678	1,109	4,156,560	965	3,512,988
Manitoba								
New Field Wildcats	59	174,313	10	30,505	19	57,343	21	59,503
Other Exploratory	10	23,743	3	6,370	4	12,425	5	12,026
Development	292	647,379	54	110,073	34	75,039	61	142,131
	361	845,435	67	146,948	57	144,807	87	213,660
Territories								
New Field Wildcats	9	12,266	32	105,969	28	121,620	36	125,811
Other Exploratory	–	–	–	–	–	–	4	3,133
Development	–	–	–	–	–	–	–	–
	9	12,266	32	105,969	28	121,620	40	128,944
Total, Western Canada								
New Field Wildcats	718	3,337,300	553	3,049,675	976	4,461,722	945	4,296,212
Other Exploratory	167	653,215	265	1,332,401	471	2,264,526	476	2,151,365
Development	2,050	8,740,229	1,718	9,363,637	1,605	7,032,859	1,449	6,160,778
	2,935	12,730,744	2,536	13,745,713	3,052	13,759,107	2,870	12,608,355
EASTERN CANADA								
Ontario								
New Field Wildcats	64	112,246	39	68,393	33	86,004	50	95,824
Other Exploratory	57	92,536	55	109,839	23	49,107	29	45,286
Development	266	271,191	213	228,190	66	94,425	67	78,136
	387	475,973	307	406,422	122	229,536	146	219,246
Quebec								
New Field Wildcats	9	10,226	5	4,287	8	9,677	–	–
Other Exploratory	–	–	–	–	–	–	–	–
Development	–	–	1	240	–	–	–	–
	9	10,226	6	4,527	8	9,677	–	–

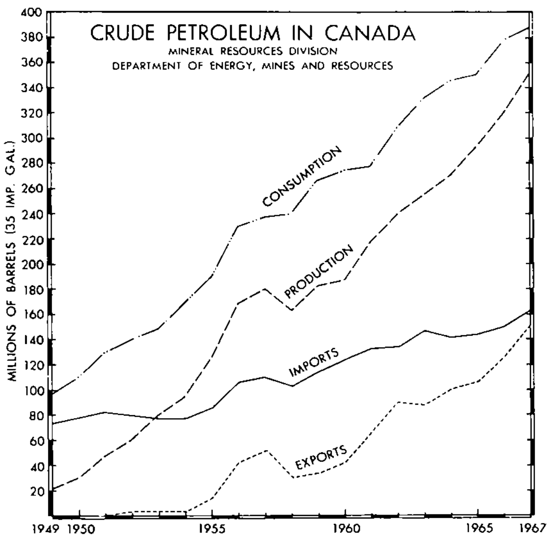
TABLE 7 (cont'd)

	1965		1960		1966		1967	
	No.	Footage	No.	Footage	No.	Footage	No.	Footage
New Brunswick								
New Field Wildcats	1	3,414	2	13,023	–	–	–	–
Other Exploratory	–	–	–	–	–	–	–	–
Development	7	21,143	–	–	1	2,460	4	9,190
	8	24,557	2	13,023	1	2,460	4	9,190
Nova Scotia[2]								
New Field Wildcats	–	–	1	9,840	–	–	1	15,106
Other Exploratory	–	–	–	–	–	–	–	–
Development	–	–	–	–	–	–	–	–
	–	–	1	9,840	–	–	1	15,106
Newfoundland								
New Field Wildcats	1	1,381	–	–	3	14,384	–	–
Other Exploratory	–	–	–	–	–	–	–	–
Development	–	–	–	–	–	–	–	–
	1	1,381	–	–	3	14,384	–	–
Total, Eastern Canada								
New Field Wildcats	75	127,267	47	95,543	44	110,065	51	110,930
Other Exploratory	57	92,536	55	109,839	23	49,107	33	54,476
Development	273	292,334	214	228,430	67	96,885	67	78,136
	405	512,137	316	433,812	134	256,057	151	243,542
Total, Canada								
New Field Wildcats	793	3,464,567	600	3,145,218	1,020	4,571,787	996	4,407,142
Other Exploratory	224	745,751	320	1,442,240	494	2,313,633	509	2,205,841
Development	2,323	9,032,563	1,932	9,592,067	1,672	7,129,744	1,516	6,238,914
	3,340	13,242,881	2,852	14,179,525	3,186	14,015,164	3,021	12,851,897

Source: Canadian Petroleum Association.
[1] Two wells drilled off the west coast are included with British Columbia. [2] One well drilled off the east coast is included with Nova Scotia.
– Nil.

recovery projects were discontinued. At year end, the Cold Lake region in eastern Alberta was the centre of interest for most of the companies experimenting with thermal recovery methods. The oil-bearing sandstone here is over 100 feet thick which makes it ideally suited for steam flooding. These heavy-oil deposits (10°-12° API) underlie more than 3,000 square miles in central Alberta near the Saskatchewan border and are beyond the depth at which they could be economically mined by open pit methods. It has been estimated that the combined deposits contain over 80 billion barrels of oil. The cyclic steam injection project in the Lloydminster field, has been only partially successful.

Enhanced recovery schemes continued to be implemented at a record rate in Alberta in 1967. Beginning in October, 15,000 barrels of water a day began to be injected into the Rainbow "B" pool to increase the ultimate recovery factor to 65 per cent or 178 million barrels. Eleven water injection wells were added to the Beaverhill Lake, House Mountain "C" pool. Injection capacity at year end was 14,900 barrels of water per day and an ultimate recovery of 42 per cent or 43 million barrels is anticipated. Another waterflood scheme was initiated in the East Swan Hills field where ultimate recovery will be raised to 46 million barrels by the daily injection of 16,500 barrels of water per day. Other significant floods were established in the Hamilton Lake and Willesden Green fields during the year as well as in the Lloydminster heavy oil field where waterflood methods have been quite successful. A waterflood method is also replacing a miscible flood (LPG and water) in a section of the Pembina field. This miscible flood was the largest operating flood of its kind and was recently declared to be non-effective by the Alberta Conservation Board.



A significant event in the history of the Canadian oil industry was the official opening of the Great Canadian Oil Sands Limited's bituminous sands project, 20 miles north of Forth McMurray, Alberta on September 30, 1967. The $230 million plant will process, at capacity, about 100,000 tons of oil sand per day to produce 45,000 barrels daily of high grade synthetic crude oil which will be transported by pipeline to the main pipeline terminals at Edmonton. Some mining and mechanical problems were being overcome by plant modifications at year end. The plant should be operating at full capacity in 1968.

The Institute of Sedimentary and Petroleum Geology was officially opened in Calgary, Alberta, September 5, 1967. The Institute will function as a Division of the Geological Survey of Canada and will provide, through field and laboratory research, scientific information concerning the geology of the western and northern sedimentary basins. The main research sections are the Arctic Islands Section, the Mesozoic Stratigraphy Section and the Palaeontology Section. The Petroleum Assessment Section includes a senior petroleum geologist who will act as an investigator and interpreter of geological factors governing the occurrence and natural concentration of petroleum.

SASKATCHEWAN

The absence of significant discoveries in Saskatchewan in recent years contributed to the continued downward trend in drilling that began in that province in 1966. All of the decline was confined to development drilling which was curtailed by 28 per cent in 1967; exploratory drilling footage increased by 2 per cent. Considerable interest was generated in southern Saskatchewan in 1966 by the Hummingbird discovery well which found oil in both the Mississippian, Mission Canyon formation and the Devonian, Nisku formation. Although subsequent drilling proved this to be a minor accumulation, the discovery drew strong exploration interest to the adjacent area and three widely separated Mississippian oil strikes were reported by companies operating in this area. Of importance is a joint venture drilled by Imperial Oil Limited and Central-Del Rio Oils Limited, the Tatawaga (15-29-7-15 W2) well, which flowed oil on test from the Midale member of Mississippian age. This well is located six miles northwest of the Lougheed field and may establish an important new Midale producing area.

The Middle Devonian Winnipegosis formation continued to be considered as a prime exploration target but so far the limited number of wells which have tested this formation have been unsuccessful. A considerable amount of geophysical work was undertaken in 1967 to outline favourable subsurface prospects on this trend and many of them will probably be drilled in 1968.

Most of the development drilling was confined to the peripheries of the established producing fields in southeastern and southwestern Saskatchewan. More than 10 development wells were drilled to extend the Parkman Mississippian field in southeastern Saskatchewan. The Innes field also continued to be developed. In southwestern Saskatchewan development drilling on the Rapdan-Battrum chain of Jurassic fields declined from previous years but still contributed significantly to the gross provincial drilling footage. The areal extent of the Hummingbird field is one square mile and drilling to date has produced nine oil wells in the Mississippian Ratcliffe member and six producers in the Nisku formation of Devonian age.

In the heavy oil belt of west-central Saskatchewan, development drilling proceeded at a brisk pace, no doubt encouraged by the strong demand that existed in 1967 for heavy crude oil. The Aberfeldy field was actively developed in the past year and with the addition of new waterflooding facilities, production has increased notably.

Many new waterflood projects began operating in 1967. Scurry-Rainbow Oil Limited began a 10,000 barrel-a-day injection scheme in the Workman field. In two separate projects, Husky Oil Canada Ltd. and Imperial Oil Limited added 20,000 barrels of water a day to their injection rate in the Dodsland field. In 1965, Mobil Oil Canada, Ltd. set up a fireflood pilot project in the Battrum field of southwestern Saskatchewan. The results of this type of 'secondary' recovery mechanism were so successful that Mobil has started

TABLE 8

Canada, Wells Drilled, by Province, 1966-67

	Oil		Gas		Dry		Total	
	1966	1967	1966	1967	1966	1967	1966	1967
Western Canada								
Alberta	641	648	257	283	735	659	1,644	1,590
Saskatchewan	540	421	34	44	594	500	1,109	965
British Columbia	45	50	51	43	116	93	214	186
Manitoba	26	43	–	–	35	44	57	87
Yukon and Northwest Territories	–	–	–	2	28	38	28	40
Sub-total	1,252	1,162	342	372	1,508	1,336*	3,052	2,870*
Eastern Canada								
Ontario	11	6	44	59	89	81	122	146
Quebec	–	–	–	–	8	–	8	–
Atlantic Provinces	–	–	–	–	3	4	4	4
Sub-total	11	6	44	59	100	86†	134	151†
Canada	1,263	1,168	386	431	1,608	1,422	3,186	3,021*†

Source: Canadian Petroleum Association.
– Nil;
* Includes 2 westcoast offshore wells.
† Includes 1 eastcoast offshore well.

TABLE 9

Oil Wells in Western Canada at End of Year 1966-67

	Producing Wells		Wells Capable of Production	
	1966	1967	1966	1967
Alberta	8,886	9,116	13,162	13,473
Saskatchewan	5,681	5,743	6,480	6,624
Manitoba	737	752	905	911
British Columbia	440	460	529	561
Northwest Territories	31	31	60	60
Total	15,775	16,102	21,136	21,629

Sources: Provincial government reports and Department of Indian Affairs and Northern Development.

three more pilot projects in the same field. Although the costs associated with fireflood recovery facilities are said to be several times that of waterflooding, ultimate recovery is more than double that of the most efficient waterflood systems.

BRITISH COLUMBIA

Aggregate drilling footage decreased 4 per cent to 990,000 feet, exploratory drilling was down 12 per cent to 606,000 feet and development drilling at 384,000 feet was up 11 per cent over last year's total.

In exploration, a medium sized Triassic sandstone field is developing 3 miles southwest of the Inga field. The discovery well, Tenneco South Inga 16-7-87-23 W6 tested commercial quantities of oil. Several successful stepout wells have subsequently been drilled. Another significant Triassic oil discovery was reported to have been made by Hudson's Bay Oil and Gas Company in the Crush Creek area. Details on the production potential of this well have not yet been released. There were no other significant oil discoveries reported. Seismic activity in 1967 increased from the previous year, particularly in northeastern British Columbia where exploration has been concentrated on discovering extensions to the Alberta Rainbow and Zama producing trend. The limited amount of drilling in this area has been unsuccessful.

The number of oil wells in the province capable of production increased from 529 to 561 with the largest increase being in the Peejay-Wildmint Triassic pool.

Off the west coast of Vancouver Island, Shell Canada Limited started drilling the third well of an 8- to 10-well program after conducting detailed marine seismic surveys on its extensive offshore permits. The two previous wells were abandoned earlier in the year after finding only non-commercial indications of hydrocarbons. Shell is using a $10.5 million Sedco 135 F semi-submersible drilling platform that was constructed in the dockyards at Victoria. Largest of its type in the world, it is capable of drilling in water up to 600 feet deep.

In November, the Supreme Court of Canada expressed the opinion that Canada has jurisdiction over resources under its territorial seas and on the continental shelf. The court's opinion was requested by the federal government as a test of claims made by British Columbia for jurisdiction over offshore mineral resources.

MANITOBA

Manitoba experienced a revival in drilling during 1967. Completions were up 43 per cent to a total of 87 wells and footage drilled increased by 50 per cent to total 214,000 feet. Almost all of the increase occurred in development drilling. There have been no significant discoveries made in Manitoba in recent years; nevertheless both productive rates and recoverable reserves were again increased because of waterflooding programs. Successful drilling around the fringes of established fields also added to proven reserves. Production in Manitoba has been confined to Mississippian formations with negligible indications of hydrocarbons in the Lower Palaeozoics.

YUKON TERRITORY, NORTHWEST TERRITORIES AND ARCTIC ISLANDS

Exploratory drilling in the Northwest and Yukon Territories increased slightly in 1967. Forty exploratory wells were drilled having a total footage of 125,811 feet compared with 121,620 feet and twenty-eight wells drilled in 1966. With the exception of two gas discoveries, all of the wells were dry and abandoned.

Late in 1967 twenty corporations and individuals, operating as a syndicate, formed with the Canadian government a company, called Panarctic Oils Ltd. to pioneer mineral exploration in Canada's Arctic Islands. The $20-million project is financed by Canadian interests – the Canadian government providing $9 million for a 45 per cent equity and private industry the remaining $11 million. The major participants from the private sector are Canadian Pacific Oil and Gas Limited, Cominco Ltd., Dome Mines Group and Dome Petroleum Limited. Panarctic has acquired over 44 million acres of federal oil and gas permits in the Arctic Islands from over 75 different companies. It has assumed the work obligations on these permits and will carry out a systematic exploration program primarily oriented toward the discovery of oil.

EASTERN CANADA

Although the number of drilling completions increased slightly in Ontario during 1967, total drilling footage declined 18 per cent from the previous year to 206,000 feet. Sixty-eight exploratory wells and sixty-seven development wells were drilled with only six of the development wells being completed as oil wells. No oil discoveries were made this year. Most of the exploration interest centred about the sedimentary belt adjacent to, and beneath, Lake Erie. More than three million acres at year end were under lease from the Province of Ontario in Lake Erie with this acreage extending from the Ontario shore to the international boundary in the centre of the lake. All of the exploratory successes that have been made to date in Lake Erie have been gas discoveries in Silurian formations. Six exploratory wells were drilled in New Brunswick and all were abandoned.

The Sogepet Kaskattama Province #1 well, drilled in the Hudson Bay Lowlands, immediately west of the Ontario-Manitoba border was abandoned at a depth of 2,941 feet in the Precambrian. Although the well was devoid of significant hydrocarbon indications, it demonstrated the existence of a much thicker sedimentary section than originally predicted. This is considered to be a favourable indication of potential commercial accumulations of oil or gas as these sediments are believed to thicken rapidly to the northeast. In this regard, Aquitaine Company of Canada Ltd., has embarked on another marine seismic program to the northeast of the abandoned well preparatory to drilling a future test. Offshore acreage in Hudson Bay under federal permits amounted to 54 million acres at the end of 1967.

Off the east coast of Canada, Mobil Oil Canada, Ltd. drilled a deep test on Sable Island and abandoned the well early in 1968 after encountering non-commercial gas in two horizons. The well penetrated a thick Mesozoic section before bottoming in the Palaeozoic basement complex at a depth of 15,106 feet. Thickness of undisturbed sediments and the hydrocarbon indications were favourable factors in this test. Total offshore acreage under permit increased to 151 million acres in 1967. Pan American Petroleum Corporation and Tenneco Oil & Minerals, Ltd. both conducted detailed marine seismic surveys on their extensive offshore acreage.

TABLE 10

Mileage in Canada of Pipelines for Crude Oil, Natural Gas Liquids and Products

Year-end	Miles	Year end	Miles
1955	5,079	1961	9,554
1956	6,051	1962	10,037
1957	6,873	1963	10,607
1958	7,148	1964	11,744
1959	7,945	1965	12,315
1960	8,435	1966	12,995
		1967p	13,620

Source: Dominion Bureau of Statistics.
p Preliminary.

TABLE 11

Deliveries of Crude Oil and Propane by Company and Destination, 1966-67 (millions of barrels)

Company and Destination	1966	1967
Interprovincial Pipe Line		
Western Canada	39.0	39.0
United States	65.0	77.5
Ontario	116.8	116.1
Total	220.8	232.6
Trans Mountain Oil Pipe Line		
British Columbia	30.0	31.8
State of Washington	61.2	70.2
Westridge Terminal	0.3	2.8
Total	91.5	104.8

Source: Company annual reports.

TRANSPORTATION

The increased demand for Canadian crude oil by both domestic and United States markets encouraged a sharp upturn in pipeline construction in 1967. A total of 625 miles of oil pipeline was laid bringing the operational pipeline total in Canada to 13,620 miles. In larger diameter pipeline construction, Interprovincial's 370 miles of looping, including 312 miles of 34-inch line on the Prairies and 58 miles of 20-inch loop between Toronto and Sarnia, was the major addition. In January 1968, Interprovincial Pipe Line Company was given approval by the United States to add a second pipeline to its Lakehead Pipeline facilities running south of Lake Michigan rather than by its established route across the Straits of Mackinac. A presidential permit was granted to construct a $75-million, 34-inch line from Superior, Wisconsin to Chicago. The Superior to Chicago line will connect successively with the Tecumseh and Buckeye pipeline systems by way of Cygnet, Toledo and Detroit to Port Huron. At Port Huron the Buckeye line connects with the Interprovincial Lakehead line to Sarnia. When the Superior to Chicago part of the loop is completed, Canadian crude for Detroit, Trenton, Toledo and Sarnia will be transported by the Lakehead-Tecumseh-Buckeye system. The Tecumseh-Buckeye portion of the loop will be eventually replaced by a new $37 million, 30-inch line directly from Chicago to Port Huron. The Superior-Chicago line is scheduled to be completed in 1968 and at that time will raise the capacity of the Interprovincial Lakehead system entering the United States to 821,000 barrels a day compared to the 1967 capacity of about 536,000 barrels daily.

In Alberta, Rainbow Pipe Line Company Ltd. laid a total of 143 miles of pipe to complete the first pipeline from Edmonton to the important new oil-producing region in the Rainbow Lake-Zama Lake area of the northwest corner of the province. The

TABLE 12

Crude Oil Refining Capacity by Regions

	1966		1967	
	Bbl/Day	%	Bbl/Day	%
Atlantic Provinces	125,500	11.0	128,500	10.6
Quebec	373,700	32.8	401,200	33.2
Ontario	324,400	28.5	352,400	29.1
Prairies and Northwest Territories	214,750	18.9	217,450	18.0
British Columbia	100,400	8.8	109,900	9.1
Total	1,138,750	100.0	1,209,450	100.0

Source: Department of Energy, Mines and Resources, Petroleum Refineries in Canada (Operators' List 5), January 1968.

TABLE 13

Canada, Crude Oil Received at Refineries, 1966 and 1967[p]
(barrels)

Location of Refineries	Year	Country of Origin: Canada	Middle East	Trinidad	Venezuela	Africa	USA	Total Received
Atlantic Provinces	1966	6,853	17,686,564	–	19,641,163	2,856,528	–	40,191,108
	1967[p]	7,928	11,210,553	–	20,696,169	5,361,873	2,879,889	40,156,412
Quebec	1966	–	38,609,331	4,776,633	58,872,233	15,574,861	–	117,833,058
	1967[p]	–	24,653,780	5,017,837	82,122,463	8,727,545	2,033,845	122,555,470
Ontario	1966	113,672,062	–	–	529,510	–	–	114,201,572
	1967[p]	113,180,133	–	–	444,843	–	–	113,624,976
Prairies	1966	71,333,297	–	–	–	–	–	71,333,297
	1967[p]	73,344,665	–	–	–	–	–	73,344,665
British Columbia	1966	34,473,696	–	–	–	–	–	34,473,696
	1967[p]	37,342,177	–	–	–	–	–	37,342,177
Northwest and Yukon Territories	1966	710,717	–	–	–	–	–	710,717
	1967[p]	694,914	–	–	–	–	–	694,914
Total	1966	220,196,625	56,295,895	4,776,633	79,042,906	18,431,389	–	378,743,448
	1967[p]	224,569,817	35,864,333	5,017,837	103,263,475	14,089,418	4,913,734	387,718,614

Source: Dominion Bureau of Statistics.
[p] Preliminary; – Nil.

completed system from Zama to Edmonton is 478 miles long, consisting of 298 miles of 20-inch line and 180 miles of 24-inch line. Design capacity, with full pumping power, is 265,000 barrels a day. At year end, the line was carrying 55,000 barrels a day and additional pumping facilities were being installed to increase capacity to about 125,000 barrels daily. Construction of another major pipeline to the same area began in November, 1967 by Peace River Oil Pipe Line Co. Ltd. Its line will be a 296-mile, 20-inch oil pipeline from the established Valleyview pump station to the Zama Lake oil field. It is expected that the new line will be ready for service in April 1968. The line is designed to serve the producers of northwest Alberta and will give a second outlet for oil from this fast developing region.

At Montreal, a 9-line crossing of the St. Lawrence River to provide additional crude oil and product capacity for the refining complex in the area was completed. The crude oil, petrochemical and refined products lines across the St. Lawrence River include three large crude oil lines for the Portland-Montreal pipeline, a 10-inch product line for Imperial Oil and five petrochemical feedstock and product lines for The British American Oil Company Limited and its affiliate Shawinigan Chemicals Limited. This is the largest and most complex underwater pipeline project ever undertaken in Canada.

Hudson's Bay Oil and Gas Company Limited added 29 miles of 12-inch loop between Pincher Creek and Carway on the United States border, thereby increasing the capacity of its Rangeland pipeline to 27,000 barrels a day. Rangeland is part of a 600-mile system including the Aurora pipeline, which is a short line crossing the Alberta-Montana border in southwest Alberta to Billings, Montana. Current construction on the Glacier pipeline will raise the capacity of the system to 50,000 barrels daily. In British Columbia, Western Pacific Products & Crude Oil Pipelines Ltd. increased the capacity of its 505-mile pipeline system between Fort St. John and Kamloops to 65,000 barrels daily.

Construction of both oil gathering and waterflood injection pipelines continued at a high level in western Canada in 1967. The largest gathering line project was completed at the House Mountain field in Alberta where 150 miles of pipe were laid. Husky Oil Canada Ltd. installed 46 miles of 3-to 8-inch lines in the Lloydminster field in Saskatchewan. Among the major waterflood pipeline projects were 47 miles for Union Oil Company of Canada Limited in the Peejay East oil field in northern British Columbia and 40 miles for Atlantic Richfield Company in the Swan Hills East field of Alberta.

In 1967 there were no changes in transportation charges on the two major crude oil trunklines, Interprovincial Pipe Line Company and Trans Mountain Oil Pipe Line Company.

PETROLEUM REFINING

Crude oil refining capacity of Canada's 41 operating refineries totalled 1,209,450 barrels daily in 1967 -- an increase of 70,700 barrels a day over 1966. This represents an annual gain of 6 per cent in the industry's ability to refine crude oil, slightly less than the demand increase for petroleum products which amounted to 6.2 per cent. Noteworthy additions to plants were made in Quebec, Ontario and British Columbia. Union Oil Company of Canada Limited completed the construction of a new 7,500-barrel-a-day refinery in Prince George, British Columbia. The plant went on stream in late 1967, the refinery feedstock being provided by pipeline from the company's fields in northeastern British Columbia. In Quebec, BP Refinery Canada Limited increased the crude oil capacity of its Montreal East plant by 30,000 barrels daily to 68,000 barrels a day. In Ontario, Imperial Oil Enterprises Ltd., increased crude capacity from 94,000 barrels daily to 122,000 barrels daily at its Sarnia plant. Golden Eagle Refinery Company of Canada, Limited increased the capacity of its plant in Newfoundland to 11,500 barrels a day. Minor increases were made by a few other refineries.

Imperial Oil Enterprises Ltd. maintained its position as the largest refiner in Canada. The company's nine refineries comprise 31.4 per cent of Canadian refinery capacity. The British American Oil Company Limited, with 9 refineries, increased its refinery capacity to 15.1 per cent of the nation's total and in so doing replaced Shell Canada Limited as Canada's second leading refiner. Shell plans an expansion of about 50,000 barrels daily to its Montreal East refinery. Shell operates 6 refineries, has 14.9 per cent of the total Canadian refinery capacity and is Canada's third largest refiner.

Several large refinery construction and expansion projects have been scheduled to begin in 1968. Plans for the construction of a 100,000-barrel-a-day refinery (Newfoundland Refining Company) at Come-by-Chance, Newfoundland were announced jointly by Shaheen Natural Resources Company and the Newfoundland government. Construction of a 60,000-barrel-a-day British American Oil Company refinery at Point Tupper in Cape Breton Island is also expected pending the conclusion of agreements involving the company and the federal and provincial governments.

MARKETING AND TRADE

Crude oil deliveries to Canadian refineries during 1967 averaged 1,060,000 barrels a day, approximately 2 per cent more than in 1966. Of this total, Canadian producers provided 615,000 barrels daily. This volume, which constitutes 58 per cent of domestic refinery consumption, represents only a 2 per cent gain over last year's daily average. Almost all of the increase in demand for domestic production by Canadian refineries occurred in British Columbia and

TABLE 14

Regional Consumption of Petroleum Products, by Province, 1967
(thousand barrels)

	Motor Gasoline	Kerosene Stove Oil, Tractor Fuel	Diesel Fuel Oil	Light Fuel Oils Nos. 2 and 3	Heavy Fuel Oils Nos. 4, 5 and 6
Newfoundland	1,823	1,307	2,315	1,873	2,849
Maritimes	8,930	3,068	3,410	8,089	12,088
Quebec	35,025	6,406	7,819	29,678	39,534
Ontario	52,414	3,655	8,031	35,383	24,704
Manitoba	7,056	1,099	2,731	1,948	915
Saskatchewan	9,495	1,367	3,825	1,584	671
Alberta	14,189	481	5,528	946	697
British Columbia	14,037	1,717	6,695	4,845	10,244
Northwest and Yukon Territories	173	68	374	210	102
Total	143,142	19,168	40,728	84,556	91,804

Source: Dominion Bureau of Statistics, Refined Petroleum Products monthly reports, 1967.

TABLE 15

Imports of Refined Petroleum Products, 1966-67
(millions of barrels)

	1966	1967^p
Heavy fuel oil	30.47	35.11
Light fuel oil	8.61	9.64
Stove oil	1.92	2.62
Motor gasoline	2.41	4.23
Aviation gasoline	0.16	0.37
Diesel fuel	6.24	6.74
Lubricating oil	1.83	1.74
Petroleum coke	2.40	2.06

Source: Dominion Bureau of Statistics.
1967 figures are totals of monthly imports from Refined Petroleum Products.
^{p} Preliminary.

the Prairie provinces. Although the domestic market for Canadian crude oil has not expanded in such a spectacular manner as the export market, it remained the most important outlet for Canadian production. The closure of the Suez Canal altered some marketing patterns for a time and yearly figures reflect these changes. Thus it is likely that eastern Canada would have been a larger user of Canadian oil.

Imports of crude oil averaged 447,000 barrels a day in 1967, up 9.3 per cent from 1966. Shortages created by the conflict in the Middle East helped boost imports of Venezuelan crude oil to 283,000 barrels daily in 1967, an increase of 31 per cent over the 1966 total. On the other hand, Middle East supplies dipped to 98,000 barrels a day in 1967, down 36 per cent from 1966. To partially offset the shortfalls resulting from the Middle East crisis, Canada imported over 13,000 barrels daily from the United States in 1967. All of this went to Quebec and the Atlantic Provinces which depend almost entirely on foreign crude oil for refinery feedstocks. The Middle East sources were Iran, Saudi Arabia, Iraq, Kuwait and the Trucial States. Libya provided approximately 14,000 barrels a day, about the same as last year. Imports from Nigeria, which had been increasing rapidly in the past two years, declined to 24,000 barrels a day in 1967, down 10 per cent from 1966. The decrease was due to a disruption in supplies caused by the civil strife in Nigeria. This shortfall might have been more severe but for the fact that Canada receives most of its imported Nigerian crude oil from offshore oil fields which have been largely unaffected by the hostilities.

By year's end the flow of oil from the Middle East had been restored to normal although the Suez Canal still remained closed to shipping. The closure of the canal had less impact on the oil industries supply routes than previously feared. By the end of 1967 the world's tanker fleet, which is turning to vessels having a deadweight tonnage of 100,000 or more, was able to transport crude oil to markets by way of the southern tip of Africa to meet the requirements of all consuming countries.

Imports of petroleum products averaged 187,000 barrels a day in 1967, up 14 per cent from 1966. The bulk of the product imports are used in eastern Canada, consisting primarily of fuel oil and diesel fuel from Venezuela and the Netherland Antilles and heavy fuel oil from the United States. The large increase in

TABLE 16

Supply and Demand of Oils, 1966-67
(thousand barrels)

	1966r	1967p
SUPPLY		
Production		
Crude oil and condensate	320,543	351,287
Other natural gas liquids	49,237	53,356
Net production	369,780	404,643
Imports		
Crude oil	149,011	163,149
Products	59,657	68,205
Total imports	208,668	231,354
Change in stocks		
Crude and natural gas liquids	− 1,968	− 5,343
Refined petroleum products	− 7,471	+ 937
Total change	− 9,439	− 4,406
Oils not accounted for	+ 1,471	+ 1,420
Total supply	570,480	633,011
DEMAND		
Exports		
Crude oil	123,691	150,345
Products	12,979	15,192
Total	136,670	165,537
Domestic sales		
Motor gasoline	136,144	142,795
Middle distillates	146,785	155,569
Heavy fuel oil	82,385	91,097
Other products	38,302	46,403
Total	403,616	435,864
Uses and losses		
Refining	28,408	29,799
Field, plant and pipeline	1,786	1,811
Total	30,194	31,610
Total demand	570,480	633,011

Source: Dominion Bureau of Statistics and provincial government reports.
r Revised; p Preliminary.

product imports consisted mainly of heavy fuel oil and motor gasoline which came from the United States. Imported crude oil and finished products were valued at $540 million.

Shortages in the United States, created by the disruption of Middle East oil supplies, helped boost Canadian exports of crude oil to 412,000 barrels a day, a gain of 22 per cent over 1966. Shipments of Canadian crude oil to the United States west coast region via Trans Mountain pipeline rose 14.6 per cent to 192,000 barrels daily in 1967. Over 5 million barrels of this was delivered by ship to the California market. Most of the remainder of Canada's crude oil exports was delivered to the United States mid-continent by Interprovincial Pipe Line Company. Exports to this region averaged 212,000 barrels a day, up 19 per cent from 1966. During the last four months of 1967, Interprovincial was unable to fully supply its refinery customers in central Canada. The shortfall in supply was due to the late delivery of equipment for its 34-inch pipeline loop between Edmonton and Superior and the 100,000-barrel-a-day increase in capacity planned for 1967 did not materialize until early in 1968. Exports of products, including natural gas liquids, to all sectors of the United States averaged 36,000 barrels a day in 1967, up 20 per cent from 1966. In addition, approximately 5,700 barrels a day of propane were shipped to Japan.

A most important development in Canadian crude oil marketing this year was the United States government's approval of the construction of a pipeline via Chicago to transport crude to Ontario. This line will be owned by Interprovincial's wholly owned subsidiary, Lakehead Pipe Line Company, Inc. and will provide a future market outlet for Canadian crude oil in the Chicago area, as well as much needed increased capacity for delivery of crude oil to the Ontario market. Demand for petroleum products in the United States midwest is growing rapidly but crude output from its sources of supply is no longer sufficient to meet requirements. Much of the needed supply will come from Louisiana via the new Capline pipeline which should be operating in 1968. However, Canadian crude oil, which is competitive in this area, could obtain a share of the market within a few years. The general expectation is that Canada will increase its exports to United States at reasonable rates such that Canadian oil will supplement rather than supplant United States crude oil in the midwest market area.

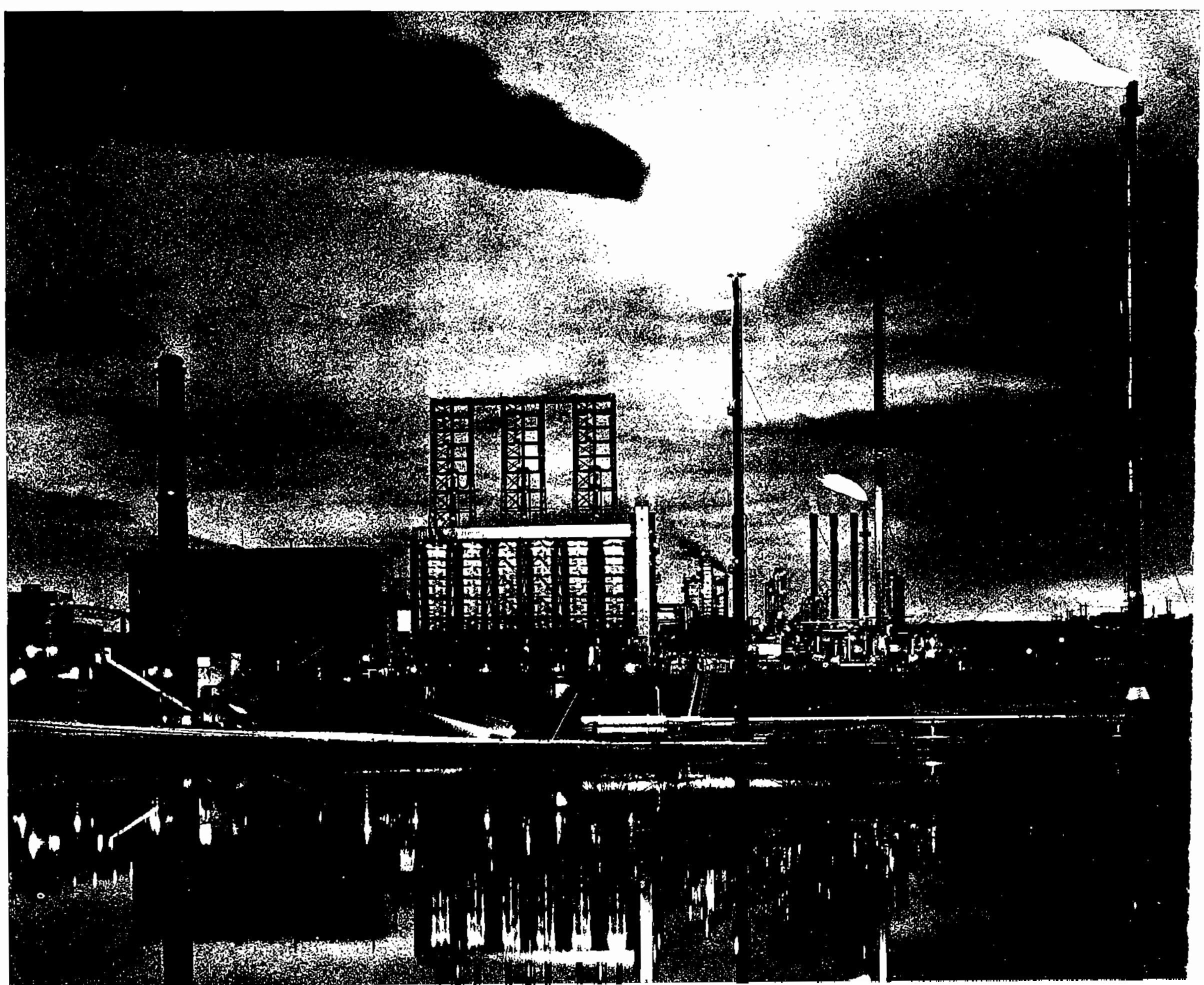
Canadian exports to the United States west coast region may be cut back in 1968 as a result of increased Alaskan production. Should this trend accelerate, Canadian exports to this region may be reduced to 120,000 barrels per day within the next two years. Increased exports to the eastern Rocky Mountain region of the United States may partially offset the declining demand for Canadian crude oil by the Puget Sound refineries. Exports to the eastern Rocky Mountain area have increased from 3,000 barrels per day when they began in 1962 to 19,000 barrels per day late in 1967. Projected future supply-demand patterns for this Rocky Mountain market area show a need for increased supplies of Canadian crude oil and condensate. Exports to this area are expected to increase to 35,000 barrels a day in 1968 and progressively gain in subsequent years. The additional volumes will be supplied from Alberta and shipped through Hudson's Bay's recently expanded pipeline that extends from Rimbey to the Montana border.

The Alberta government announced a new "oil sands" policy early in 1968. Under this policy the limit on production of oil from the Athabasca bituminous sands will be increased from 45,000 to 150,000 barrels a day provided that new markets are found and shared with conventional crude oil production. The heavy oils of the Cold Lake type will in future be subject to the same policy as the Athabasca type oil sands. The 150,000-barrel-a-day ceiling would not apply to any other markets that could be reached by "oil sands" production but are out of the range of the conventional industry. Such markets would not only be those geographically distant but would also include specialty markets that are not expected to be served by conventional producers because of price, quality or other reasons. This policy change is not expected to have any pronounced impact on marketing conventional crude oil for at least another five years.

The Kennedy Round negotiations had no effect on the 10 1/2 cent a barrel tariff on crude oil testing at over 25° A.P.I. gravity, entering the United States from Canada.

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

FIRST COMMERCIAL ATTEMPT TO TAP AN OIL RESERVE OF THREE HUNDRED BILLION BARRELS: Great Canadian Oil Sands' extraction and processing plant at Fort McMurray, Alberta, began production of upgraded synthetic crude oil from vast bituminous sand reserves in late 1967. Other companies continued testing various methods of recovery based on private and government research over the past half century.



Phosphate

W.E. KOEPKE*

Canada imports phosphate rock for manufacturing agricultural and industrial phosphate products sold in domestic and export markets. There is no production of phosphate rock in Canada. United States is the chief supplier of rock and is Canada's largest export market for finished phosphate products. The existence of a large phosphate manufacturing industry in Canada is mainly attributable to the abundant resources of electrical energy, sulphur and natural gas; the first two are necessary for the breakdown of phosphate rock and natural gas provides the raw material for the manufacture of ammonia, which is required to make ammonium phosphate fertilizers. About four fifths of the world's phosphate rock consumption is for agricultural purposes. On the basis of farmland acreage, Canada's production and consumption of phosphate fertilizers is relatively low compared with other advanced nations but its annual growth rates in both output and consumption during the past few years have exceeded all other major nations. Canada ranks as one of the world's leading exporters of phosphate fertilizers, surpassed only by United States and four or five west European nations.

PHOSPHATE ROCK

DEFINITION OF TERMS

Phosphate is a term used to describe a rock, mineral, or salt containing one or more phosphorus compounds. Phosphate rock, or more correctly phosphorite, is a rock that contains one or more suitable phosphate minerals, normally calcium phosphate, in sufficient quantity for use, either directly or after beneficiation, in the manufacture of phosphate products. Sedimentary phosphate rock is the most widely used phosphate raw material followed by apatite, which is typically represented by the formula $Ca_5(PO_4)_3$ (F, Cl, OH). The term phosphate rock, in general usage, includes apatite. Other sources of phosphate include guano and basic slag, a byproduct of some steel mills.

Phosphate rock is graded either on the basis of its P_2O_5 equivalent (phosphorus pentoxide or 'phosphoric acid' in general usage) or $Ca_3P_2O_5$ content (tricalcium phosphate or bone phosphate of lime – BPL). For comparative purposes, 0.458 P_2O_5 equals 1.0 BPL and one unit of P_2O_5 contains 43.6 per cent phosphorus.

IMPORTS AND CONSUMPTION

Canada's phosphate rock imports in 1967 reached a record 2.3 million tons, up 4.5 per cent from the previous year. Close to 94 per cent came from United States, of which approximately equal proportions were from the sedimentary deposits (fields) of Florida and the Western States (Idaho, Montana, Utah and Wyoming). Morocco supplied just over 5 per cent and lesser quantities came from other North African countries and Netherlands Antilles.

Florida rock enters Canada by three modes of transport: direct unit-train shipments to inland markets in eastern Canada; seaborne shipments to lower St. Lawrence River plants; and back-haul seaborne-rail shipments via Vancouver to markets in Alberta with potash from Saskatchewan as the outgoing cargo, which was inaugurated in 1965. Rock from the Western States field moves by rail to inland plants in southern British Columbia and Alberta, with small quantities going to Manitoba.

*Mineral Resources Branch.

TABLE 1

Canada, Phosphate Rock Imports and Consumption, 1966-67

	1966		1967^p	
	Short Tons	$	Short Tons	$
Imports				
United States	2,077,845	17,853,000	2,146,596	18,435,000
Morocco	82,432	1,172,000	125,307	1,811,000
Netherlands Antilles	9,721	434,000	7,864	317,000
French Africa, n.e.s.	11,343	142,000	–	–
Total	2,181,341	19,601,000	2,279,767	20,563,000
	1965		1966	
Consumption (available data)				
Fertilizers, stock and poultry feed	1,431,597		1,546,834	
Chemicals	172,254		185,830	
Other*	3,064		2,824	
Total	1,606,915		1,735,488	

Source: Dominion Bureau of Statistics.
* Includes amounts for refractories, food processing, medicinals and pharmaceuticals.
^{p} Preliminary; – Nil; n.e.s. Not elsewhere specified.

TABLE 2

Canada, Phosphate Rock Imports and Consumption, 1958-67
(short tons)

	Imports	Consumption
1958	744,164	728,906
1959	797,063	786,044
1960	941,998	891,894
1961	1,056,885	976,639
1962	1,155,966	1,116,607
1963	1,297,427	1,166,573
1964	1,406,424	1,448,571
1965	1,695,296	1,606,915
1966	2,181,341	1,735,488
1967^p	2,279,767	. .

Source: Dominion Bureau of Statistics.
^{p} Preliminary; . . Not available.

OCCURRENCES IN CANADA

There are numerous occurrences of low-grade phosphate rock in Canada. They are of limited extent and fall into three main categories as follows: apatite deposits within Precambrian metamorphic rocks in eastern Ontario and southwestern Quebec; apatite deposits of some carbonate alkaline complexes in Ontario and Quebec; and sedimentary phosphate rock deposits of late Palaeozoic – early Mesozoic age in the southern Rocky Mountains.

The Precambrian metamorphic apatite deposits of Ontario and Quebec occur in pyroxenites as small, irregular, scattered pockets and veins with phlogopite mica and pink calcite. Most of the outcrops are in the Rideau Lakes region of eastern Ontario and the Lievre River area of southwestern Quebec. Many of these deposits were worked extensively between 1869 and 1900 before low-cost Florida rock entered world markets. Among the more important alkaline complex apatite occurrences are: Nemegos deposits, some 150 miles northwest of Sudbury; Oka deposit, 20 miles west of Montreal; and some deposits north of Arvida. The Nemegos deposits have been examined extensively during the past few years by Multi-Minerals Limited and have been the basis for hydrochloric acid-leach feasibility studies carried out by a West German company, Klockner-Humboldt-Deutz A.G.

Sedimentary phosphate beds are fairly widespread in the Rocky Mountains. Most of the exposures occur along the Alberta-British Columbia border between the International Boundary and Banff. Beds at the base of the Fernie shale have received considerable attention during recent years.

WORLD PRODUCTION

World production of phosphate rock reached 76.6 million metric tons in 1967, a mere 3.3 per cent increase from 1966 and well below the average annual growth rate experienced in the early 1960s. The growth rate had averaged 6 per cent annually throughout the 1950s but unprecedented demands for phosphate fertilizers boosted it to 12 per cent annually from 1960 to 1966. Year-end stocks in 1966 were abnormally high so some production schedules were scaled down in 1967.

TABLE 3

World Phosphate Rock Production, 1966-67
('000 metric tons)

	1966	1967^{p}
USA	35,425	35,380
USSR	14,780	16,450
Morocco	9,428	
Tunisia	3,190	13,341
Algeria	80	
Togo	1,146	2,301
Senegal	1,142	
South Africa	1,063	
Rhodesia	65	1,447
Uganda	16	
Egypt	661	
Jordan	797	2,203
Israel	565	
Nauru, Ocean Island	2,417	
Christmas Island	1,057	3,338
Makatea	180	
Others	2,082	2,182
Total	74,094	76,642

Source: *The Journal of World Phosphorus and Potassium.*
^{p} Preliminary.

CANADIAN PHOSPHATE INDUSTRY

TECHNOLOGY

Canadian producers use the two most basic methods for decomposing phosphate rock, thermal reduction and acid treatment. Thermal reduction involves the smelting of phosphate rock with carbon (coke) and a silicious flux to produce elemental phosphorus, ferro-phosphorus, carbon monoxide and calcium silicate slag. Electric Reduction Company of Canada, Ltd. (ERCO) uses this process, employing electric furnaces, at Varennes, Quebec, just east of Montreal. ERCO is the only producer of elemental phosphorus in Canada, yearly capacity of which at the Varennes plant is 20,000 tons.

About 9 tons of phosphate rock grading 66-68% BPL are required to manufacture one ton of phosphorus by this method. Although elemental phosphorus can be used for making fertilizers, it is generally used in the manufacture of chemicals, insecticides, detergents and other industrial compounds.

For the acid treatment decomposition process, almost any strong mineral acid may be used. In Canada, only the two most common acidulants – sulphuric acid and phosphoric acid – are used in commercial practice; the former is by far the most important. Nitric acid is used to some extent in some countries. Hydrochloric acid processes have received considerable attention during the past few years.

When phosphate rock is treated with sulphuric acid, either single superphosphate or phosphoric acid (correctly named orthophósphoric acid – H_3PO_4) is produced. For the former, the rock is treated with sufficient acid to convert the tricalcium phosphate into water-soluble monocalcium phosphate; the co-product of the reaction, calcium sulphate, remains in the mixture. Normal raw material requirements to produce one ton of superphosphate, grading 20 per cent P_2O_5 equivalent, are 0.64 ton of phosphate rock (70-72% BPL) and 0.47 ton of sulphuric acid (100 % basis). Canada has five producers of this type with a combined yearly capacity of about 400,000 tons of single superphosphate (Table 4).

To produce phosphoric acid, larger quantities of sulphuric acid are added to maintain a fluidic slurry that facilitates removal of calcium sulphate by filtering. Off-stream acid, containing 30 to 32 per cent P_2O_5 equivalent, may be used either directly in the manufacture of phosphate fertilizers or concentrated by evaporation to as high as 54 per cent P_2O_5 equivalent prior to further use or sale as merchant acid. Typical raw material requirements for one ton of P_2O_5 equivalent produced are 3.1 tons of phosphate rock (74-75% BPL) and 2.6 tons of sulphuric acid (100 % basis), which is equivalent to 0.86 ton of sulphur. Also, for every ton of P_2O_5 equivalent produced, about 4.5 tons of waste calcium sulphate are generated. Canada has ten producers of phosphoric acid with a combined yearly capacity of about 775,000 tons of P_2O_5 equivalent.

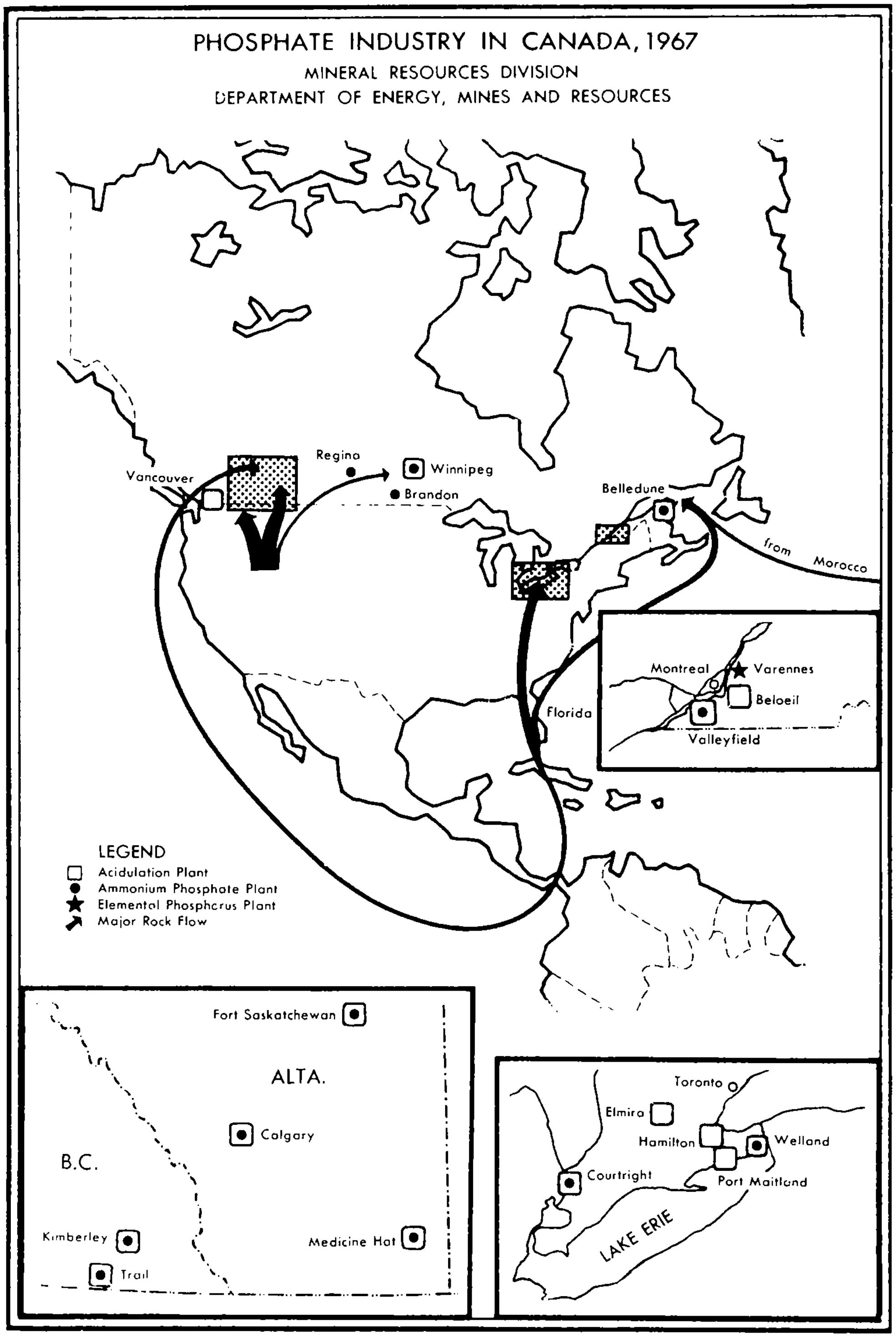
Most of the acid is then neutralized with ammonia to form ammonium phosphate fertilizers. Common grades are 16-20-0 (16 per cent N, 20 per cent P_2O_5 equivalent, and 0 per cent K_2O equivalent), 11-48-0 and 18-46-0. At some plants, phosphoric acid is used to acidulate phosphate rock in which case the end product is triple superphosphate, normally grading 46 per cent P_2O_5 equivalent.

TABLE 4

Canada, Phosphate Fertilizer Plants, 1967

Company	Plant Location	Acidulation Capacity tpy P_2O_5 eq.	Principal Products	Basis for H_2SO_4
Belledune Fertilizer Limited	Belledune, N.B.	90,000	am ph	SO_2 smelter gas
Border Fertilizer Ltd.	Winnipeg, Man.	16,000	am ph	sulphur
Canadian Industries Limited	Beloeil, Que.	28,000	s s	sulphur
	Hamilton, Ont.	28,000	s s	sulphur
	Courtright, Ont.	80,000	am ph	SO_2 pyrrhotite
Cominco Ltd.	Regina, Sask.	. .	am ph	. .
	Kimberley, B.C.	128,000	am ph	SO_2 pyrrhotite
	Trail, B.C.	86,000	am ph	SO_2 smelter gas
Cyanamid of Canada Limited	Welland, Ont.	13,000	t s, am ph	sulphur
Electric Reduction Company of Canada, Ltd.	Port Maitland, Ont.	190,000	H_3PO_4, s s, t s, ca ph	SO_2 smelter gas & sulphur
Elmira Fertilizers Limited*	Elmira, Ont.	4,000	s s	sulphur
Green Valley Fertilizer & Chemical Co. Ltd.	North Surrey, B.C. (near Vancouver)	1,000	s s	SO_2 smelter gas
Northwest Nitro-Chemicals Ltd.	Medicine Hat, Alta.	60,000	am ph	sulphur
St. Lawrence Fertilizers Ltd.	Valleyfield, Que.	56,000	t s, am ph	SO_2 smelter gas
Sherritt Gordon Mines, Limited	Fort Saskatchewan, Alta.	45,000	am ph	sulphur
Simplot Chemical Company Ltd.	Brandon, Man.	. .	am ph	. .
Western Co-operative Fertilizers Limited	Calgary, Alta.	65,000	am ph	sulphur
Total		890,000		

* Superphosphate production was suspended in late 1967.
am ph – Ammonium phosphates
s s – Single superphosphate
t s – Triple superphosphate
ca ph – Food supplement calcium phosphate
. . Not applicable, H_3PO_4 is made elsewhere.


PHOSPHATE INDUSTRY IN CANADA, 1967
MINERAL RESOURCES DIVISION
DEPARTMENT OF ENERGY, MINES AND RESOURCES
Vancouver
Regina
Winnipeg
Brandon
Belledune
from Morocco
Florida
Montreal
Varennes
Beloeil
Valleyfield
LEGEND
Acidulation Plant
Ammonium Phosphate Plant
Elemental Phosphorus Plant
Major Rock Flow
Fort Saskatchewan
ALTA.
Calgary
B.C.
Kimberley
Medicine Hat
Trail
Toronto
Elmira
Hamilton
Welland
Courtright
Port Maitland
LAKE ERIE

PRODUCTION AND DEVELOPMENTS

Production of phosphate fertilizers in Canada in the fertilizer year 1966/67 (twelve months ended June 30, 1967) reached 533,460 tons of P_2O_5 equivalent, up 15.6 per cent from the previous twelve months. This is slightly higher than the average annual growth rate of 15 per cent experienced between 1959/60 and 1965/66.

During the calendar year 1967, two phosphate fertilizer plants – one at Valleyfield, Quebec, and the other at Courtright, Ontario – that had been brought into operation in late 1966 reached near or full capacity; two new plants were officially placed on stream; one expansion, at Port Maitland, Ontario, was completed; and one new project was started. In addition, construction of an elemental phosphorus plant was under way.

The two new phosphate fertilizer producers are Simplot Chemical Company Ltd. at Brandon, Manitoba, and Belledune Fertilizer Limited, at Belledune, New Brunswick. Simplot's $30-million complex, officially opened in February 1967, includes an ammonia plant with ancillary units and a 350,000-ton-a-year ammonium phosphate plant; phosphoric acid is imported from the parent firm's operations in Idaho. Belledune Fertilizer, jointly owned by Brunswick Mining and Smelting Corporation Limited and ERCO, officially opened a $19-million phosphoric acid-ammonium phosphate plant in November 1967. Sulphuric acid is supplied from the adjacent lead-zinc smelter, which is operated by Belledune Acid Limited, also a subsidiary of Brunswick.

In April 1967, Imperial Oil Limited announced plans for a $50-million, 500,000-ton-a-year fertilizer complex near Redwater, Alberta, some 35 miles northeast of Edmonton. Imperial's complex will include the following plants: sulphuric acid, phosphoric acid-ammonium phosphate, ammonia, nitric acid, ammonium nitrate and urea. Production is scheduled for 1969.

ERCO is building a $40-million plant at Long Harbour, on Placentia Bay, south coast of Newfoundland. Production at the rate of 50,000 tons annually is expected to start in late 1968. Most of the phosphorus will be shipped in two specially built 7,000-ton vessels to the company's parent firm, Albright & Wilson Ltd. in England; some will go to ERCO's phosphate works at Port Maitland, Ontario.

TABLE 5

Canada, Phosphate Fertilizer Production, Years Ended June 30, 1958-67
(short tons P_2O_5 equivalent)

1958	175,145
1959	175,000
1960	199,570
1961	231,840
1962	261,033
1963	299,453
1964	353,547
1965	374,159
1966	461,608
1967	533,460

Source: Dominion Bureau of Statistics.

TABLE 6

World Production of Phosphate Fertilizers, 1965/66 - 66/67[1]
('000 metric tons P_2O_5 equivalent)

Country	1965/66	1966/67[p]
USA	4,260	4,651
USSR[2]	1,599	1,710
France[3]	1,218	1,330
Australia	940	970
West Germany	857	861
Japan	588	655
Italy	512	516
Canada	419	484
Belgium	415	421
Britain[4]	420	403
Others	4,172	4,499
Total	15,400	16,500

Sources: United Nations FAO, Mon. Bull. Agr. Econ. Stat., Feb. 1968.
[1] Fertilizer year July 1 to June 30; [2] Calendar year referring to first part of split year; [3] Fertilizer year May 1 to April 30; [4] Fertilizer year June 1 to May 30.
[p] Preliminary.

CONSUMPTION AND TRADE

Consumption of phosphate fertilizers in Canada in the fertilizer year 1966/67 was 412,214 tons of P_2O_5 equivalent, up 12 per cent from the previous twelve months but a percentage decline from the average annual growth rate of 15 per cent experienced between 1959/60 and 1965/66. Unfavourable wet weather caused delay in the 1967 spring seeding and contributed to a slackening of sales. Domestic markets in 1967 were divided almost equally between the prairie provinces and the rest of Canada. This pattern contrasts sharply with 1959/60 when farmers in eastern Canada purchased almost twice as much phosphate plant nutrient as those in western Canada.

TABLE 7

Canada, Trade in Selected Phosphate Products, 1966-67

	1966		1967p	
	Short Tons	$	Short Tons	$
Imports				
Calcium phosphate				
United States	17,784	1,755,000	18,718	1,860,000
Japan	2,287	157,000	955	69,000
Belgium and Luxembourg	1,542	98,000	1,300	85,000
Total	21,613	2,010,000	20,973	2,014,000
Fertilizers				
Normal superphosphate				
United States	70,687	1,452,000	35,492	810,000
Triple superphosphate				
United States	45,438	3,099,000	46,821	2,638,000
Chemicals				
Potassium phosphates				
United States	1,800	527,000	1,676	465,000
Sodium phosphate, tribasic				
United States	944	161,000	969	171,000
France	22	2,000	–	–
Total	966	163,000	969	171,000
Sodium phosphates, n.e.s.				
United States	7,204	1,365,000	8,855	1,640,000
West Germany	173	42,000	33	8,000
Britain	1	1,000	–	–
Total	7,378	1,408,000	8,888	1,648,000
Exports				
Nitrogen phosphate fertilizers				
United States		22,782,000		26,596,000
Malaysia-Singapore		7,000		–
Total		22,789,000		26,596,000

Source: Dominion Bureau of Statistics.
p Preliminary; – Nil; n.e.s. Not elsewhere specified.

Considerable quantities of phosphate fertilizers move between Canada and United States, particularly in areas where plants are close to farming communities in the neighbouring country. Although there have been occasional marked fluctuations within the past decade, Canada's exports of phosphate fertilizers have usually doubled its imports. Exports for the fertilizer year 1966/67 were 138,133 tons of P_2O_5 equivalent, just over one quarter of Canada's output.

TABLE 8

Canada, Phosphate Fertilizer Consumption and Trade, Years Ended June 30, 1958-67
(short tons P_2O_5 equivalent)

Years Ended June 30	Consumption	Imports*	Exports
1958	127,170	44,455	80,768
1959	144,876	44,103	87,957
1960	153,243	45,040	98,318
1961	177,132	46,188	100,166
1962	196,763	47,035	111,182
1963	223,314	44,443	101,890
1964	264,245	86,279	102,842
1965	293,758	66,604	97,207
1966	367,591	65,498	126,524
1967	412,214	73,936	138,133

Source: Dominion Bureau of Statistics.
* Excludes nutrient content of mixtures.

CANADIAN INDUSTRY OUTLOOK

The outlook for the Canadian phosphate industry is favourable although sales of phosphate fertilizers are not expected to regain the growth rates experienced during recent years. Apart from a domestic source of phosphate rock, the Canadian industry is in a particularly favourable position insofar as raw materials are concerned. Rock is readily available from foreign suppliers at competitive prices. Sulphur, although more costly than in recent years, is in adequate supply in Canada even though world shortages do exist. Natural gas, which is the key raw material used in manufacturing ammonia in North America for the preparation of ammonium phosphate fertilizers, is in abundant supply. Electrical power, necessary for the manufacture of elemental phosphorus, is relatively cheap and plentiful from hydro-generating plants.

In 1968, phosphate fertilizer sales by Canadian producers are expected to rise but at a lower rate than experienced in recent years. Sharp increases in sulphur costs during 1966 and 1967 have put abnormal upward pressure on domestic and export prices of phosphate fertilizers while prices on the other two plant nutrients, nitrogen and potash, have weakened. Reports indicate that farm incomes weakened slightly in 1967, particularly in Western Canada where sales have been exceptionally high in recent years. Competition has become very strong in Canada's main export market, United States, where producers are reported to be faced with overcapacity and large inventories. On the brighter side, improvements in transportation and distribution facilities combined with a greater acceptance of high-analysis fertilizers continue to lessen the cost per unit of plant food to the farmer thereby tending to increase sales. These two factors, plus the farmers' increasing awareness of the role that fertilizers play in boosting crop yields, should be sufficient to retain a moderate expansion in both domestic and export sales.

PRICES AND TARIFFS

Phosphate rock prices are based upon the BPL content. Maximum limits of moisture, iron and alumina are specified. Bonuses are paid and penalties assessed for variations above and below the base grade. Although much phosphate rock is supplied on a contract basis, price quotations serve as a reliable guide. Depending upon the material, prices for phosphate fertilizers are based on the unit content or minimum analysis of the available phosphoric acid (a.p.a.).

The December 25, 1967, issue of *Oil, Paint and Drug Reporter* listed the following prices:

Phosphate rock, Florida land pebble, run-of-mine, washed, dried, unground, bulk, carlots, f.o.b. mines, per short ton:

66-68% BPL	$ 6.50
68-70	7.50
70-72	8.15
74-75	9.20
76-77	10.20

Defluorinated phosphate, feed grade, paper bags, carlots (some truckloads), various U.S. points, 18%P, per short ton:	$65.25 - $91.00
Phosphoric acid, agricultural, grade, f.o.b. Occidental, Fla., per unit-ton, 52-54% a.p.a.	$ 1.26
Superphosphate, run-of-pile, pulverized, bulk, carlots, f.o.b. works, per unit-ton, under 22% a.p.a.	$ 0.92 - $ 1.10
Ammonium Phosphate, fertilizer grade, bulk, 50-ton car, f.o.b. plant, per ton, 18-46-0	$89.50 - $90.50

Although the listing for phosphate rock remained unchanged from the previous year, reports indicate that towards the end of 1967 some prices increased 2 to 3 per cent above those presented above. Prices for phosphoric acid, superphosphate and ammonium phosphate range from 7 to 10 per cent higher than those listed a year ago; these increases are largely attributed to rising sulphur costs.

Phosphate rock and phosphate fertilizer materials enter Canada duty free. Compounded fertilizers that are imported for direct application are subject to a 5 per cent ad valorem tariff for Most Favoured Nations and 10 per cent for general entry. Under the Kennedy Round tariff negotiations, Canada is committed to remove the Most Favoured Nation tariff beginning July 1, 1968.

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Platinum Metals

A.F. KILLIN*

The USSR, Republic of South Africa, Canada and Colombia, in that order, produce nearly all the world's platinum metals (platinoids). In Canada the platinoids – platinum, palladium, rhodium, ruthenium, iridium and osmium – are recovered as byproducts from the refining of nickel-copper ores and the volume of recovery varies with the production of these ores. Canadian production in 1967 was 403,270 ounces valued at $34,586,996; an increase of 7,211 ounces and $2,216,932 from 1966.

The United States Bureau of Mines estimates world production in 1967 at 3,050,000 ounces; 100,000 ounces more than in 1966. The USSR does not publish production statistics but the US Bureau estimates Russian production at 59 per cent of the world total. The Republic of South Africa produced 800,000 ounces in 1967 and Colombia 20,000 ounces. There was minor production in the United States and Japan.

World consumption statistics are not available. Consumption in the non-communist world exceeded mine production and supplies were purchased from the USSR. As in previous years the USSR pattern of sales was unpredictable.

The dual pricing formula for platinum persisted in 1967. It consists of a producers price quoted by Engelhard Industries, Inc., and Johnson, Matthey & Co., Limited and a free market price quoted by merchant dealers and the agents selling for the USSR. Most of the platinoids produced in the non-communist world were sold at the producers price. Metal reclaimed from scrap and the Russian metal were sold at the free market price. Price fluctuations are listed later in this review.

Fluctuating prices and limited supply have inhibited greater use of the platinoids and encouraged substitution. However, the unique properties of the platinum group metals and the ability to recover them from scrap have prevented any large-scale substitution. Continued growth in demand has prompted the South African producer to increase output at a rapid rate.

PRODUCTION

CANADIAN

The platinum metals in Canadian ores (0.025 ounce per ton or less) are collected in the nickel-copper sulphide matte from the nickel smelting process. Nickel-copper matte anodes are purified by electrolysis and the precious metals released are collected as sludge from the electrolytic tanks. This sludge is purified, then shipped to refineries in Britain and the United States for the recovery of the individual platinum metals.

*Mineral Resources Branch.

TABLE 1

Platinum Metals – Production and Trade, 1966-67

	1966		1967p	
	Troy Ounces	$	Troy Ounces	$
Production[1]				
Platinum, palladium, rhodium, ruthenium, iridium	396,059	32,370,064	403,270	34,586,996
Exports				
Platinum metal in ores and concentrates				
Britain	423,882	24,188,000	447,130	27,487,000
Norway	10,139r	883,000r	9,948	955,000
United States	–	–	20	2,000
Total	434,021	25,071,000	457,098	28,444,000
Platinum metals				
Britain	6,428	533,000	17,497	1,226,000
United States	1,131	193,000	1,237	156,000
Other countries	45	3,000	23	3,000
Total	7,604	729,000	18,757	1,385,000
Platinum metals in scrap				
United States	13,663	1,208,000	15,355	1,523,000
Britain	18,743	1,515,000	6,982	864,000
Japan	–	–	4,000	188,000
Other countries	–	–	60	14,000
Total	32,406	2,723,000	26,397	2,589,000
Re-Exports[2]				
Platinum metals, refined and semiprocessed	199,152	11,779,822	164,033	9,087,955
Imports				
Platinum lumps, ingots, powder and sponge				
Britain	9,565	1,087,000	14,184	1,761,000
United States	1,769	196,000	2,266	295,000
Belgium and Luxembourg	–	–	4	1,000
Total	11,334	1,283,000	16,454	2,057,000
Other platinum group metals in lumps, ingots, powder and sponge				
Britain	183,296	13,479,000	188,639	10,730,000
United States	3,223	168,000	6,755	331,000
Belgium and Luxembourg	–	–	1,041	43,000
Total	186,519	13,647,000	196,435	11,104,000
Total platinum and platinum group metals				
Britain	192,861	14,566,000	202,823	12,491,000
United States	4,992	364,000	9,021	626,000
Belgium and Luxembourg	–	–	1,045	44,000
Total	197,853	14,930,000	212,889	13,161,000
Platinum crucibles				
United States	22,858	2,262,000	15,450	1,702,000
Britain	220	23,000	–	–
Total	23,078	2,285,000	15,450	1,702,000

TABLE 1 (Cont'd)

	1966		1967p	
	Troy Ounces	$	Troy Ounces	$
Platinum metals, fabricated materials, not elsewhere specified				
Britain	12,979	1,370,000	11,050	1,166,000
United States	8,114	584,000	9,274	517,000
Netherlands	526	19,000	–	–
Total	21,619	1,973,000	20,324	1,683,000

Source: Dominion Bureau of Statistics.
[1] Platinum metals content of concentrates, residues and matte shipped for export.
[2] Platinum metals, refined and semiprocessed, imported and re-exported after undergoing no change or alteration.
p Preliminary; r Revised; – Nil.

TABLE 2

World Production of Platinum-Group Metals
(troy ounces)

	1965	1966p	1967e
USSR	1,700,000	1,700,000	1,800,000
Republic of South Africa	753,800	784,000	800,000
Canada	463,127	396,059	403,270
United States	35,026	51,432	35,000
Colombia	11,141	17,780	20,000
Other countries	6,906	10,729	14,730
Total	2,970,000	2,960,000	3,073,000

Source: US Bureau of Mines Minerals Yearbook, 1966 and Commodity Data Summaries, January 1968.
p Preliminary; e Estimated.

Most of Canada's platinum metals are produced from ores mined in the Sudbury area of Ontario. Nickel ores containing platinoids are also mined in Quebec, Manitoba, British Columbia, and from deposits in Ontario in addition to those at Sudbury. No precious metals are recovered in Canada from the British Columbia ores because the concentrates are sold to Japan for treatment.

Metal Mines Limited at Gordon Lake, Ontario, and two mines in Quebec, Marbridge Mines Limited at Malartic and Lorraine Mining Company Limited at Belleterre, shipped nickel-copper concentrates to Sudbury for treatment by The International Nickel Company of Canada, Limited (Inco), and Falconbridge Nickel Mines, Limited.

In the Sudbury area, Inco operated the Frood-Stobie, Creighton, Garson, Levack, Murray, Crean Hill, MacLennan, Copper Cliff North and Totten underground mines and the Clarabelle and Crean Hill open pits. The ore was concentrated in the Creighton, Levack, Copper Cliff and Frood-Stobie mills and the concentrates smelted at Coniston and Copper Cliff. The nickel-copper matte was refined in the company's refinery at Port Colborne, Ontario. Precious metal sludges from the refinery were shipped to Britain for separation and refining of the platinum metals. Inco will bring the Coleman, Kirkwood, Copper Cliff South and Little Stobie mines into production by December, 1969 with a consequent increase in output of platinoids. Falconbridge operated the Falconbridge, East, Onaping, Hardy, Fecunis and North mines, the Falconbridge, Hardy and Fecunis mills and a smelter in the Sudbury area. Nickel-copper matte from the smelter was shipped to the company's refinery at Christiansand, Norway, where platinoids are recovered and refined. Falconbridge was developing two new mines for production and will increase its nickel and precious metal output by 1969.

FOREIGN

SOUTH AFRICA

Rustenburg Platinum Mines Limited, the non-communist world's largest platinum metals producer, announced a further expansion program. Originally scheduled to expand from 600,000 ounces of platinoids a year to 750,000 ounces, the company has announced that capacity will be increased to 850,000 ounces a year, which is expected to be reached in 1970. The smelter in South Africa, jointly owned by Rustenburg and Johnson, Matthey & Co. South Africa (Pty) Limited will be expanded and Johnson, Matthey has announced that it will build a refinery at Wadeville in South Africa to separate and refine the platinum metals from partially refined material from the smelter. The capacity of the refinery has not been announced. Union Corporation, a South African investment firm, announced plans to bring a platinum metals mine into production near Rustenburg. Production at 100,000 ounces a year is expected by 1969.

TABLE 3

Platinum Metals – Production and Trade, 1958-67

	Production[1]			Exports		Imports[4]
	Platinum (troy oz)	Other Platinum Metals (troy oz)	Total (troy oz)	Domestic[2] $	Re-exports[3] $	$
1958	146,092	154,366	300,458	15,014,321	4,893,616	8,641,360
1959	150,382	177,713	328,095	12,497,221	8,676,998	6,466,280
1960	..	..	483,604	16,068,728	8,404,563	12,951,420
1961	..	..	418,278	26,331,101	9,820,374	11,242,328
1962	..	..	470,787	24,340,175	8,644,781	12,925,466
1963	..	..	357,651	24,555,816	10,144,484	13,590,575
1964	..	..	376,238	20,812,514	20,888,749	17,369,291
1965	..	..	463,127	30,103,254	11,389,395	13,461,546
1966	..	..	396,059	25,800,000ʳ	11,779,822	14,930,000
1967ᵖ	..	..	403,270	29,829,000	9,087,955	13,161,000

Source: Dominion Bureau of Statistics.
[1] Platinum metals, content of residues, concentrates and matte shipped to Britain and Norway for treatment. [2] Value of platinum metals and platinum concentrates exported for treatment. [3] Re-exports of platinum metals, refined and semiprocessed imported from Britain. [4] Imports, mainly from Britain, of refined and semiprocessed platinum metals derived from Canadian concentrates and residues, most of which is re-exported.
ᵖ Preliminary; .. Not available for publication; ʳ Revised.

USSR

Platinoids in the USSR are derived mainly from the mining of deposits in the nickel-bearing basic and ultra-basic rocks of the Norilsk region of Siberia. Small amounts of placer platinum are recovered from the southern Urals. Russian production in 1967 is estimated by the US Bureau of Mines at 1.8 million ounces.

COLOMBIA

The 20,000 ounces of platinum metals produced in Colombia were recovered from placer deposits in the Choco district.

UNITED STATES

Mine production of platinoids in the United States was from placer deposits in the Goodnews Bay area of Alaska. Some primary production was obtained as a byproduct of gold and copper refining.

USES

Platinum metals are valuable to industry because of their many special properties, the chief of which are catalytic activity, resistance to corrosion, resistance to oxidation at elevated temperatures, high melting points, high strength and high ductility. Platinum and palladium are the principal platinum metals. Iridium, osmium, ruthenium and rhodium are used mainly as alloying elements to modify properties of platinum and palladium. Rhodium is used in plating.

The catalytic action of platinum, palladium, rhodium and ruthenium is utilized in the oil industry for the production of high octane gasolines; in the chemical industry for the production of sulphuric and nitric acids and the hydrogenation of organic chemicals; and in the drug industry for the manufacture of pharmaceuticals, vitamins and antibiotics. A recent development is the use of platinum metal salts and complexes as homogeneous catalysts for the oxidation, isomerisation, hydrogenation and polymerisation of olefins.

The corrosion resistance of the platinum metals is utilized in laboratory utensils to contain corrosive liquids and as protective coatings for vessels used in the melting of materials for laser crystals. Wear resistance of the platinum metals makes them ideal for use as spinnerets for the production of glass, rayon and other synthetic fibres. Platinum and platinum alloys are used for the cathodic protection of ships' hulls and as inert anodes in electro-deposition. Palladium is used as contacts in automatic electric switching gear and in dentistry. Wear resistance and beauty of finish are the qualities that create a demand for the platinum metals in the manufacture of high-quality jewelry.

PRICES

Prices of platinum metals a troy ounce varied during the year. The following table summarizes the price changes as quoted in the United States by *Metals Week*.

TABLE 4

Prices of Platinum Metals, 1967

	$/ troy ounce
Iridium	
January 1 to March 19	180
Dealers*	205
March 20 to December 31	185-190
Dealers*	200-205
Osmium (nominal)	
January 1 to December 31	300-450
Palladium	
January 1 to January 8	35-37
Dealers*	38-39
January 9 to December 31	37-39
Dealers*	42-43
Platinum	
January 1 to January 24	100
Dealers*	157-160
January 25 to December 10	109-112
Dealers*	210-220
December 11 to December 31	109-125
Dealers*	225-230
Rhodium	
January 1 to January 8	197-200
Dealers*	205
January 9 to March 19	207-210
Dealers*	215-220
March 20 to December 10	220-225
Dealers*	250-260
December 11 to December 31	245-250
Dealers*	262-265
Ruthenium	
January 1 to December 31	55-60
Dealers* (nominal)	45

Source: *Metals Week.*
* Average.

TARIFFS

	British Preferential	Most Favoured Nation	General
CANADA			
Platinum wire and platinum bars, strips, sheets, plates, platinum, palladium, iridium, osmium, ruthenium and rhodium in lumps, ingots, powder, sponge or scrap	free	free	free
Platinum crucibles	free	free	free
Platinum retorts, pans, condensers, tubing and pipe, and preparations of platinum for use in manufacture of sulphuric acid	free	free	free
Platinum and black oxide of copper for use in manufacture of chlorates and colours	free	10%	10%
UNITED STATES			
Platinum, including gold- or silver- plated platinum but not rolled platinum			
Unwrought			
Metals of the platinum group separately, native combinations of such metals and artificial combinations of such metals containing by weight not less than 90% of the metal platinum			free
Other, including alloys of platinum			40% ad val
Semimanufactured			
Bars, plates and sheets, all not under 0.125 inch thick wholly of metals of the platinum groups separately, wholly of native combinations of metals of the platinum group, or wholly of artificial combinations thereof containing by weight not less than 90% of metal platinum			free
Other, including alloys of platinum			40% ad val

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT) that was convened in 1964 to consider reductions in tariffs submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968 and final reductions on January 1, 1972.

Potash

W. E. KOEPKE*

World demand for potash continued to rise during 1967 but supply outpaced demand and prices weakened further as producers attempted to reduce stocks. North American potash prices began to soften early in 1966 following an unusually large build-up in stocks. The year-end carry-over was high and the problem was further compounded when widespread unfavourable wet weather caused delay in the 1967 spring seeding season and sharply reduced anticipated potash fertilizer sales. World potash stocks at the close of 1967 were believed to be at an all-time high.

In spite of the highly competitive marketing conditions, Canada's potash industry in Saskatchewan continued its rapid development and gained greater prominence as the world's largest exporter. During 1967, three mines operated at capacity; a fourth was brought on stream; three were partially readied for start-up in 1968; development was well advanced on two others; one project was started; and plans for one expansion were announced. Canada now ranks third among world potash producers following United States and USSR – a remarkable achievement considering that regular production in Canada began only in 1962. Reflecting the weakened prices, the preliminary value of production (shipments) in 1967 averaged $30.00 a ton of K_2O equivalent compared with $31.49 in 1966 and $37.53 in 1965.

When applied as a noun, the term potash means potassium oxide (K_2O) equivalent and when used as an adjective it refers to potassium compounds or potassium-bearing materials. Of the 70-odd potassium-bearing minerals, only a few of the soluble potash salts found in underground bedded deposits and lake, sea, or subsurface brines are of any economic significance. Other potash sources include wood ashes, kelp, guano and organic matter. Almost 95 per cent of the world's potash production is for fertilizers. Small quantities are used in the manufacture of soaps, glass, ceramics, textiles, dyes, explosives and numerous chemicals.

Potash minerals and compounds are normally graded in terms of K_2O equivalent. For example, potassium chloride (KCl), which accounts for over 90 per cent of the world's potash fertilizer consumption, has a K_2O equivalent of 63.2 per cent; fertilizer grades produced in Canada grade a minimum of 60 per cent K_2O equivalent. Pure potassium chloride contains 52.4 per cent K.

PRODUCTION, TRADE AND CONSUMPTION

Production (shipments) of potash in Canada rose sharply to 2.6 million tons of K_2O equivalent in 1967, a 29.4-per-cent increase from 1966. The value was $77.3 million compared with $62.6 million in 1966.

Canadian potash consumption amounts to just over 8 per cent of its output so most of this country's potash production must be sold in export markets. Potash exports in 1967 were valued at $86 million compared with $76 million in 1966. In 1967, an estimated 1,380,000 tons of K_2O equivalent, representing close to 54 per cent of Canada's potash output and almost two thirds of Canada's total potash exports, went to United States. Japan was the next largest customer followed by Britain, which was served mainly through newly-built terminal and warehousing facilities at Rotterdam, Netherlands.

Almost all of Canada's overseas sales, as well as a substantial portion to southeastern United States, are channelled through the Vancouver port area, some

*Mineral Resources Branch.

TABLE 1

Canada, Potash Production and Trade, 1966-67

	1966		1967P	
	Short Tons	$	Short Tons	$
Production (shipments) K_2O equivalent	1,990,053	62,664,666	2,578,200	77,346,000
Imports – Fertilizer potash				
Potassium chloride				
West Germany	14,634	430,000	13,434	351,000
France	8,657	231,000	7,004	165,000
United States	4,822	158,000	6,969	199,000
Britain	33	1,000	13	2,000
Total	28,146	820,000	27,420	717,000
Potassium sulphate				
United States	14,875	640,000	21,736	828,000
France	6,853	253,000	4,700	147,000
Italy	3,478	166,000	3,638	188,000
West Germany	150	6,000	200	8,000
Total	25,356	1,065,000	30,274	1,171,000
Potash fertilizer, not elsewhere specified				
United States	13,161	229,000	21,442	357,000
Total, potash fertilizers	66,663	2,114,000	79,136	2,245,000
Potash chemicals				
Potassium carbonate	790	147,000	693	127,000
Potassium hydroxide	1,648	319,000	1,685	336,000
Potassium nitrates	1,616	210,000	1,699	215,000
Total, potash chemicals	4,054	676,000	4,077	678,000
Exports – Fertilizer potash				
Potassium chloride (muriate of potash)				
United States		53,389,000		58,923,000
Japan		11,713,000		10,060,000
Netherlands*		5,378,000		9,165,000
India		19,000		3,320,000
New Zealand		3,387,000		1,655,000
South Korea		–		854,000
Taiwan		754,000		709,000
Other countries		1,725,000		1,457,000
Total		76,365,000		86,143,000

Source: Dominion Bureau of Statistics.
*Much of this was trans-shipped to Britain.
PPreliminary: – Nil.

900 miles from the potash mines. Two bulk-loading terminals, Vancouver Wharves Ltd. and Pacific Coast Bulk Terminals Ltd., together provide storage for 155,000 tons of potash product and a loading capacity of almost 7,000 tons per hour. A third bulk terminal for loading potash, Neptune Terminals Ltd., is expected to be completed by mid-1968. Deep-sea berthing facilities at these terminals can accommodate vessels up to 65,000 dead weight tons.

The bulk of Canada's potash consumption is contained in mixed fertilizers sold in the farming communities of southern Ontario and Quebec. Consumption of potash fertilizers in Canada in the fertilizer year 1966/67 (twelve months ended June 30,

1967) reached 178,142 tons of K_2O equivalent, up 14 per cent from the previous twelve months and considerably higher than the average annual growth rate of 9.8 per cent experienced between 1959/60 and 1965/66.

TABLE 2

Canada, Potash Production and Trade, Years Ended June 30, 1958-67
(short tons K_2O equivalent)

Year Ended June 30	Production	Imports*	Exports
1958	–	90,145	5,152
1959	. .	91,794	. .
1960	. .	85,820	. .
1961	–	101,370	. .
1962	–	124,370	. .
1963	403,679	75,180	310,633
1964	747,257	58,115	638,749
1965	1,176,408	49,780	983,556
1966	1,927,843	34,522	1,676,174
1967	2,204,231	38,090	2,004,504

Source: Dominion Bureau of Statistics.
* Includes potassium chloride, potassium sulphate, and sulphate of potash magnesia, except that contained in mixed fertilizers.
– Nil; . .Not available.

TABLE 3

Canada, Available Data on Potash Consumption, 1965-66
(short tons)

	1965	1966
Potassium chloride		
Fertilizers and chemicals	192,709	202,721
Other*	1,242	2,126
Total	193,951	204,847
Potassium sulphate		
Fertilizers	21,000^e	24,000^e
Potassium magnesium sulphate		
Fertilizers	6,600^e	9,000^e
Potassium nitrate		
Mixed Ferlilizers	75^e	80^e

Source: Dominion Bureau of Statistics.
* Cleansers, soaps, gypsum products, medicinals and miscellaneous minor uses.
^{e} Estimated.

TABLE 4

Canada, Consumption of Potash Fertilizers, Years Ended June 30, 1958-67
(short tons K_2O equivalent)

Year Ended June 30	In Materials	In Mixtures	Total
1958	4,282	80,393	84,675
1959	4,443	83,631	88,074
1960	4,387	84,888	89,275
1961	5,404	96,514	101,918
1962	6,558	99,934	106,492
1963	9,704	102,285	111,989
1964	14,087	106,609	120,696
1965	18,264	117,142	135,405
1966	20,644	135,695	156,339
1967	27,806	150,336	178,142

Source: Dominion Bureau of Statistics.

CANADIAN OPERATIONS

GENERAL

Underground potash deposits occur in the prairie provinces of western Canada and in the Malagash peninsula of Nova Scotia. The deposits in western Canada underlie a broad northwesterly trending belt that extends across southern Saskatchewan into the bordering areas of Alberta and Manitoba; they occur within the Prairie Evaporite Formation, which constitutes the upper 50 to 700 feet of the Middle Devonian Elk Point Group. Depths of the Saskatchewan deposits, the only ones in production, range from 3,000 feet at the northern edge to 7,000 feet near the International Boundary. Individual potash beds are as much as 20 feet in thickness. Sylvite (KCl), halite (NaCl) and carnallite ($KCl.MgCl_2 6H_2O$) are the predominant minerals with the first two forming a mechanical mixture known as sylvinite, which is the chief 'ore'. Saskatchewan deposits range as high as 35 per cent K_2O equivalent. Potash reserves, grading a minimum of 25 per cent K_2O equivalent, are estimated at 50 billion tons.

Mining is accomplished by two methods, conventional shafts and solution. In the former, room-and-pillar patterns are followed using electrically-powered continuous miners to cut openings ranging from 7 to 10 feet in height and 18 to 22 feet in width. Mining is on one level and working depths at the various mines range from 3,100 to 3,400 feet. Shuttle cars and/or portable conveyors transfer the broken rock to main conveyors for haulage to the shaft area. There is some underground crushing. The hoisted rock is further crushed and fed into flotation cells for mineral separation. Sylvite is the floated mineral. The sylvite is then dried and screened resulting in three or four 'grades' of potassium chloride (muriate of potash in common terminology): granular, coarse, standard and special standard. Chemical or 'soluble' grades are also recovered from a crystallization circuit.

For solution mining, a controlled, weak brine is pumped into the potash beds at about 5,200 feet through a selected pattern of cased wells. Potash-rich solutions are circulated to surface for refining. Refining involves a sequence of multiple-effect evaporation and crystallization whereby potassium chloride crystals are precipitated, drawn-off, dried and screened.

SASKATCHEWAN

In July 1967, the areas of active interest were designated and identified by the Province of Saskatchewan as Commercial Potash Area's No. 1 and 2 under the Oil and Gas Conservation Act. Area No. 1, covering some 21,000 square miles, extends from west of Saskatoon southeasterly to the Saskatchewan-Manitoba border. Area No. 2 covers a 936-square mile area around Unity, the site of the first attempt to mine potash in Saskatchewan. In December 1967, there were 52 potash disposition holders in Saskatchewan with 997,869 acres under lease, 99,840 acres pending lease, and 4,152,793 acres under permit.

Exploration and development work carried out during the past few years, including 1967, have been heaviest in three regions of Area No. 1, Saskatoon-Lanigan, Esterhazy-Yorkton, and Regina-Duval. By the end of 1967, four potash mines were operating – three using conventional mining methods and one employing a solution process. Annual capacity of the four mines is 4.95 million tons of potash product. Expansions and new mines scheduled for completion in 1968 on through to the end of 1971 will bring Saskatchewan's annual production capacity to over 12 million tons of potash product (KCl).

International Minerals & Chemical Corporation (Canada) Limited (IMC) is the largest potash producer in Canada. During 1967, IMC operated its K-1 mine near Esterhazy at capacity and started up a second mine, its K-2 mine. The K-2 shaft, six miles southeast of the K-1 shaft, was completed to a depth of about 3,220 feet in January and the refinery was placed on stream in April. The K-2 mine is designed to produce 1.5 million tons of potash product annually but provisions were made to expand capacity to 2.5 million tons. Total cost of the K-2 mine is estimated at $60 million. IMC's two mines are connected underground at the potash horizon.

Kalium Chemicals Limited operates the only commercial potash solution mine in the world. Kalium's mine at Belle Plaine, some 20 miles west of Regina, began operating in 1964 with a designed capacity of 600,000 tons of potash product annually. Output during 1967 is believed to have reached a level of 750,000 tons. In October 1967, Kalium announced plans to spend $10 million to modify and expand its productive capacity by 50 per cent; completion was expected early in 1969.

Potash Company of America (PCA) became the first company to mine potash in Canada. PCA's mine, some 14 miles east of Saskatoon, began operating in 1958 but was forced to close down a year later because of water seepage into the shaft; it was re-opened in 1965 and has subsequently operated at capacity. In January 1967, PCA began sinking a second shaft about 3,000 feet from the existing one; completion to a depth of 3,500 feet is expected in 1969 at an estimated cost of $12 million. Although the second will initially serve to improve mine ventilation and supply, it is designed with a hoisting capacity to allow expansion to three million tons of product annually. On December 31, 1967, PCA was merged into Ideal Cement Company to become Ideal Basic Industries, Inc. The potash operations will continue to operate as a division of Ideal Basic under the name Potash Company of America.

Allan Potash Mines, a joint venture financed by United States Borax & Chemical Corporation, Homestake Mining Company and Swift Canadian Co., Limited, reached the potash beds in July 1967, at a depth of 3,372 feet at its No. 2 shaft near Allan, some 40 miles east of Saskatoon. This became the first shaft in the history of Saskatchewan potash mining to be completed without major water flooding. At the end of the year, the surface facilities and No. 1 service and ventilation shaft, which had been delayed by flooding in 1966, were nearing completion. The mine is designed to produce 1.5 million tons of potash annually and cost an estimated $80 million.

Alwinsal Potash of Canada Limited, a consortium of French and German potash producers, is developing a potash mine near Lanigan, about 70 miles east of Saskatoon. In September 1967, the company reached its potash target at a depth of 3,288 feet and, at year-end, surface facilities were nearly completed and ready for start-up in mid-1968. The mine is designed to produce 1.0 million tons of potash product annually and cost an estimated $60 million. A second shaft may be sunk later.

Duval Corporation is constructing a potash mine six miles west of Saskatoon. By the end of 1967, the two shafts had been sunk to depths of approximately 3,350 feet, some 30 feet below the potash beds, and the surface facilities were nearing completion. Production was scheduled for late 1968. The mine is designed to produce 1.0 million tons of potash product annually and is estimated to cost $63 million.

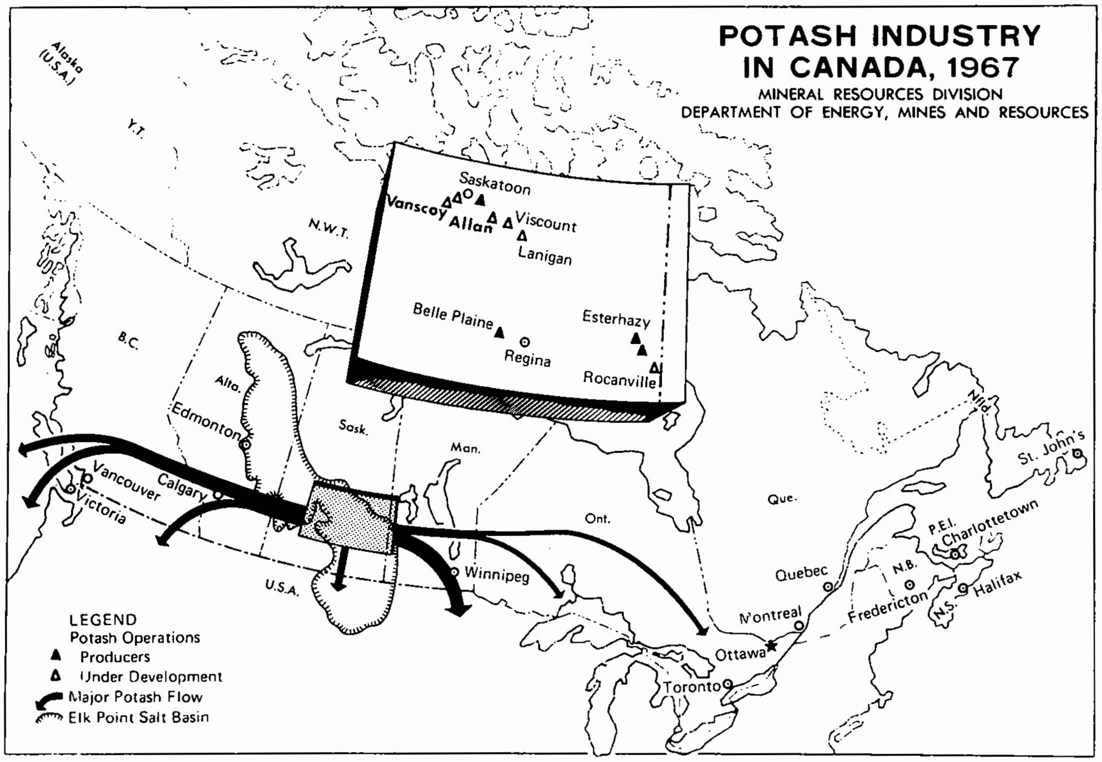
Cominco Ltd. is developing a $65-million potash mine near Vanscoy, 20 miles southwest of Saskatoon. By the end of 1967, the two production shafts were approaching the potash beds and refinery construction was in the final stages. The main shaft was expected to reach the potash zone at a depth of 3,500 feet early in

TABLE 5

Canada, Summary of Potash Mines, 1967

Company	Location*	Capital Cost $ million	Initial Production (scheduled)	Capacity Millions stpy**		Remarks
				KCl	K_2O eq.	
Producers						
IMC, K-1	Esterhazy	65	1962	2.00	1.20	One 18-ft shaft serving potash horizon at 3,148 feet.
K-2	Esterhazy	60	1967	1.50	0.90	One 18.5-ft shaft serving potash horizon at 3,150 feet.
Kalium	Belle Plaine	50	1964	0.75	0.45	Solution mining from beds about 5,200 feet.
PCA	Saskatoon	50	1965	0.70	0.42	One 16-ft shaft serving potash horizon at 3,315 feet. Sinking No. 2 shaft 3,000 feet from No. 1.
Sub-total		225		4.95	2.97	
Prospective Producers						
Allan	Allan	80	(1968)	1.50	0.90	One 16-ft shaft bottomed at about 3,600 feet and a second nearly completed.
Alwinsal	Lanigan	60	(1968)	1.00	0.60	Sinking one 18-ft shaft to 3,290 feet. A second shaft is planned.
Duval	Saskatoon	63	(1968)	1.00	0.60	Sinking two 16-ft shafts 850 feet apart to a depth of about 3,500 feet.
Cominco	Vanscoy	65	(1969)	1.20	0.72	Sinking two shafts (one 16-ft and one 18.5 ft) 500 feet apart to about 3,600 feet.
Noranda	Viscount	86	(1969)	1.50	0.90	Sinking two 16-ft shafts 440 feet apart to a depth of about 3,350 feet.
Sylvite	Rocanville	70	(1971)	1.00	0.60	Sinking two 16-ft shafts 500 feet apart to a depth of about 3,300 feet.
Sub-total		424		7.20	4.32	
Grand Total		649		12.15	7.29	

*All in the Province of Saskatchewan; **Calculations based on conversion factor of 0.60 K_2O equivalent equals 1.0 KCl.



1968. Production at an annual rate of 1.2 million tons of potash product is expected to begin early in 1969.

Noranda Mines Limited is spending an estimated $86 million for developing a potash mine at Viscount, 45 miles east of Saskatoon. In 1967, both shafts successfully penetrated the water-bearing Blairmore formation and reached a depth of 2,060 feet. Although subsequent water flows from deeper beds were expected to cause some difficulty and delay in shaft-sinking operations, construction should proceed on schedule. Revisions in plant design boosted the initial capacity from 1.2 million tons to 1.5 million tons of potash product a year. The mine, which is to be operated under the name of Central Canada Potash, is scheduled to begin production late in 1969 and reach full capacity in 1972.

Sylvite of Canada Ltd. announced plans in June 1967, to develop a $70-million potash mine near Rocanville, about 25 miles southeast of Esterhazy. Sylvite is controlled by Hudson Bay Mining and Smelting Co., Limited; other interests include Francana Development Corporation Ltd., Anglo American Corporation of Canada Limited, and Tombill Mines Limited. Two 16-ft diameter shafts, 500 feet apart, are to be sunk to a depth of about 3,300 feet. Production is scheduled for January 1971, at a rate of 1.0 million tons of potash product annually.

In addition to the projects under construction, several other companies have been engaged in exploration in Saskatchewan and in conducting mine feasibility studies. Among them are Scurry-Rainbow Oil Limited, Canberra Oil Company Ltd., Kerr-McGee Corporation, Lynbar Mining Corporation Limited, and Southwest Potash Corporation. Lynbar Mining is spending $500,000 on a solution-mining pilot project near Duval, some 50 miles north-northwest of Regina. In June 1967, Lynbar Mining concluded agreements with CENTROZAP and POLCOOP, two Polish Foreign trade organizations, to proceed with a solution-mining plant and to purchase potash should the pilot project prove successful. In 1967, Southwest Potash suspended development of its potash property near Yorkton; the company indicated that oversupply of world potash and weak prices were among the factors contributing to the postponement.

On December 30 1967, the Province of Saskatchewan approved an amendment to the subsurface mineral regulations that allows the lessee of Crown potash lands to obtain an extension on his lease by payment of \$90,000 annually to the province. The amendment enables the lessee to retain his lease and protect his exploration investment without a large expenditure should he prefer to postpone mine development.

NOVA SCOTIA

The results of the exploration programs carried out by the Nova Scotia Department of Mines and the Atlantic Development Board in the Malagash-Wallace area of Cumberland County, Nova Scotia, became available in 1967. A 71 foot evaporite section, averaging about 5 per cent K_2O equivalent, was encountered at a depth of nearly 4,000 feet.

WORLD REVIEW

Apart from the interruptions caused by the two World Wars and the cartel arrangements that flourished in the intervening years, world supply and demand for potash have traditionally been in balance. Between the late 1940s and early 1960s, the growth rate for both production and consumption averaged nearly 8 per cent annually. United States was the leading potash producer, followed by West Germany, East Germany, France and USSR. In the early 1960s the growth rate for consumption dropped as low as 2 per cent and then picked up sharply to over 11 per cent in 1965. In the same period, Canada emerged as a major producer and output from USSR increased considerably so that the average annual growth rate for world potash output increased to 10.6 per cent during 1962-65. World potash output in 1965 was 13.7 million metric tons, about 1.5 million metric tons greater than consumption. The effects of this imbalance became noticeable in 1966 as production continued to increase at a high level and prices weakened, particularly in North America. The imbalance between supply and demand lingered into 1967 and prices deteriorated further. While Canada, USSR, and East Germany to some extent, continued to increase their potash output, the severe competition forced some long-standing West European and United States producers to scale down production and to close some mines. In 1967, world potash production amounted to 15.5 million metric tons of K_2O equivalent, up 6.3 per cent from the previous year. Consumption in 1967 was an estimated 13.7 million metric tons.

TABLE 6

World Potash Production, 1966-67
('000 metric tons K_2O equivalent)

Country	1966	1967[p]
United States	3,012	2,993
USSR	2,540	2,800[e]
Canada	1,805	2,339
Germany, West	2,291	2,268
East	2,006	2,177
France	1,782	1,780
Spain	474	468
Israel	372	380
Italy	261	250
Chile (nitrate)	15	15
Total	14,558	15,470

Sources: U.S. Bureau of Mines, Mineral Industry Survey, Potash, April 1968; for Canada, Dominion Bureau of Statistics.

[p] Preliminary; [e] Estimated.

UNITED STATES

Potash production in United States decreased slightly in 1967 and further reductions are anticipated in 1968. In the Carlsbad, New Mexico, potash district, International Minerals & Chemical Corporation cutback on production by 50 per cent on July 1, 1967. In September, Duval Corporation suspended mining operations temporarily at one of its three mines and United States Borax & Chemical Corporation closed its mine in November. Although these cutbacks involve approximately 25 per cent of the mine capacity in the Carlsbad district, greater output from other producers in the area, together with moderate gains in Utah, will likely prevent total United States potash production from falling too sharply.

USSR

USSR potash production in 1967 amounted to an estimated 2.8 million metric tons, approximately double its output five years earlier. Potash is mined in three widely separated areas of USSR: near the towns of Solikamsk and Berezniki on the west side of the Ural Mountains, some 120 miles north of Perm; near the towns of Kalush and Stebnikov in the Carpathian Mountains of Ukranian SSR; and near Soligorsk, some 75 miles south of Minsk, Byelorussia (White Russian SSR). Although the mines in the Urals currently supply the largest part of USSR's potash output, the Soligorsk deposits are reported to be very large and could become the second largest producing area in the world, next to Saskatchewan. Development of the Soligorsk deposits began in 1958 with the first and second sections of No. 1 Combine beginning production in 1963 and 1964 respectively. The first and second sections of Soligorsk No. 2 Combine came on stream in 1965 and 1967. Construction is in progress for No. 3 Combine and a fourth is planned.

WEST GERMANY

Potash output in West Germany amounted to almost 2.3 million metric tons in 1967, down slightly from 1966 and from its record production in 1965.

Beginning in late 1966 and continuing into early 1967, temporary cutbacks were apparently made at a number of mines: production is expected to pick up again during the course of the next few years.

EAST GERMANY

In East Germany, potash production was raised slightly in 1967 through the adoption of new mining methods and new, high-capacity, trackless mining equipment at some of the mines near Erfurt, the centre of the industry. A new potash deposit was being developed near Magdeburg, some 85 miles north of Erfurt. The operation, scheduled to come on stream in 1970, is reportedly designed to mine 24,000 tons of potash rock daily, almost equal to one quarter of East Germany's current mining rate.

FRANCE

France's potash output remained at approximately the same level in 1967 as in recent years. Renewed efforts have been launched to rationalize mining operations being faced with dwindling reserves and to reorganize the entire industry in order that current production levels be maintained. The state-owned Mines Domaniales de Potasse d'Alsace (MDPA), which had controlled France's potash industry since World War II, was recently renamed Mines de Potasse d'Alsace and merged with another state-owned group to create a new holding organization, Enterprise Miniere et Chimique.

OTHERS

Potash production in Spain, Israel and Italy remained at nearly the same levels in 1967 as in 1966. Expansions underway in Spain and Israel will enable each of those countries to produce close to 600,000 metric tons of potash by 1970. Minor expansions are also underway in Italy.

Potash deposits are about to be exploited in a number of other countries. Compagnie des Potasses du Congo is being aided by funds from the European Investment Bank, The International Bank for Reconstruction and Development (World Bank) and Banque Nationale de Paris to develop an underground deposit near Saint Paul, Republic of Congo (Brazzaville) some 30 miles inland from the port at Pointe Noire. Part of the total $82 million US expenditure is for improved transportation facilities and a new wharf near Pointe Noire; production at a rate of 500,000 metric tons of potash annually is scheduled to begin in 1969. Elsewhere in Africa, preliminary investigations and development work have been conducted in the Donakil Depression of Ethiopia and in Morocco.

In South America, feasibility studies are continuing in hope of producing phosphate rock and potash in the Sechura desert of northern Peru. The potash is contained in near-surface brines.

In England, Charter Consolidated Ltd., of the Anglo-American group, and Imperial Chemical Industries Ltd. have formed a joint partnership known as Cleveland Potash Ltd. to proceed with development of the potash beds near Staithes, north Yorkshire. The $60 million US mine is expected to begin production in 1973 at an estimated rate of 1 million tons of potash products annually, thereby making Britain self-sufficient in potash. The potash beds, grading 26 to 30 per cent K_2O equivalent, are at a depth of almost 4,000 feet. Reserves have been estimated to be sufficient to keep the mine operating for a period of at least 15 years. Elsewhere in north Yorkshire, Whitby Potash, a subsidiary of Armour & Company, is conducting pilot studies in hope of establishing a potash solution-mine.

OUTLOOK

World production of potash is expected to increase moderately in 1968 and by the year-end one can anticipate a better balance between supply and demand as consumption continues at a fairly high level. This will be followed by a surge in output as new mines come on stream or reach full operating capacity in 1969 and 1970. A steadier growth rate in output, averaging just over 5 per cent annually, can be anticipated thereafter.

Canada is expected to become the world's leading potash producer in 1968, followed by USSR. These two countries will continue to outpace other producers with Canada providing nearly one third of the world's potash supply in the early 1970s.

PRICES

Metals Week of December 25, 1967 quoted the following United States prices: per short tons unit (20 lbs) K_2O contained, bulk, f.o.b. Carlsbad, New Mexico, Muriate 60% K_2O.

	June-Sept. 1967	Oct. 1967 -Jan. 1968	Feb.-May 1968
Standard	26¢	28¢	30¢
Coarse	29½	31	33½
Granular	32½	34½	36½
Sulphate, 50% K_2O			
Standard	70¢	75¢	80¢
Granular	78¢	83	88

f.o.b. Saskatchewan, Canada
(same quotes as f.o.b. Carlsbad – will equalize to Carlsbad delivery if it is cheaper).

The prices listed for standard, coarse, and granular muriate covering the period October 1967 to January 1968 average about 27.5 per cent below those quoted a year earlier.

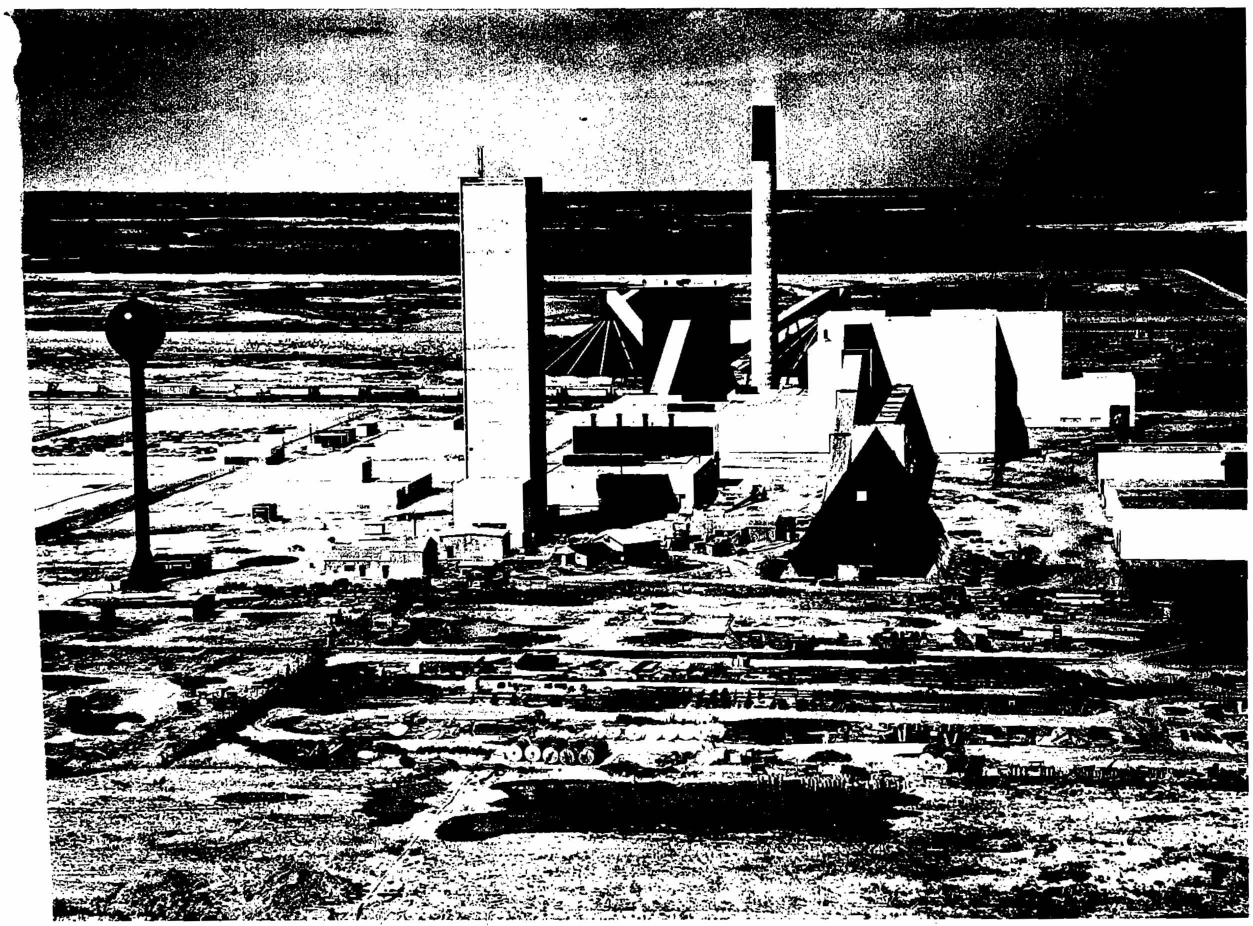
TARIFFS

	British Preferential	Most Favoured Nation	General
CANADA			
Potash, muriate and sulphate of crude; saltpetre or nitrate of potash	free	free	free
German potash salts and German mineral potash	free	free	free
Potassium chloride	free	free	25%
Potash, chlorate of, not further processed than ground	free	15%	20%

UNITED STATES

Potassium chloride or muriate of potash	free
Potassium sulphate	free
Potassium nitrate or saltpetre, crude	free

SKILFUL PLANNING: IMC's potash mine near Esterhazy, Saskatchewan, soon after it started production in April 1967. Development of the potash deposit by means of a tunnel from the company's original K-1 mine, six miles away, made it possible to commence production as soon as the shaft was completed early in the year.



Rare Earths

W.H. JACKSON*

The rare earths have a wide distribution in nature. Significant deposits, which are not economic under present conditions, are known in a number of countries. Minerals considered to be potential sources include euxenite, brannerite, priorite, pyrochlore, bastnasite, monazite, apatite and xenotime.

The common classification of the rare earths includes elements 57 to 71 inclusive, which are lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium and lutetium. The term 'rare earth elements' includes yttrium, element 39, as its chemistry is similar to that of the main group and from a geological viewpoint the occurrence is also the same. Some workers also include scandium, element 21. Of the rare earth elements, only promethium is not recovered from naturally-occurring minerals. It was detected in 1947 as a fission product of spent nuclear fuels and can be recovered from this source.

While separated compounds have a high unit value, ores and concentrates generally contain mixtures of the rare earths and these have a low value unless they contain significant amounts of yttrium or europium. The light rare earths are generally considered to be those from lanthanum to gadolinium and the heavy rare earths those of higher atomic number than gadolinium.

DOMESTIC INDUSTRY

Rare earth concentrate is a valuable byproduct of uranium mines in the Elliot Lake district of Ontario where recovery of uranium is followed by precipitation of the rare earth content from the barren solutions. The rare earths are in brannerite and monazite, which are some of the minerals present in the Elliot Lake ores. Output in 1966 was 20,724 pounds of contained yttrium oxide valued at $130,223. In 1967, production increased to 160,078 pounds valued at $1,689,864. There are no facilities in Canada for the separation of individual rare earths and all output is exported in the form of bulk concentrate having a relatively high content of yttrium oxide.

Rio Algom Mines Limited began production in 1965 followed by Stanrock Uranium Mines Limited in early 1966. In 1967, Denison Mines Limited began production and is now the largest producer of yttrium oxide in the world. Stanrock changed from bacterial leaching to a flooding technique for the recovery of uranium and has ceased recovery of rare earths. Future Canadian production is related to the level of uranium output in the Elliot Lake district and possibly that of the Agnew Lake district, about 40 miles to the east, where the uranium property of Agnew Lake Mines Limited is being developed.

Rare earths are also associated with uranium deposits in the Bancroft area of Ontario and at one deposit in British Columbia; the distribution of rare earth elements in these deposits is not known. Phosphorite formations in western Canada contain small quantities of rare earths and so does Florida phosphate imported into Canada for the production of phosphoric acid. Other potential sources include the rare earth content of apatite or pyrochlore associated with carbonatite rocks. Again, the distribution of rare

*Mineral Resources Branch.

earth elements is not known and there remains the problem of working out recovery methods and determining if markets exist for the particular rare earth mixture present in such sources.

Few laboratories are equipped to analyze samples containing rare earth elements. Assay results can be misleading as a guide to further work on a prospect or on the examination of possible byproduct sources unless the laboratory is provided with information on the mineralogy or chemistry of the test material.

WORLD INDUSTRY

Monazite contains both thorium and rare earths. The price paid for monazite is low as thorium must be removed in processing and there is little demand for it. Bastnasite contains no thorium and production from California is the main and increasing source of rare earth concentrate for world markets. Bastnasite ores are suitable for the recovery of the light rare earths in mixture or separately and especially for the recovery of europium. The main world source of yttrium is byproduct concentrate production from Canada. Yttrium and the heavy rare earths were also recovered from euxenite residues in the United States in 1967 by Metal Traders Inc.

Monazite production in 1967 in Malaysia and Nigeria, amounting to 1,060 tons and 114 tons respectively, was a byproduct of tin mining. Australian production, estimated at 2,000 tons a year, is a co-product of rutile and zircon recovery from beach sands. Production in Malagasy Republic declined by two thirds since 1965 to 410 tons in 1967. United States production is not published.

In 1967, Molybdenum Corporation of America produced 12,750 tons of rare earths in concentrate, about the same as in 1966, from its deposit at Mountain Pass, California. The bastnasite occurs in a carbonatite deposit and the ore, mined by open pit, grades 10 per cent rare earth oxides. Mill capacity is 25,000 tons of concentrate annually. The company processes its own requirements and sells concentrate to others. Its chemical plant produced 9,000 pounds of europium oxide compared with 11,400 pounds in 1966. Cerium hydrate, lanthanum hydrate and lanthanum carbonate circuits were installed at the chemical plant. A high-purity rare earth separation plant was built at Louviers, Colorado.

The Finnish producer, Typpi Oy, is still the only company recovering yttrium and europium from apatite but the feasibility of such processes is under consideration by processors of phosphate rock.

Other processors of rare earths buy concentrates on a negotiated basis. Processors of rare earths include: in the United States, Molybdenum Corporation of America, American Potash and Chemical Corporation, Michigan Chemical Corporation, Davison Chemical Co., and Research Chemical Co.; in Austria, Treibacher Chemische Werke Aktiengesellschaft; in France, Pechiney, Compagnie de Produits Chimiques et Electrometallurgiques; in Britain, New Metals and Chemicals Limited, London and Scandinavian Metallurgical Company, Johnson, Matthey and Co., Limited and Thorium Limited; in Finland, Typpi Oy; in West Germany, Th. Goldschmidt A.G. In Japan, Nippon Yttrium Company owned by Mitsui Mining and Smelting Co. and Tohoku Metal Company was producing yttrium by ion exchange but in 1967 acquired rights to a solvent extraction process from Pyrites Co. Inc.; the latter has subsequently been merged with Molybdenum Corporation. The USSR has its own deposits and processing plants. Output is sold through Techsnabexport. India and Brazil also have plants that produce rare earth chemicals.

Solvent extraction or solvent extraction followed by ion exchange are the means used to separate the various rare earth compounds of higher purity.

USES

Rare earth oxides, products of chemical extraction, are mainly used as mixtures in about the same proportions as they occur in concentrate. Mixtures are used in glass–polishing compounds, as catalysts in the petroleum industry, for the production of mischmetal, and as alloying agents in nodular iron, steel, and magnesium. Mischmetal has a stable use in lighter flints and Ronson Metals Corporation in the United States and Treibacher in Austria are the leading producers. The above uses are the main industrial uses in terms of tonnage but not in value.

The rare earths used in ceramics are cerium and praseodymium; neodymium and praseodymium are used to colour glass and lanthanum is a component of glass for camera lenses. Gadolinium and europium are used in control rods for nuclear reactors. Neodymium is found in lasers and also in capacitors along with lanthanum. Artificial garnets for microwave control contain gadolinium and yttrium.

The main market in terms of dollar value is for red phosphors in the form of yttrium-europium orthovanadate or oxysulphide. These compounds are used mainly in colour television tubes but also have application in mercury vapour lamps. Sales of television sets did not achieve anticipated growth rates in 1967. Also, there was improved efficiency in the use of phosphors. The result was basically a temporary oversupply for yttrium and europium compounds.

PRICES

Metals Week in December 1967 quoted a nominal value of $180 a long ton for monazite sand, c.i.f. United States ports. Bastnasite concentrates, f.o.b. California, were quoted at 30 cents a pound for material containing 55 to 60 per cent rare earth oxide and 35 cents a pound for a grade of 68 to 72 per cent. Mixed rare earth oxide from this source assaying 88 to 92 per cent was quoted at 45 cents a pound.

In general, a mixed concentrate commands a relatively low price and prices are subject to negotiation between buyer and seller. Concentrates high in rare earth elements in demand, mainly europium and yttrium, command higher prices but these would still be subject to negotiation. The grade of concentrate shipped by the Canadian uranium mines has not been published but it is high enough to command an average price of $10.05 a pound contained Y_2O_3.

Rare earth oxide suitable for glass polishes sell from US $0.75 to $1.50 a pound. Representative prices per pound for some oxides of 99.9 per cent purity include: $7.50 for cerium, $7.80 for lanthanum, $37.50 for neodymium, $55 for yttrium, $550 to $850 for europium. Metal prices, per pound, at the end of 1967 were quoted at $20 to $70 for cerium and lanthanum, $115 for neodymium, $160 for yttrium and $3,600 for europium. Mischmetal sells for $3.00 a pound.

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Roofing Granules

H.S. WILSON*

The consumption of roofing granules in Canada increased 8.9 per cent in 1967 to 145,737 short tons, valued at $3,869,403 million. The consumption of artificially-coloured granules increased 3.6 per cent in volume and 4.4 per cent in value over the 1966 values. The amount of naturally-coloured granules used increased 16.3 per cent in volume and 17.5 per cent in value. The consumption of slag granules increased by 2.8 per cent and 13.9 per cent in volume and value respectively.

The consumption of Canadian-produced granules was 79.7 per cent of the total amount of granules used in 1966 compared with 79.4 per cent in 1967. The Canadian-produced amount of naturally-coloured granules used increased from 82.6 per cent to 83.7 per cent while the amount of Canadian, artificially-coloured granules decreased from 77.7 per cent of the amount consumed in 1966 to 75.9 per cent in 1967. Of the slag granules consumed, 83.0 per cent was produced in Canada in 1967, compared with 80.7 per cent in 1966.

Table 1 shows the consumption in 1966 and 1967 by type and colour, and the consumption of domestic and imported granules. Table 2 shows granule consumption from 1954 to 1967, the total annual values, the average price per ton for each year and the percentage of granules consumed that were produced in Canada. Table 3 shows the average prices of naturally- and artificially-coloured granules, both domestic and imported, for 1966 and 1967. In all tables, the prices are f.o.b. consumer plants.

CANADIAN PRODUCERS

Manufacturers of roofing granules in Canada are located at Havelock, Ont., Montreal, Que., and Vancouver, B.C.

Minnesota Minerals Limited at Havelock crushes a trap rock (basalt) for production of granules and operates a colouring plant supplying a wide range of artificially-coloured granules. Crushing produces size ranges suitable for other applications as well – such as in highway construction and as a concrete aggregate.

Industrial Granules Ltd., of Montreal, the producer of a black slag granule, obtains the raw material, a waste slag, from steam-generating plants at Halifax, N.S. and Concord, New Hampshire, USA. The company also produces headlap granules from hornfels, an altered slate from St. Bruno, Que.

G. W. Richmond of Vancouver, B.C. produces granules from a slate.

ROOFING PLANTS

Six companies manufacturing roofing shingles in 15 plants in 1967 were located as follows:

Building Products of Canada Limited
Edmonton, Alta.
Montreal, Que.
Winnipeg, Man.

Canadian Gypsum Company, Limited
Montreal, Que.
Mont Denis, Ont.
St. Boniface, Man.
Vancouver, B.C.

Canadian Johns-Manville Company, Limited
Asbestos, Que.

Domtar Construction Materials Ltd.
Brantford, Ont.
Burnaby, B.C.
Lachine, Que.
Lloydminster, Alta.

*Mineral Processing Division, Mines Branch.

TABLE 1

Consumption*

	1966		1967	
	Short tons	$	Short tons	$
Consumption				
By kind				
Artificially coloured	78,159	2,516,535	80,953	2,626,672
Naturally coloured	55,698	1,057,404	64,784	1,242,731
Total	133,857	3,573,939	145,737	3,869,403
By colour				
Black and grey-black	55,159	1,164,592	64,088	1,327,721
Grey	21,951	402,170	22,321	487,621
White	21,948	860,139	21,338	741,723
Green	17,799	607,636	18,964	682,041
Red	6,503	187,919	6,900	212,870
Brown and tan	6,468	194,105	7,514	233,080
Blue	2,289	96,945	2,788	121,003
Buff	801	28,214	566	21,299
Turquoise	342	14,786	311	13,630
Coral, cream and yellow	325	9,844	325	10,153
Not differentiated	272	7,589	622	18,262
Total	133,857	3,573,939	145,737	3,869,403
Canadian-produced				
Artificially coloured	60,697	1,851,128	61,459	1,858,250
Naturally coloured	46,034	843,586	54,231	1,010,073
Total	106,731	2,694,714	115,690	2,868,323
Imported, United States				
Artificially coloured	17,462	665,407	19,494	768,422
Naturally coloured	9,664	213,818	10,553	232,658
Total	27,126	879,225	30,047	1,001,080

*Values calculated from figures supplied by consumers.

Iko Asphalt Roofing Products Limited
Brampton, Ont.
Calgary, Alta.

The Philip Carey Company Ltd.
Lennoxville, Que.

TABLE 2

Consumption 1954-67

	Total Tons	Total Dollars	Average Price $/ton	Canadian Percent-age
1967	145,737	3,869,403	26.55	79.4
1966	133,857	3,573,857	26.70	79.7
1965	127,066	3,409,421	26.83	76.9
1964	140,890	3,852,704	27.35	73.9
1963	125,909	3,392,354	26.94	68.8
1962	125,463	3,476,875	27.71	59.5
1961	123,486	3,286,670	26.62	35.8
1960	113,826	2,962,363	26.03	44.7
1959	138,758	4,182,615	30.14	37.1
1958	134,565	4,509,638	31.82	29.8
1957	110,543	3,405,655	30.90	29.8
1956	133,691	3,884,961	29.20	25.0
1955	147,877	4,087,668	27.70	18.3
1954	133,917	3,563,578	26.61	19.0

TABLE 3

Average Granule Prices
($ per short ton)

	Canadian		Imported	
	1966	1967	1966	1967
Naturally coloured				
Rock	17.80	18.47	18.61	18.38
Slag	20.66	22.89	24.95	24.71
Slate	19.89	17.32	–	–
Artificially coloured				
Black and grey-black	22.05	23.62	32.99	36.97
Grey	26.02	33.56	29.39	30.86
White	39.00	30.88	39.58	41.32
Green	32.43	34.48	40.10	41.19
Red	27.30	28.69	34.62	36.74
Brown and tan	28.59	29.64	36.42	36.57
Blue	40.12	41.24	46.50	49.02
Buff	33.79	36.57	39.53	39.75
Turquoise	38.04	39.26	48.31	49.26
Coral, cream and yellow	28.97	31.24	41.62	–
Not differentiated	–	30.49	29.70	27.90
Average	28.82	29.88	35.56	36.06

– Nil.

Salt

D.H. STONEHOUSE*

A major increase in rock salt shipments from the two Ontario producers resulted in the total salt production for 1967 reaching a record high level. At 5.3 million tons, shipments were 18 per cent over those of 1966. Over 86 per cent of production came from Ontario plants; Nova Scotia operations accounted for about 9 per cent. Rock salt which accounted for approximately 57 per cent of the total volume recorded a 38 per cent increase. Production of fine vacuum salt remained nearly constant (10 per cent of total volume), as did the production of salt from brines (33 per cent of total volume).

Imports of salt have shown consistent increases each year and rose by 11 per cent in volume and 18 per cent in value during 1967. The value of exports increased by 65 per cent, entirely because of an increase in shipments of salt to the United States. The extraordinary increase in shipments to the United States was mainly because snow and ice conditions in some northern states were so severe during the winter of 1966-67 that inventories of ice control salt for highways were reduced greatly and had to be re-stocked during 1967. There is also a growing acceptance of rock salt for ice and snow removal.

Available consumption data indicate that many minor salt-consuming industries have used increased amounts of salt during recent years. However, the largest single consuming centre, the chemical industry, showed decreased salt consumption during 1965. The exact amount of salt used for de-icing purposes is not known; the estimated 750,000 tons is conservative.

PRODUCERS

ONTARIO

Thick salt beds underlie the southwestern section of Ontario between Kincardine and Amherstburg at various depths from 800 feet to 1,800 feet. Exploitation of this resource through two rock salt mining operations and a number of brine-well operations has permitted Ontario to maintain its position as the leading salt-producing province.

The Canadian Rock Salt Company Limited, mines rock salt from the 980-foot horizon at Ojibway, Ontario. The company operates two shifts a day, five days a week producing about 4,000 tons per shift. A room and pillar mining method is used in which rooms 50 feet wide and up to 20 feet high enable a 56 per cent extraction. The use of diesel-powered front-end loaders, telescopic shuttle trucks, universal undercutters, hydraulically powered drills and other, more conventional mining equipment has permitted a fast and steady work cycle to be maintained. Recent additions to the facilities at Ojibway include a package warehouse, tertiary crushing and screening equipment and additional electronic sorting equipment.

At Goderich, Ontario, Domtar Chemicals Limited, Sifto Salt Division, operates a rock salt mine at a depth of 1,760 feet. Extraction is by room and pillar methods using diesel-operated loading and hauling equipment including a six cubic yard, articulated, front-end loader, and a number of 25-ton rock-wagons. Roof conditions in the mine warrant a steady program of roof-bolting for which a new rock-bolting machine was purchased during the year. Bolts up to 14 feet in length can be set. Production through the underground screening plant is at the rate of 400 tons per hour.

Salt is recovered from brining operations at four centres – Goderich, Sarnia, Amherstburg and Sandwich, a suburb of Windsor. At Goderich, Domtar Chemicals Limited operates brine wells for the production of fine evaporated salt. Caustic soda and

*Mineral Processing Division, Mines Branch.

TABLE 1

Salt – Production and Trade, 1966-67

	1966		1967p	
	Short Tons	$	Short Tons	$
Production (shipments)				
By type				
Fine vacuum salt	571,497	10,340,434	. .	. .
Mine rock salt	2,180,671	10,745,140	. .	. .
Salt content of brines used or shipped	1,739,866	2,760,614	. .	. .
Total	4,492,034	23,846,188	5,301,958	28,622,306
By provinces				
Ontario	3,782,191	15,243,719	4,579,913	20,240,156
Nova Scotia	474,981	4,724,993	470,950	4,152,500
Alberta	122,814	1,772,947	134,150	1,911,650
Saskatchewan	84,979	1,443,635	91,145	1,671,000
Manitoba	27,069	660,894	25,800	647,000
Total	4,492,034	23,846,188	5,301,958	28,622,306
Imports				
Total, salt and brine				
Mexico	220,841	302,000	234,382	345,000
United States	174,634	1,330,000	208,104	1,716,000
Bahamas	76,405	304,000	79,520	328,000
Spain	35,133	134,000	43,244	173,000
Jamaica	2,496	45,000	1,748	8,000
Britain	39	3,000	14	1,000
Total	509,548	2,118,000	567,012	2,571,000
Exports				
United States	. .	3,371,000	. .	5,779,000
Jamaica	. .	98,000	. .	81,000
Leeward and Windward Islands	. .	23,000	. .	18,000
New Zealand	. .	24,000	. .	13,000
Bermuda	. .	10,000	. .	9,000
Guyana	. .	26,000	. .	6,000
Other countries	. .	36,000	. .	20,000
Total	. .	3,588,000	. .	5,926,000

Source: Dominion Bureau of Statistics.
p Preliminary; . . Not available.

chlorine are produced by Dow Chemical of Canada, Limited at Sarnia from brine obtained from company-owned wells. Allied Chemical Canada, Ltd. recently expanded its facilities at Amherstburg where the company produces soda ash, industrial salt, calcium chloride and other chemicals utilizing local limestone and salt recovered from brine. At Sandwich, The Canadian Salt Company Limited produces a fine evaporated salt from brine, and Canadian Brine Limited exports brine across the Detroit River via pipelines to a chemical plant in Detroit. Fused salt is produced at the Sandwich plant of The Canadian Salt Company Limited.

NOVA SCOTIA

The Canadian Rock Salt Company Limited operates a rock salt mine at Pugwash where a dome-like body of salt is worked by room and pillar methods from the 630-foot horizon. Rooms up to 40 feet in width and 30 feet in height have been opened, and in some sections benching has nearly doubled the original

TABLE 2

Salt – Production and Trade, 1958-67
(short tons)

	Production[1]	Imports	Exports	
			Tons	$
1958	2,375,192	340,887	906,707[2]	. .
1959	3,289,976	369,967	1,274,077	4,639,522
1960	3,314,920	191,940	. .	3,461,366
1961	3,246,527	199,365	. .	2,829,138
1962	3,638,778	245,836	. .	3,987,668
1963	3,721,994	332,581	. .	3,701,356
1964	3,988,598	405,574	. .	3,618,569
1965	4,584,096	441,601	. .	4,996,509
1966	4,492,034	509,548	. .	3,588,000
1967p	5,301,958	567,012	. .	5,926,000

Source: Dominion Bureau of Statistics.
[1] Producers' shipments. [2] Adjusted to include salt content of brine, estimated at 500,000 tons, exported to the United States during 1958.
pPreliminary; . .Not available.

TABLE 3

World Production of Salt
('000 short tons)

	1966
United States	36,463
China	14,300e
USSR	10,500e
Britain	8,105
West Germany	7,117
India (including Goa)	4,909
France	4,630
Canada	4,492
Italy	3,900
Other countries	28,554
Total	122,970

Source: U.S. Bureau of Mines Minerals Yearbook, 1966.
e Estimated.

height of the rooms. Salt mined at the rate of 1,200 to 1,500 tons per day is beneficiated on surface and shipped for use mostly on highways in Quebec, the Maritimes and the northeastern United States. Brine, made on surface from mined rock salt, is used to produce fine evaporated salt through multiple stage, vacuum pan evaporation at the same plant site.

At Nappan, Domtar Chemicals Limited, Sifto Salt Division produces fine evaporated salt from brine which is recovered from depths of 1,100 to 1,800 feet.

Exploration for salt in the Port Hawkesbury area was conducted during 1967 by three major chemical-producing companies. The results of diamond drilling indicate the presence of large amounts of salt, but no company has as yet announced a possible production method.

PRAIRIE PROVINCES

The Canadian Salt Company Limited operates fine evaporated salt plants at Neepawa, Manitoba, and at Lindbergh, Alberta, each producing from natural brine occurring at depth. Each plant produces a number of grades of salt for domestic markets, for livestock and for use on highways. At Lindbergh, production of a high-purity, fused, coarse salt has been doubled with the installation of an additional reverberatory furnace. Domtar Chemicals Limited, Sifto Salt Division, produces fine evaporated salt from brine at Unity, Saskatchewan, where facilities for making fused salt products are operated also. Western Chemicals Ltd. of Calgary makes caustic soda, chlorine and hydrochloric acid at Duvernay, Alberta, using brine from company wells. A new operation at Brandon, Manitoba, by Dryden Chemicals Limited will produce chlorine, caustic soda, soda ash, muriatic acid and sodium chlorate from brine pumped from salt deposits beneath the plant site.

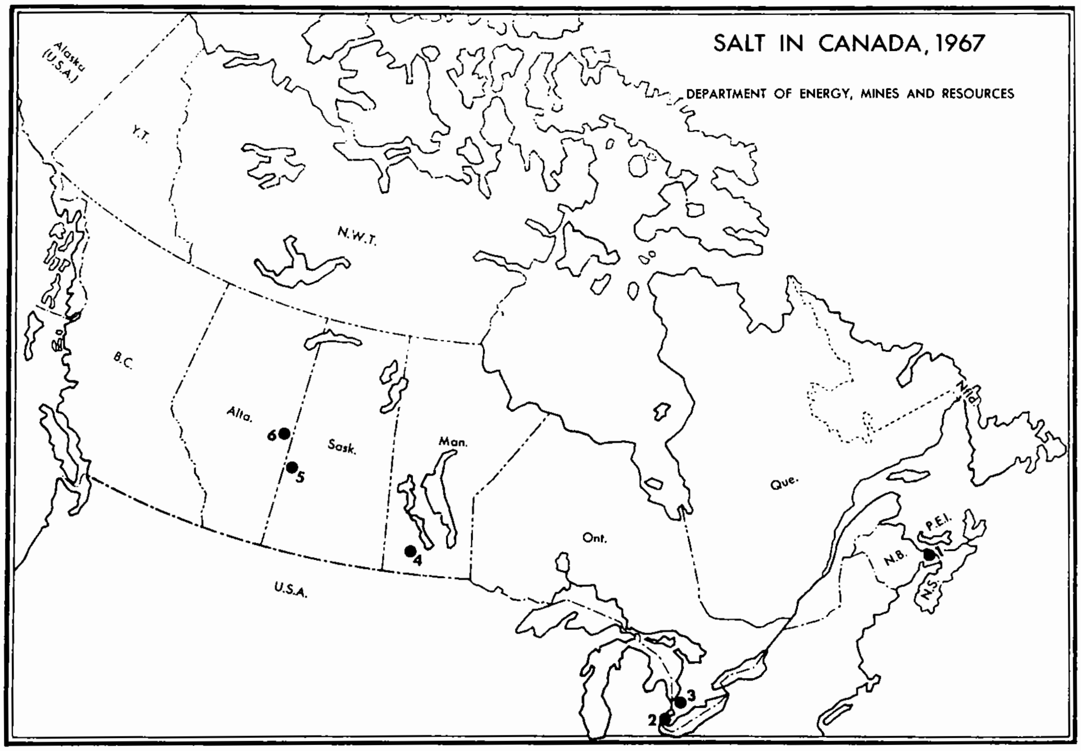
Domtar Chemicals Limited, Sifto Salt Division announced in July, 1968 that the plant at Unity, Saskatchewan would be expanded in two stages, the first to be completed in late 1969, to permit an annual output of more than 200,000 tons.

A new development, announced in June, 1968 by The Canadian Salt Company Limited, will produce fine evaporated salt at Belle Plaine, Saskatchewan by 1969. Sodium chloride in both brine and solid form will be carried via a mile-long pipeline from the potash operation of Kalium Chemicals Limited to the new plant site where production capacity will be 200,000 tons per year. The Neepawa plant will be phased out.

OTHER OCCURRENCES

Salt is known to occur at depth in the Mabou-Port Hood area of Inverness County, Nova Scotia; the Port Malcolm and Port Richmond areas of Richmond County, Nova Scotia; near Antigonish in Antigonish County, Nova Scotia; under Hillsborough Bay, Prince Edward Island; in the area south of Moncton, New Brunswick; under large areas of southwestern Manitoba, central Saskatchewan and northeastern Alberta; immediately north of Great Slave Lake; and near Norman Wells in the District of Mackenzie.

Brine springs are plentiful in southwestern Newfoundland, north-central Nova Scotia, the Sussex area



EVAPORATOR PLANTS

(numbers refer to numbers on map)

1. Domtar Chemicals Limited, Sifto Salt Division, Nappan , N.S.
   The Canadian Rock Salt Company Limited, Pugwash, N.S.
2. The Canadian Salt Company Limited, Sandwich, Ont.
   Allied Chemical Canada, Ltd. Amherstburg, Ont.
3. Domtar Chemicals Limited, Sifto Salt Division, Goderich, Ont.
4. The Canadian Salt Company Limited, Neepawa, Man.
5. Domtar Chemicals Limited, Sifto Salt Division, Unity, Sask.
6. The Canadian Salt Company Limited, Lindbergh, Alta.

FUSION PLANTS

2. The Canadian Salt Company Limited, Sandwich, Ont.
5. Domtar Chemicals Limited, Sifto Salt Division, Unity, Sask.
6. The Canadian Salt Company Limited, Lindbergh, Alta.

MINES

1. The Canadian Rock Salt Company Limited, Pugwash, N.S.
2. The Canadian Rock Salt Company Limited, Ojibway, Ont.
3. Domtar Chemicals Limited, Sifto Salt Division, Goderich, Ont.

of New Brunswick, southwestern Manitoba and northeastern Alberta, on Vancouver and Saltspring Islands in southwestern British Columbia and at Kwinitsa, east of Prince Rupert, British Columbia.

USES

Salt is the most common and the least expensive source of sodium and chlorine for the manufacture of chemicals containing these elements. There are 11 primary chemicals made directly from salt, and most of these are used to make large numbers of other chemicals for direct use or for use in manufacturing processes. Approximately 90 per cent of the salt used for production of chemicals is used to make chlorine and caustic soda. Much of the salt used for the manufacture of chemicals is used as brine. The Canadian output of chlorine has risen steadily over recent years and during 1967 reached a record high. According to the Chlorine Institute, Canadian capacity is now about 2,280 tons per day and is expected to increase by 20 per cent during 1968. Such plants as Hooker Chemicals Limited of North Vancouver and Interprovincial Co-Operatives Limited of Saskatoon and Regina have increased output, and new operations have been started at Brandon, Manitoba, and at Fort Saskatchewan, Alberta by Dryden Chemicals Limited and Dow Chemical of Canada, Limited respectively. A three-company merger will produce chlorine and caustic soda in the Port Hawkesbury area in Nova Scotia. The main market for caustic soda and chlorine is the pulp and paper industry.

TABLE 4

Available Data on Consumption of Salt in Specified Canadian Industries, 1964 and 1965
(short tons)

	1964	1965
Industrial chemicals	1,895,107	1,043,398
Slaughtering and meat packing	58,756	58,894
Food processing	61,836	63,655
Starch, glucose, malt	11,976	13,013
Breweries	580	682
Pulp and paper	67,812	65,307
Leather tanneries	7,059	7,424
Soaps and cleaning compounds	2,375	2,782
Dyeing and finishing textiles	1,547	1,663
Artificial ice	212	208
Snow and ice control	750,000[e]	750,000[e]
Fishing industry	75,000[e]	75,000[e]

Source: Dominion Bureau of Statistics except for estimates which are made by the Mineral Processing Division.
[e] Estimated.

The removal of ice and snow from winter highways has become necessary in most of our industrialized areas, and the use of rock salt or compressed evaporated salt for this purpose has become widely accepted in sections of Canada where climatic conditions warrant such use. However, the use of salt as a soil stabilizer for highway construction has not received as much attention in Canada as in sections of the United States.

Considerable quantities of salt are used in food processing operations such as bakeries, canneries and dairies. Meat packers, tanners and manufacturers of casings use significant amounts in their products, as does the textile industry where it is used for fixing dyes. Considerable quantities are used in animal feeds, in refrigeration, in water softener regeneration and as stock salt.

TECHNOLOGY

Salt occurs either in solid form as rock salt, or in solution as a brine. Under conditions favourable to evaporation, soluble salts are crystallized and deposited from saturated solutions. Sodium chloride deposits several thousand feet thick have been formed from sea-waters under lagoonal conditions. Calcium carbonate and sulphates are often associated with the sodium chloride, and where the evaporation was carried to completion, magnesium and potassium salts were formed.

Some deposits have been formed by evaporation of waters containing salts leached from surrounding material. These playa deposits can contain a considerable quantity of carbonate, sulphate and boron.

Because of plastic qualities exhibited when under great pressure, salt bodies can be deformed – dome structures are a result of such action.

In Canada, salt production is realized from mining underground deposits, from brining such deposits and from processing natural brine. Mining operations employ room and pillar methods and heavy equipment to remove and process large amounts of salt at low cost. The depth at which a mine is operated, and conditions peculiar to specific mines, determine room and pillar sizes. Rooms vary from 30 to 60 feet in width and from 18 to 50 feet in height. Brining operations consist of circulating water through an underground cavity in a salt deposit and recovering the brine for evaporation on surface, usually in a vacuum-pan installation. One Canadian producer uses the waste fines and scalped material from its rock-salt operation to produce a brine under controlled conditions. The brine is then put through a vacuum-pan evaporation cycle and fine evaporated salt is recovered.

Market requirements dictate whether rock salt or evaporated salt is used and what quality and screen size is acceptable. Rock salt is normally crushed,

TARIFFS

	British Preferential	Most Favoured Nation	General
CANADA			
Fishery salt	free	free	free
Bulk salt	free	3% per 100 lb	5% per 100 lb
Salt in bags, barrels, etc.	free	3.5% per 100 lb	7.5% per 100 lb
Table salt	5%		
UNITED STATES			
Bulk salt	1.7% per 100 lb		
Salt in bags, barrels, etc.	3.5% per 100 lb		
Salt in brine	10% ad val.		

screened and shipped in bulk or in sacks. Rock-salt fines can be compacted to yield a greater recovery of coarser sizes. Some fine evaporated salt is compressed into blocks, licks or briquettes, the last being crushed and sized for specific applications. Various additives are included during processing as required, to provide iodine, cobalt and antiset material.

The association of various amounts of gypsum, anhydrite and limestone with rock salt in some deposits makes necessary some process of beneficiation. Taking advantage of the lesser friability of the impurities, it is common to scalp off coarser fractions after secondary crushing of coarse mine feed. Recent advances in the fields of electronic scanning and thermoadhesive separation have made the application of such devices practical for use in upgrading coarse rock-salt output for certain markets demanding high purity.

Studies have been performed by the Ontario Department of Highways over a 19-month period, to determine the effectiveness of corrosion inhibitors in salt used on highways. Results indicated that salt is the most efficient and most economical material for control of ice and snow on highways and that inhibitors tested did not arrest the corrosion caused by salt to any appreciable degree.

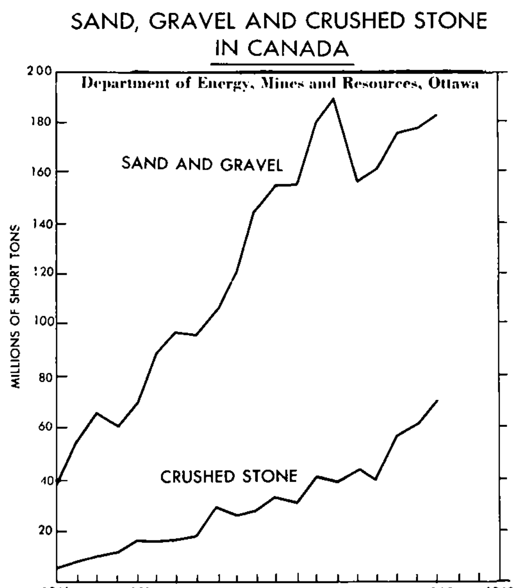
The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Sand, Gravel and Crushed Stone†

F.E. HANES*

The estimated** production of sand and gravel and crushed stone in 1966 amounted to 267,070,000 short tons and $206,230,000, increases of approximately 5.3 and 5.1 per cent respectively over the 1965 production figures.

The estimates made for the 1965 total sand, gravel and crushed stone materials during 1964 were conservative in all categories both in volume and value. This was particularly true for the statistics involving the crushed stone product for which the estimated values in 1965 were between 5 and 6 per cent less than the ultimate final values shown in Table 1. Crushed stone estimates have been calculated by using the percentage increase of structural materials estimated for 1966 compared with 1965; based on the final revised value for 1965 this percentage amounted to 6.35. In view of the increased activity in construction during 1966 preparatory to Expo 67 and other major construction involving road and dam building, crushed stone materials are expected to increase by 6 to 8 per cent over 1965 figures. The volume and value of crushed stone estimated for 1966, based on the more optimistic rate of increase of 8 per cent, will be 76,140,000 short tons and $80,460,000. The production of sand and gravel estimated by the same method used in 1965 will be 190,930,000 short tons and $125,770,000. It is evident that for similar reasons given for estimates of crushed stone, estimates for sand and gravel will be conservative, particularly for volume. Demand for fill and base course materials will be great with increased amounts of low-value per ton material being used.



*Mineral Processing Division, Mines Branch.
**Values estimated by the author based on values for construction supplied by the Dominion Bureau of Statistics.
†This is a reprint of the 1966 review, subsequent information is not available.

The total production of structural materials, minerals, stone, sand and gravel and the construction industries in Canada all show marked increases over 1965 values. Total structural materials increased 8.2 per cent from $434.2 million in 1965 to a preliminary value of $469.6 million in 1966. The total mineral industry increased by 6.9 per cent. Both volume and value increases in 1966 over 1965 for total stone production amounted to 4 and 5.1 per cent. Figures for total sand and gravel production in 1966 have increased substantially compared with the 1965 production.

The estimated value of total construction in 1966 amounting to 11,199 million dollars is a 14.3 per cent increase over the 1965 value of $9,806 million.

Table 1 shows the final volume and value figures for 1964 and 1965 by location and type.

TABLE 1

Sand, Gravel and Crushed Stone

	1964		1965	
	Short Tons	$	Short Tons	$
Production				
By provinces				
Sand and Gravel				
Newfoundland	4,431,349	3,370,310	4,063,734	3,684,891
Prince Edward Island	608,923	481,283	412,064	374,081
Nova Scotia	6,471,709	4,186,112	6,574,387	4,498,803
New Brunswick	4,630,700	2,598,603	4,491,514	2,594,846
Quebec	39,542,804	19,981,840	40,507,369	19,583,351
Ontario	69,747,691	50,584,294	75,082,026	55,297,474
Manitoba	9,453,260	6,793,687	9,757,104	6,767,068
Saskatchewan	9,071,905	5,707,387	8,570,008	5,615,794
Alberta	16,048,992	12,898,083	13,163,941	10,661,383
British Columbia	18,457,949	10,795,465	20,484,706	12,662,016
Total	178,465,282	117,397,064	183,106,853	121,739,707
Crushed Stone				
Newfoundland	102,655	274,546	163,000	406,703
Prince Edward Island	350,000	350,000	225,306	225,306
Nova Scotia	318,250	477,425	165,730	345,921
New Brunswick	2,954,130	2,538,614	2,001,670	2,331,606
Quebec	35,582,483	37,587,412	42,119,022	41,052,148
Ontario	21,475,168	24,617,291	22,198,449	26,364,747
Manitoba	617,014	536,193	598,552	556,133
Saskatchewan	—	—	—	—
Alberta	112	520	1,008	1,425
British Columbia	1,522,692	1,647,091	3,032,052	3,165,706
Total	62,922,504	68,029,092	70,504,789	74,449,695
Total Sand and Gravel and Crushed Stone				
Newfoundland	4,534,004	3,644,856	4,226,734	4,091,594
Prince Edward Island	958,923	831,283	637,370	599,387
Nova Scotia	6,789,959	4,663,537	6,740,117	4,844,724
New Brunswick	7,584,830	5,137,217	6,493,184	4,926,452
Quebec	75,125,287	57,569,252	82,626,391	60,635,499
Ontario	91,222,859	75,201,585	97,280,475	81,662,221
Manitoba	10,070,274	7,329,880	10,355,656	7,323,201
Saskatchewan	9,071,905	5,707,387	8,570,008	5,615,794
Alberta	16,049,104	12,898,603	13,164,949	10,662,808
British Columbia	19,980,641	12,442,556	23,516,758	15,827,722
Total	241,387,786	185,426,156	253,611,642	196,189,402

TABLE 1 (con't)

	1964		1965	
	Short Tons	$	Short Tons	$
By Type				
Sand and Gravel				
For roads (roadbed surface)	98,252,618	52,313,693	93,370,062	49,954,863
Concrete aggregate	20,466,247	19,023,517	27,028,097	24,085,180
Asphalt aggregate	5,576,891	5,291,028	4,766,590	4,482,596
Railroad ballast	5,893,168	2,527,492	4,162,023	1,700,212
Mortar sand	1,596,487	1,287,984	2,362,725	1,966,241
Total	131,785,411	80,443,714	131,689,497	82,189,092
Crushed Gravel				
For roads (roadbed surface)	33,611,515	24,092,967	36,724,584	24,329,274
Concrete aggregate	6,277,569	7,587,276	6,592,767	8,887,195
Asphalt aggregate	2,947,496	2,378,125	2,902,775	2,544,793
Railroad ballast	1,790,249	1,239,869	2,224,443	1,685,542
Other Uses	2,053,042	1,655,113	2,972,787	2,103,811
Total	46,679,871	36,953,350	51,417,356	39,550,615
Total Sand, Gravel and Crushed Gravel	178,465,282	117,397,064	183,106,853	121,739,707
Crushed Stone				
Concrete aggregate	19,300,500	21,869,957	14,835,012	17,123,787
Railway ballast	2,612,650	2,398,781	2,809,888	3,266,572
Road metal	34,300,682	35,993,846	44,676,576	44,829,304
Rubble and riprap	1,359,265	1,484,109	2,201,138	2,779,032
Terrazzo, stucco and artificial stone	87,749	1,068,354	154,507	1,071,993
Other Uses	5,261,658	5,214,045	5,827,668	5,379,007
Total	62,922,504	68,029,092	70,504,789	74,449,695
Total Sand, Gravel, Crushed Gravel and Crushed Stone	241,387,786	185,426,156	253,611,642	196,189,402

Both Ontario and British Columbia report large increases in the production of sand and gravel. Nova Scotia, Manitoba and Quebec also had increases in volume of production, however only Nova Scotia reported an increase in value. Newfoundland marketed 8.4 per cent less sand and gravel but did so at a higher value per ton. Alberta's production was greatly reduced while Prince Edward Island, New Brunswick and Saskatchewan were all slightly lower both in volume and value.

Crushed stone production in Newfoundland, Quebec, Ontario, Alberta and British Columbia was reported to have increased both in volume and value; the remaining provinces, with the exception of Manitoba, reported losses in both volume and value. Manitoba improved its dollar per ton value although its production was down about 3 per cent.

Natural sand and gravel concrete aggregate and mortar sand products showed marked increases in volume and value in 1965 compared with 1964. Sand and gravel used in 1965 for road construction was approximately 5 per cent lower in volume and value. Decreases of 28 per cent in volume and 33 per cent in value for railroad ballast and decreases of between 1 and 2 per cent in volume and value for material used for asphalt mixes were reported.

Crushed gravel was used in increased volumes at increased values in all categories in 1965 compared with 1964 with one exception; a decreased volume of aggregate for asphalt mixes was reported in 1965.

Crushed stone aggregate for road construction was used in greater volume (30 per cent) and at increased value (25 per cent) in 1965 compared with 1964. Only a slight increase in volume of crushed stone was used for railroad ballast but its value was greatly increased. Crushed stone for use in concrete decreased approximately 25 per cent in volume and almost 22 per cent in value for the same period. Terrazzo chips, including stucco dash and material for use in the manufacture of artificial stone almost doubled production but remained unchanged in value.

IMPORTS AND EXPORTS

Table 2 shows the 1966 volume of imports to be relatively unchanged compared with 1965 with an increase in value of 5 per cent. Exports increased in volume by 3.6 per cent and 16.9 per cent in value in 1966 compared with 1965.

TABLE 2

Imports and Exports — Sand, Gravel and Crushed Stone

	1965		1966p	
	Short Tons	$	Short Tons	$
Imports				
Sand and Gravel	570,977	682,701	566,800	741,000
Crushed stone, including stone refuse	1,493,439	3,493,404	1,442,348	3,638,000
Total	2,064,416	4,176,105	2,009,148	4,379,000
Exports				
Sand*	637,058	849,045		
Gravel*	50,883	26,448	700,255	928,000
Crushed limestone and refuse	1,098,073	1,576,949	1,150,169	1,939,000
Total	1,786,014	2,452,442	1,850,424	2,867,000

p Preliminary; * Not available as separate classes after 1965.

Selenium and Tellurium

A.F. KILLIN*

SELENIUM

Selenium occurs sparsely disseminated throughout the earth's crust in a wide variety of selenium-bearing minerals. None of these minerals occurs in sufficient concentration to allow commercial exploitation for their selenium content alone and all production is derived as a byproduct of copper and lead refining.

Non-communist world production is distributed among the copper-refining nations including United States, Canada, Japan, Australia, Belgium and Luxembourg, Finland, Mexico, Zambia, Peru and Sweden. There is also production in the U.S.S.R. and other communist nations. United States, Canada and Japan are the major producers outside the communist bloc and rank in that order. Because of the metal's byproduct relationship to copper, supply tends to vary with fluctuations in copper production and not in response to demand. This limiting factor on the availability of selenium has tended to discourage research into new and expanded uses.

Canada's selenium production in 1967 was 752,221 pounds valued at $3,467,155, an increase of 176,739 pounds and $676,068 from 1966. Domestic consumption is approximately 15,000 to 20,000 pounds a year; the balance is exported or stockpiled. Britain and United States are the major export markets for Canadian selenium, absorbing 92 per cent of the total exported. Selenium is well established in its present uses and since new uses are slow in development, no sudden change is expected in the pattern of consumption and trade.

Canadian Copper Refiners Limited at Montreal East, Quebec, operates Canada's largest selenium recovery plant. The company's refinery treats anode copper from the Noranda smelter of Noranda Mines Limited and the Murdochville smelter of Gaspé Copper Mines, Limited, both in Quebec, and blister copper from the smelter of Hudson Bay Mining and Smelting Co., Limited at Flin Flon, Manitoba. The selenium plant can produce commercial grade metal (99.5% Se), high-purity metal (99.9% Se) and a great variety of metallic and organic selenium compounds. Annual capacity is 450,000 pounds of selenium in metals and salts.

The 270,000-pound-a-year selenium recovery plant of The International Nickel Company of Canada, Limited at Copper Cliff, Ontario, treats tankhouse slimes from the company's Copper Cliff copper refinery and its Port Colborne, Ontario, nickel refinery. The marketable product is a minus 200-mesh selenium powder (99.5%).

*Mineral Resources Branch.

TABLE 1

Selenium – Production, Exports and Consumption, 1966–67

	1966		1967P	
	Pounds	$	Pounds	$
Production				
All forms[1]				
Quebec	342,151	1,659,432	517,425	2,328,400
Ontario	111,000	538,350	133,300	646,500
Saskatchewan	61,513	298,338	54,631	264,960
Manitoba	60,818	294,967	46,865	227,295
Total	575,482	2,791,087	752,221	3,467,155
Refined[2]	546,085		754,360	
Exports (metal)				
United States	266,400	1,872,000	266,500	1,405,000
Britain	272,300	1,577,000	229,600	1,431,000
Argentina	11,700	53,000	10,100	48,000
Brazil	11,300	50,000	6,300	28,000
Spain	6,500	29,000	5,800	30,000
Australia	4,900	19,000	4,800	21,000
Other countries	15,000	76,000	16,300	77,000
Total	588,100	3,676,000	539,400	3,040,000
Consumption (selenium content)	20,533		22,370[3]	

Source: Dominion Bureau of Statistics.

1. Recoverable selenium content of blister copper treated at domestic refineries, plus refined selenium from domestic primary materials. 2. Refinery output from all sources. 3. Producers' domestic shipments, refined selenium.

PPreliminary.

Consumption and Uses

Selenium is used in the glass, rubber, chemical, steel and electronics industries. Development of the dry-plate rectifier during World War II brought about a sharp increase in the demand for selenium that persisted into the post-war period. Selenium prices rose to such an extent that substitution in all applications took place and subsequently the demand and price for selenium declined. Stable prices and the efforts of the Selenium and Tellurium Development Association have gradually built up new markets and recaptured some of the lost markets. Sales and consumption have increased and steady growth in demand is forecast.

Canadian consumption of selenium in 1967 was 22,370 pounds of which approximately half was in the manufacture of glass; the rest was in the rubber, electronics, steel and pharmaceutical industries.

Selenium is used in glassmaking both as a decolourizer and as a colouring agent. Small quantities of selenium added to the glass batch help to neutralize the green colour imparted by iron in the glass sand. The brilliant red, ruby glass used in stop lights, signal lights, automotive taillights, marine equipment and decorative tableware, is produced by adding larger quantities of selenium to the glass batch. The ceramics and paint industries use selenium as a pigment to obtain colours from orange to dark maroon and in the colouring of inks for printing on glass containers.

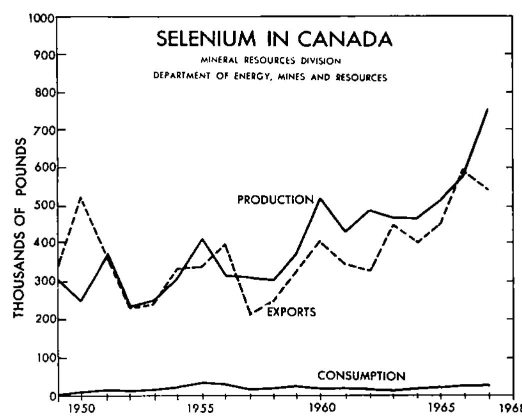


TABLE 2

Selenium – Production, Exports and Consumption, 1958–67
(pounds)

	Production		Exports Metals and Salts[3]	Consumption[4]
	All Forms[1]	Refined[2]		
1958	306,990	342,141	250,351	16,600
1959	368,107	372,410	325,712	22,156
1960	521,638	524,659	404,410	14,461
1961	430,612	422,955	345,800	13,160
1962	487,066	466,654	325,600	12,587
1963	468,772	462,385	445,700	12,424
1964	465,746	462,795	401,300	13,968
1965	512,077	514,595	451,200	15,888
1966	575,482	546,085	588,100	20,533
1967[p]	752,221	754,360	539,400	22,370[5]

Source: Dominion Bureau of Statistics.
1. Recoverable selenium content of blister copper treated at domestic refineries, plus refined selenium from domestic primary material. 2. Refinery output from all sources. 3. From 1958 to 1960, exports of selenium metal and compounds; from 1961, exports of metal, metal powder, shot, etc. 4. For 1958, producers' domestic shipments of selenium produced at domestic refineries, for 1959 and years following consumption (selenium content) as reported by consumers. 5. Producers' domestic shipments, refined selenium.
[p]Preliminary.

The chemical industry uses selenium as a catalyst in the manufacture of cortisone and nicotinic acid. Selenium and selenium compounds are used in the preparation of various proprietary medicines for the control of dermatitis in humans and animals, and for the correction of dietary deficiencies in animals.

Finely-ground metallic selenium and selenium diethyldithiocarbamate (selenac) are used in natural and synthetic rubber to increase the rate of vulcanization and to improve the ageing and mechanical properties of sulphurless and low-sulphur rubber stocks. Selenac acts as an accelerator in butyl rubber.

Selenium, in proportions from 0.20 to 0.35%, improves the porosity of stainless steel castings. Ferroselenium (55 to 57% Se) is added to stainless and lead-recarburized steels to improve their machineability and other properties.

TABLE 3

Free World Production of Selenium, 1965–67
(pounds)

	1965	1966	1967[e]
United States	540,000	620,000	600,000
Canada	512,077	575,482	752,221
Japan	348,038	423,391	450,000
Sweden	176,209	165,345	170,000
Belgium and Luxembourg	93,034	91,270	100,000
Zambia	57,573	58,000	. .
Other countries	62,069	71,512	. .
Total	1,789,000	2,005,000	. .

Source: US Bureau of Mines Mineral Yearbook, 1966 and US Bureau of Mines Commodity Data Summaries, January 1968.
[e]Estimate; . . Not available.

TABLE 4

Canadian Industrial Use of Selenium, 1965–66
(pounds of contained selenium)

	1965	1966
By end-use		
Glass	8,370	6,512
Other*	7,518	14,021
Total	15,888	20,533

Source: Consumers' reports to Dominion Bureau of Statistics.
*Electronics, rubber, steel, pharmaceuticals.

PRICES

Throughout 1967 selenium prices per pound of selenium were quoted in the United States by *Metals Week* as follows:

Commercial grade powder – $4.50
High purity selenium – $6.00

TARIFFS

	British Preferential	Most Favoured Nation	General
CANADA	%	%	%
In pure form as lumps, powder, ingot, blocks, if of a class not produced in Canada	Free	15	25
Above forms, if produced in Canada	15	20	25
Alloys, rod, sheet, or processed form	15	20	25

Tariffs (Cont'd)

UNITED STATES	
Selenium metal, selenium dioxide, selenium salts	Free
Other selenium compounds	8% ad val.

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT) that was convened in 1964 to consider reductions in tariffs submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968 and final reductions on January 1, 1972.

TELLURIUM

Like selenium, tellerium is recovered in Canada from the tankhouse slimes of the two electrolytic copper refineries and the Port Colborne nickel refinery. It is refined by the same two companies. Total production in 1967 was 82,098 pounds valued at $530,379, an increase of 9,859 pounds and $60,826 from 1966. Refined production in 1967 was 70,105 pounds.

TABLE 5

Tellurium – Production and Consumption, 1966–67

	1966		1967P	
	Pounds	$	Pounds	$
Production				
All forms[1]				
Quebec	56,421	366,736	61,755	401,400
Saskatchewan	3,390	22,035	7,452	48,438
Ontario	9,000	58,500	6,500	39,000
Manitoba	3,428	22,282	6,391	41,541
Total	72,239	469,553	82,098	530,379
Refined[2]	72,745		70,105	
Consumption (refined)[3]	3,140		1,005	

Source: Dominion Bureau of Statistics.

1. Includes the recoverable tellurium content of blister copper treated plus refined tellurium from domestic primary material. 2. Refinery output from all sources. 3. Producers' domestic shipments.

PPreliminary.

CONSUMPTION AND USES

Tellurium is recovered from the same sources as selenium and therefore its production and growth of consumption are governed by the same factors. Low production and the odour and toxicity of tellurium continue to inhibit its use in industry. When it is absorbed into the body by direct contact or inhalation, tellurium has an adverse physiological effect resulting in a strong garlic odour imparted to the breath and perspiration.

TABLE 6

Production of Tellurium, 1958–67
(pounds)

	All Forms*	Refined**
1958	38,250	42,337
1959	13,023	8,900
1960	44,682	41,756
1961	77,609	81,050
1962	58,725	57,630
1963	76,842	79,640
1964	77,782	80,255
1965	69,794	69,930
1966	72,239	72,745
1967P	82,098	70,105

Source: Dominion Bureau of Statistics.

*Includes recoverable tellurium content of blister copper, not necessarily recovered in year designated, plus refined tellurium from domestic primary material.
**Refinery production from all sources.

PPreliminary.

TABLE 7

Free World Production of Tellurium
(pounds)

	1965	1966	1967e
United States	195,000	199,000	190,000
Canada	69,794	72,239	82,098
Peru	36,045	39,654	40,000
Japan	20,126	22,701	30,000
Other countries	35	6	. .
Total	321,000	333,600	. .

Source: US Bureau of Mines Minerals Yearbook, 1966 and US Bureau of Mines Commodity Data Summaries, January 1968.
eEstimated; . . Not available.

TABLE 8

Refined Tellurium Used in Canada, 1965–66
(pounds of contained tellurium)

	1965	1966
By end-use		
Metal alloys	1,870	862
Total	1,870	862

Source: Consumers' reports to Dominion Bureau of Statistics.

Tellurium, as a component of alloys containing gallium, bismuth and lead, is used in thermoelectric devices for the direct conversion of heat into electricity, and for cooling as a result of its Peltier effect. Although these devices have received increased attention, the amount of tellurium used in these applications has not risen as fast as was expected.

Rubber containing tellurium is resistant to heat and abrasion. Its principal use is for the jacketing of portable electric cables used in mining, dredging, welding, etc. Tellurium is added to sulphurless or low-sulphur stocks of natural and synthetic rubber in powder form or as tellurium diethyldithiocarbamate to improve the rubber's ageing and mechanical properties. The diethyldithiocarbamate compound also helps to reduce the porosity of thick rubber sections and, in combinations with mercaptobenzothiazol, is one of the fastest known accelerators for butyl rubber.

Tellurium powder is added to molten iron to control the depth of chill in grey-iron castings. A 99.5 per cent copper and 0.5 per cent tellurium alloy is used in the manufacture of welding tips and in radio and communications equipment because it can be extensively cold-worked, has good hot-working properties and high thermal and electric conductivity. Up to 0.1 per cent tellurium in lead forms a corrosion-resistant alloy used to sheath marine cables and to line tanks subject to chemical corrosion.

PRICES

The price for 100 pound lots of tellurium in the United States as quoted by *Metals Week* was $6 a pound for both powder and slab.

TARIFFS

	British Preferential %	Most Favoured Nation %	General %
CANADA			
In lumps, powder, ingots, etc.*	Free	15	25
In alloys, rod, sheet, or processed form	15	20	25
UNITED STATES			
Tellurium metal		8% ad val	
Tellurium salts and compounds		10% ad val	

*This tariff applies if material is determined to be of a class or kind not produced in Canada, otherwise tariff quoted immediately below applies.

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT) that was convened in 1964 to consider reductions in tariffs submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968 and final reductions on January 1, 1972.

Silica

R. K. COLLINGS*

Silica (silicon dioxide) occurs as the mineral quartz in sand, sandstone, quartzite and vein quartz deposits. Although deposits are widespread in occurrence, only those of high silica content are of commercial interest.

Domestic production of silica is confined to Ontario, Quebec, Manitoba, Saskatchewan, Alberta and British Columbia, and mainly consists of crushed quartzite and sandstone, and sand for use as metallurgical flux. Flux accounted for 65 per cent of the total production of silica in 1966; the remainder consisted of lump silica for use in silicon and ferrosilicon manufacture and in the production of elemental phosphorus (13 per cent), and silica sand for glass manufacture, silicon carbide production, foundry use and for other purposes (22 per cent).

Silica production, at 2.2 million tons valued at $5.5 million, was slightly below that of 1966. Exports, at 56,200 tons valued at $170,000 were well below those of 1966, there being no production of lump quartzite at Killarney, Ontario, for export to ferrosilicon producers in the United States.

Imports of silica which, from the standpoint of tonnage, chiefly consist of silica sand but also include silica brick and a small but valuable tonnage of quartz crystal and pebble, recorded a 25 per cent decrease in value compared to 1966 as a result of reduced imports of silica brick. The tonnage of sand imported dropped 6 per cent to 952,459 tons; however, value increased 3.7 per cent to $4 million.

Although the annual production of silica sand in Canada has gradually increased over the last decade, the two current domestic producers today supply only 25 to 30 per cent of the Canadian market. Industrial Minerals of Canada Limited, the chief producer, operates two silica quarries in southern Quebec and supplies perhaps 60 per cent of the Quebec silica sand and flour market. The balance of the Quebec market is supplied by a United States producer. Industrial Minerals markets a substantial tonnage of silica flour in Ontario but is unable to compete with imported sand in that province because of higher processing costs and freight rates. This sand market is entirely supplied by producers in northeastern United States. Canada's only other producer of high-quality silica sand, The Winnipeg Supply and Fuel Company, Limited, Winnipeg, now supplies about 50 per cent of the silica sand market in western Canada but is unable to compete with imported sand in the southern Ontario market or in British Columbia. The British Columbia sand market is largely supplied by a producer at Valley, Washington.

Interest in silica deposits, particularly with regard to those relatively close to established markets, was maintained at a high level during the year and although there have been no official announcements of new plants, one or two such announcements are expected in the near future.

PRINCIPAL PRODUCERS

QUEBEC

Union Carbide Canada Mining Ltd., the name of the company was changed in November 1967 from Union Carbide Exploration Ltd., quarries quartzitic sandstone at Melocheville, Beauharnois County, for use in ferrosilicon manufacture at Beauharnois. Fines

*Mineral Processing Division, Mines Branch.

TABLE 1

Silica – Production and Trade, 1966-67

	1966		1967p	
	Short Tons	$	Short Tons	$
Production, quartz and silica sand*				
By province				
Ontario	1,161,057	902,089	1,011,528	410,269
Quebec	529,112	3,340,066	550,000	3,350,000
Manitoba	393,204	969,742	456,000	1,181,160
Saskatchewan	183,750	149,938	151,000	120,800
British Columbia	23,899	112,174	54,272	364,816
Nova Scotia	8,638	40,032	9,000	47,500
Alberta	–	–	2,530	53,200
Total	2,299,660	5,514,041	2,234,330	5,527,745
By use				
Flux	1,497,247	1,109,613		
Ferrosilicon	287,968	1,197,519		
Silicon carbide	44,603	252,710		
Glass	158,357	957,614		
Other uses	311,485	1,996,585		
Total	2,299,660	5,514,041	2,234,330	5,527,745
Imports				
Silica Sand				
United States	1,003,421	3,522,000	948,195	3,839,000
Norway	4,619	41,000	2,204	43,000
Australia	4,339	297,000	1,926	126,000
Britain	906	3,000	134	. . .
Total	1,013,285	3,863,000	952,459	4,008,000
Silex and crystallized quartz				
United States	280	116,000	126	140,000
Brazil	7	278,000	5	242,000
Other countries	1	1,000	11	3,000
Total	288	395,000	142	385,000
Firebrick and similar shapes, silica	(Thousands)	$	(Thousands)	$
United States	3,245	2,292,000	1,889	1,587,000
West Germany	782	1,008,000	52	19,000
Japan	1,280	473,000	–	–
Total	5,307	3,773,000	1,941	1,606,000
	Short Tons	$	Short Tons	$
Exports				
Quartzite				
United States	156,038	530,000	56,200	170,000

Source: Dominion Bureau of Statistics.
*Producers' shipments, including crude and crushed quartz, crushed sandstone and quartzite, and natural silica sands.
pPreliminary; – Nil; . . . Less than one thousand dollars.

TABLE 2

Silica – Production and Trade, 1958-67
(short tons)

	Production		Imports			
	Quartz and silica Sand	Silica Brick[1] (000's brick)	Silica Sand	Silex or crystallized quartz	Flint and ground flintstones	Exports of Quartzite
1958	1,453,656	2,815	603,343	12,024	542	17,074
1959	2,163,546	1,926	792,129	13,815	786	147,412
1960	2,260,766	. .	720,826	10,521	1,232	13,057
1961	2,194,054	. .	693,210	10,327	1,339	26,774
1962	2,085,620	. .	765,431	8,960	1,193	156,205
1963	1,836,612	. .	787,157	11,887	1,812	47,437
1964	2,117,273	. .	771,900	5,176	. .	146,206
1965	2,433,685	. .	834,780	5,104	. .	111,533
1966	2,299,660	. .	1,013,285	288	. .	156,038
1967[p]	2,234,330	. .	952,459	142	. .	56,200

[1]Not available after 1959. Beginning 1960; silica to make silica brick included in production of quartz and silica.
[p]Preliminary; . .Not available.

from this operation are used in foundry work, in cement manufacture and as metallurgical flux.

E. Montpetit et Fils Ltée also quarries sandstone in the Melocheville area. This sandstone is used by Chromium Mining & Smelting Corporation, Limited, for ferrosilicon production at Beauharnois.

Industrial Minerals of Canada Limited, Toronto, produces silica sand and flour at St. Canut, Two Mountains County, from Potsdam sandstone. The sand is used for glass and silicon carbide manufacture, and for foundry purposes. The flour is used by steel foundries, as a filler in asbestos-cement products, and in various cleaners. This company, having acquired the silica mine at St. Donat de Montcalm from Simsil Mines Inc. (formerly Dominion Industrial Mineral Corporation) early in 1967, is now capable of supplying a wide range of sizes of silica sand and flour to the Quebec market. The St. Donat deposit, a friable quartzite, is about 50 miles from St. Canut, production being trucked to St. Canut for final processing. Industrial Minerals also holds a sandstone property near Ste. Scholastique, 10 miles from St. Canut.

Baskatong Quartz Products, with head office in Montreal, produces lump and crushed quartz from a deposit on the southwestern shore of Lake Baskatong. This material is used, in lump form, in silicon metal manufacture and, to a limited extent, as grinding pebble. The crushed quartz is sold for use as exposed aggregate in decorative concrete.

ONTARIO

Union Carbide Canada Limited periodically operates a quarry at Killarney in the Lorraine quartzite formation that extends along the northern end of Georgian Bay. Most of the production is exported to company-owned plants in the United States for ferrosilicon production. The balance is used in Canada for the same purpose.

MANITOBA

The Winnipeg Supply and Fuel Company, Limited, operates a sand deposit on Black Island, Lake Winnipeg. Sand from this deposit is shipped to Selkirk where it is washed, sized, and sold for glass manufacture, foundry purposes and for other uses.

BRITISH COLUMBIA

Pacific Silica Limited quarries quartz near Oliver. This quartz is crushed, sized and sold as stucco-dash, roofing rock and poultry grit. Part of the production is exported to the United States for the manufacture of silicon carbide and ferrosilicon.

OTHER AREAS

Metallurgical silica is quarried near Howick, Quebec, for use in elemental phosphorus production at Varennes; near Sudbury, Ontario, and Thompson, Manitoba, for use in smelting nickel-copper ores; and west of Flin Flon, in Saskatchewan, for use in smelting copper-zinc ore.

SPECIFICATION AND USES

LUMP SILICA

Silica Flux

Quartz, quartzite, sandstone and sand are used as fluxes in smelting low-silica, base metal ores. A high silica content is required. Impurities such as iron and alumina are not objectionable in small amounts. Lump silica used as flux is usually minus one, plus 5/16 inch in size.

Silicon Alloys

Lump quartz, quartzite and well-cemented sandstone are used in the manufacture of silicon, ferrosilicon and other alloys of silicon. The silica content should be 98 per cent, the iron, expressed as Fe_2O_3 and alumina should be less than 1 per cent each, and the total iron and alumina less than 1 1/2 per cent. Lime and magnesia should each be less than 0.2 per cent. Phosphorus and arsenic are objectionable. Size is usually minus 6, plus 1 inch.

Silica Brick

Quartz and quartzite, crushed to minus 8 mesh, are used in the manufacture of silica brick for high-temperature refractory furnaces. The iron and alumina should be less than 1 per cent each and other impurities, such as lime and magnesia, should be low.

TABLE 3

Available Statistics on Consumption of Silica by Specified Industries, 1966

	Short tons
Smelter flux[1]	1,536,683
Glass manufacturing (including glass fibre)	421,840
Foundry sand	765,215
Artificial abrasives	169,177
Ferrosilicon	163,353
Metallurgical use	75,667
Concrete products	60,080
Gypsum products	53,311
Asbestos products	34,623
Chemicals	22,097
Fertilizers, stock and poultry feed	12,963
Other	57,659
Total	3,372,668

Source: Dominion Bureau of Statistics.
[1]Producers' shipments of quartz and silica for flux purposes.

Aggregate

Crushed and sized quartz and quartzite are used as exposed aggregate in precast concrete building panels, slabs, sidewalks and decorative landscape units, in addition to their traditional use in stucco applications. Colour and texture are important. Some architects prefer a white, opaque quartz, while others prefer the shiny, translucent variety.

Other Uses

Lump quartz and quartzite are used as lining in ball and tube mills and as lining and packing for acid towers. Naturally occurring flint pebbles and rounded pebbles produced from lump quartz or quartzite are used as grinding media for the reduction of various nonmetallic ores.

SILICA SAND

Glass Manufacture

Naturally occurring sand and sand produced by crushing quartzite or sandstone are used in the manufacture of glass and fused silicaware. The silica content should be 99 per cent and that of iron (Fe_2O_3) less than 0.02 per cent. Other impurities such as alumina, lime and magnesia should be low. All sand preferably should be between 20 and 100 mesh.

Silicon Carbide

Sand used for silicon-carbide manufacture should have a silica content of 99 per cent. Iron (Fe_2O_3) and alumina should be less than 0.1 per cent each. Lime, magnesia and phosphorus are objectionable. A coarse-grained sand is preferred. All sand should be plus 100 mesh, with the bulk of it plus 35 mesh.

Hydraulic Fracturing

Sand used in the hydraulic fracturing of oil-bearing formations must be clean and dry and have a high compressive strength, a high silica content, and be free of acid-consuming constituents. The grain size should be between 20 and 35 mesh. Grains should be well rounded to facilitate placement and to provide maximum permeability.

Foundry Use

Naturally occcurring sand and sand produced by the reduction of sandstone are used by the foundry industry for moulding. Sands for this purpose vary greatly in screen size and chemical composition. Grain size varies between 20 and 200 mesh in closely sized ranges. A rounded grain is preferred.

Sodium Silicate

Sand for the manufacture of sodium silicate should contain more than 99 per cent silica, less than 0.25 per cent alumina, less than 0.05 per cent lime and magnesia combined, and less than 0.03 per cent iron as Fe_2O_3. All sand should be between 20 and 100 mesh.

Other Uses

Coarsely ground, closely sized quartz, quartzite, sandstone and sand are used as abrasive grit in sandblasting operations and for the manufacture of sandpaper. Various grades of sand are used in water-treatment plants as filtering media. Silica is also used in portland cement manufacture.

SILICA FLOUR

Silica flour, formed by grinding quartz, quartzite, sandstone or sand, is used in the ceramic industry for enamel frits and pottery flint. It is also used as an inert filler in rubber and asbestos-cement products, as an extender in paint and as an abrasive ingredient in soaps and scouring powders. Silica flour is finding increasing application in concrete used in the fabrication of autoclave-cured products such as building blocks and panels.

QUARTZ CRYSTAL

Quartz crystal with desirable piezoelectric properties is used in radio-frequency control apparatus, radar and other electronic devices. Crystal for this purpose must be perfectly transparent and free of all impurities and flaws. The individual crystals should weigh 100 grams or more and measure at least 2 inches in length and 1 inch or more in diameter. Most of the world's crystal requirement is met by natural crystal from Brazil; however, natural crystal is being replaced, in part, by excellent quality synthetic crystal grown in the laboratory from quartz 'seed'.

There is only a small demand for quartz crystal in Canada and virtually no production, domestic requirements being met by imports chiefly from Brazil and the United States. Quartz Crystals Mines Limited, Toronto, has produced minor tonnages from an occurrence near Lyndhurst, Ontario, however, there has been no production from this mine during the past few years.

PRICES

The price of the various grades of silica varies greatly because it depends upon such factors as location of deposit, the purity and degree of beneficiation required, and market conditions. High-quality silica sand, in carload lots, sells for $8 to $10 per ton in Montreal and Toronto.

TARIFFS

CANADA	
Sand and ganister	free
Silex, or crystallized quartz, ground or unground	free
UNITED STATES	
Sand containing by weight 95% or more silica and not more than 0.6% oxide of iron, per long ton	50 cents
Quartzite, whether or not manufactured	free
Silica, not specially provided for	free

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reduction in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Silver

J.G. GEORGE*

Mine production of silver in 1967 was 36,426,079 troy ounces, 3 million ounces greater than in 1966 and the largest in Canada's history. The previous record was 34,016,829 ounces produced in 1960. The increase was due mainly to byproduct output at the Kidd Creek base-metal mine of Ecstall Mining Limited, a wholly-owned subsidiary of Texas Gulf Sulphur Company near Timmins, Ontario, which completed its first full year of operation in 1967. Much higher output in Ontario, together with small increases in Manitoba and Saskatchewan, offset declines in the other provinces and the two Territories. Notwithstanding reduced production in the Cobalt-Gowganda area, Ontario was again the leading silver-producing province; its output was more than 4.5 million ounces higher than in 1966. The value of Canadian output was $63 million, or 35 per cent higher than in 1966, partly due to increased output, but more particularly because of higher silver prices.

Base-metal ores continued to be the main source of Canada's mine output of silver, accounting for more than 85 per cent of total production. Almost 14 per cent came from silver-cobalt ores mined in northern Ontario and the remainder was byproduct recovery from lode and placer gold ores.

The principal Canadian silver producers are listed in Table 4 and the accompanying map shows their approximate locations. The five largest mine producers in declining order of output were Ecstall Mining Limited in Ontario, United Keno Hill Mines Limited in the Yukon Territory, Cominco Ltd. (Sullivan mine) in southeastern British Columbia, Noranda Mines Limited (Geco Division) in Ontario, and Brunswick Mining and Smelting Corporation Limited (No. 12 mine) near Bathurst, New Brunswick. Base-metal ores mined by these five producers accounted for about 50 per cent of Canada's total silver production. Largest producer in the Cobalt-Gowganda area of Ontario was again Silverfields Mining Corporation Limited with output of 1,132,622 ounces.

Canada's two largest producers of refined silver were again Canadian Copper Refiners Limited at Montreal East, Quebec, which produced 11,276,000 ounces from anode and blister copper, and Cominco Ltd. at Trail, British Columbia, which recovered 5,211,761 ounces in the processing of lead and zinc ores and concentrates. Other producers of refined silver were Kam-Kotia Mines Limited, Refinery Division, at Cobalt, Ontario (from silver-cobalt ores and concentrates); The International Nickel Company of Canada, Limited (Inco) at Copper Cliff, Ontario (from nickel-copper concentrates); Royal Canadian Mint at Ottawa, Ontario (from gold bullion); and Hollinger Consolidated Gold Mines, Limited at Timmins, Ontario (from gold precipitates).

Canada's exports of silver in ores and concentrates and as refined metal, totalling 24,143,093 ounces in 1967, remained at about the same level as in 1966. A decline in exports of silver in ores and concentrates was more than compensated for by a rise in exports of refined silver. More than 77 per cent of total exports went to the United States. Imports into Canada declined substantially from those of 1966, mainly because of reduced requirements for coinage. Virtually all of the 5,383,872 ounces imported in 1967 came from the United States.

*Mineral Resources Branch.

TABLE 1

Canada, Silver Production, Trade and Consumption, 1966-67

	1966		1967P	
	Troy Ounces	$	Troy Ounces	$
Production*				
By provinces and territories				
Ontario	10,900,204	15,249,385	15,582,832	27,020,631
British Columbia	5,548,823	7,762,803	5,492,062	9,523,235
Quebec	5,214,146	7,294,590	4,921,250	8,533,447
Yukon	4,194,580	5,868,217	3,769,533	6,468,370
New Brunswick	3,108,669	4,349,028	2,785,198	4,829,533
Northwest Territories	1,662,192	2,325,407	1,439,124	2,495,441
Newfoundland	1,097,425	1,535,298	1,056,734	1,832,377
Manitoba and Saskatchewan	1,151,155	1,610,466	1,290,096	2,237,027
Nova Scotia	540,663	756,388	89,238	154,739
Alberta	17	23	12	21
Total	33,417,874	46,751,605	36,426,079	63,094,821
By sources				
Base-metal ores	27,350,045		31,017,222	
Gold ores	478,943		452,720	
Silver-cobalt and silver ores	5,579,283		4,954,330	
Placer gold ores	9,603		1,807	
Total	33,417,874	46,751,605	36,426,079	63,094,821
Refined silver	21,298,325		20,824,158	
Exports				
In ores and concentrates				
United States	8,147,203	9,753,000	5,304,304	6,500,000
Belgium and Luxembourg	2,098,182	2,294,000	1,551,913	1,424,000
Japan	773,351	984,000	1,357,349	1,787,000
West Germany	201,981	174,000	1,343,751	1,789,000
Australia	3,709	4,000	518,173	933,000
Sweden	333,294	464,000	152,777	211,000
Britain	187,999	162,000	116,847	117,000
Other countries	104,750	92,000	62,304	86,000
Total	11,850,469	13,927,000	10,407,418	12,847,000
Refined metal				
United States	12,093,535	16,850,000	13,389,938	22,750,000
Britain	145	1,000	247,856	499,000
West Germany	105,454	145,000	74,790	101,000
Venezuela	14,535	23,000	12,574	24,000
Ecuador	3,215	5,000	6,430	10,000
Jamaica	1,829	3,000	3,987	8,000
Other countries	2,429	1,000	100	...
Total	12,221,142	17,028,000	13,735,675	23,392,000
Imports				
Refined metal				
United States	14,452,372	20,174,000	5,371,481	8,211,000
Britain	25,415	39,000	11,339	20,000
Belgium and Luxembourg	–	–	1,052	2,000
Total	14,477,787	20,213,000	5,383,872	8,233,000

TABLE 1 (Cont'd)

	1966		1967P	
	Troy Ounces	$	Troy Ounces	$
Consumption, by use				
Coinage	15,481,651		8,791,757	
Silver salts	1,716,868		2,042,778	
Silver alloys	470,410		525,169	
Sterling	1,653,118		1,266,477	
Wire and rod	11,674		12,759	
Other**	1,969,983		1,937,668	
Total	21,303,704		14,576,608	

Source: Dominion Bureau of Statistics.

* Includes: a) recoverable silver in ores, concentrates and matte shipped for export
b) silver in crude gold bullion produced
c) silver in blister and anode copper produced at Canadian smelters
d) silver in base bullion produced from domestic ores
e) silver bullion produced from treatment of domestic silver-cobalt ores at Cobalt, Ontario.

** Includes sheet and miscellaneous uses.

P Preliminary; – Nil; . . . Less than one thousand dollars.

TABLE 2

Canada, Silver Production, Trade and Consumption, 1958-67
(troy ounces)

	Production		Exports			Imports	Consumption**
	All Forms*	Refined Silver	In ores and Concentrates	Refined Silver	Total	Refined Silver	Refined Silver
1958	31,163,470	25,430,204	5,098,788	16,026,550	21,125,338	2,701	9,299,809
1959	31,923,969	22,362,533	6,814,865	15,140,830	21,955,695	2,807,774	10,202,769
1960	34,016,829	22,564,397	8,897,402	12,761,063	21,658,465	3,849,115	11,742,064
1961	31,381,977	18,239,803	10,352,700	10,783,414	21,136,114	12,278,469	9,614,083
1962	30,422,972	16,749,356	8,861,858	9,445,094	18,306,952	15,182,336	15,419,342
1963	29,932,003	19,772,408	8,286,756	10,834,629	19,121,385	7,950,972	17,574,628
1964	29,902,611	20,744,682	9,478,317	10,583,439	20,061,756	5,197,764	18,775,307
1965	32,272,464	20,630,190	12,245,877	11,268,110	23,513,987	13,413,434	30,170,097
1966	33,417,874	21,298,325	11,850,469	12,221,142	24,071,611	14,477,787	21,303,704
1967P	36,426,079	20,824,158	10,407,418	13,735,675	24,143,093	5,383,872	14,576,608

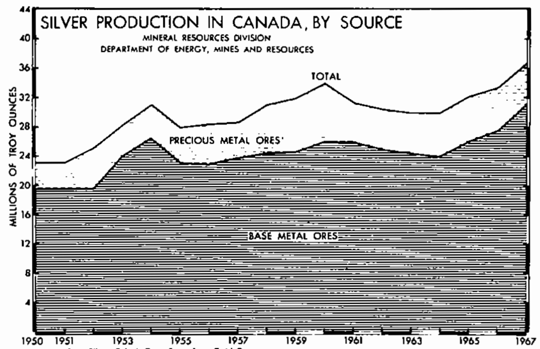
Source: Dominion Bureau of Statistics.

* Includes recoverable silver (a) in ores, concentrates and matte shipped for export; (b) in crude gold bullion produced; (c) in blister and anode copper produced at Canadian smelters; (d) in base bullion produced from domestic ores; (e) in bullion produced from the treatment of silver-cobalt ores.

** Includes consumption for coinage.

P Preliminary.

Reported consumption of silver in Canada totalled 14,576,608 ounces, some 6.7 million ounces less than in 1966.



*Mostly from Silver-Cobalt Ores; Some from Gold Ores.

WORLD PRODUCTION AND CONSUMPTION

Non-communist world production of silver in 1967, according to an estimate of Handy and Harman*, was 213.4 million ounces, or 13.7 million ounces lower than in 1966. The decrease was attributed mainly to reduced output in the United States as a result of the nationwide strike in the base-metals industry which began in July 1967 and still continued at year-end. Non-communist world consumption, in 1967, for both industrial and coinage uses, excluding requirements for US coinage which are supplied from Treasury stocks, amounted to 385.8 million ounces. The gap between production and consumption, not including US coinage requirements, was more than 172 million ounces, or slightly less than in 1966.

Consumption of silver for coinage in the non-communist world, excluding the United States, totalled 34.4 million ounces or 18.4 million ounces less than in 1966. Sharp reductions in consumption in Canada and Japan accounted for a substantial portion of the decrease. Higher silver prices have had a profound effect on world coinage. Not only has silver consumption for new minting been reduced, but the tendency for many countries to replace their silver coins with cheaper but acceptable metals is becoming stronger.

On a mine-production basis, Canada was again in 1967 one of the world's leading silver producers; others were Mexico, Peru and the United States.

New production of silver in the United States, the world's largest consumer, declined from 43.7 million ounces in 1966 to 31.0 million ounces in 1967. Consumption was estimated by Handy and Harman at 145.0 million ounces for industrial use and 43.8 million ounces for coinage. The large deficit in requirements continued to be met by releases from US Treasury stocks, demonitized coinage, secondary silver derived from discarded jewelry, silverware, and similar items, and liquidation of speculative holdings. Treasury bullion reserves were reduced during 1967 from 592 to 348 million ounces, excluding silver in recovered coins.

TABLE 3

World Production of Silver, 1966-67
(troy ounces)

	1966	1967[e]
United States	43,668,988	31,900,000
Mexico	41,983,529	38,000,000
Canada	33,417,874	40,000,000*
Peru	32,841,243	35,000,000
Russia	27,000,000[e]	. .
Australia	18,278,000	. .
Bolivia	5,124,828	. .
East Germany	4,800,000	. .
Sweden	4,495,000	. .
Honduras	3,734,290	. .
Yugoslavia	3,651,424	. .
Chile	3,609,967	. .
Japan	3,577,735[e]	. .
Republic of South Africa	3,134,093	. .
Other countries	23,883,029	106,100,000
Total	253,200,000	251,000,000

Sources: 1966 statistics from US Bureau of Mines Minerals Yearbook, 1966. 1967 statistics from US Bureau of Mines Commodity Data Summaries, January, 1968.

* According to Dominion Bureau of Statistics, production was 36,426,079 ounces.

[e] Estimate; . . Not available.

For silver, 1967 was an historic year. Because of the accelerated rate of depletion of its stocks early in the year, the US Treasury Department announced on May 18 that it was discontinuing sales of silver to buyers other than recognized domestic concerns using silver in their operations. On June 24 the silver certificate legislation, designated as Public Law 90-29, was passed. It limited the time during which silver certificates could be redeemed to one year from the date of the Act. Therefore, after June 24, 1968, silver certificates will no longer be redeemable in silver. It also directed the Secretary of the Treasury to hold in reserve not less than 165 million ounces of silver for transfer to the strategic stockpile by June 24, 1968.

**The Silver Market* in 1967, compiled by Handy and Harman.

On July 14, the Treasury Department announced that in future it would restrict sales from its dwindling stocks to only 2 million ounces a week and that sales would thereafter be at the going market price. This brought to an end the sale of Treasury silver at the statutory $1.2929 a troy ounce, that had obtained since September 1963, and led to a sharp advance in the price of silver. The average New York price for December was $2.066 and an all-time high of $2.170 was reached on November 27, 1967. From May onwards the London price also increased sharply and reached its high for the year of 221.0 pence an ounce, equivalent to $2.212 (US), on December 14.

In order to conserve its silver inventories and as interim measures pending the conversion to pure nickel coinage in 1968, the Royal Canadian Mint temporarily suspended production of silver dollars and half-dollars, and in September reduced the silver content of all 10 and 25 cent coins from 80 per cent to 50 per cent.

On June 2, the Canadian government placed export controls on silver coins, alloys, chemicals, and on silver scrap to cope with abnormal movements of such silver-bearing materials. Silver-bearing ores and concentrates were, however, exempted from the new measures.

CANADIAN DEVELOPMENTS

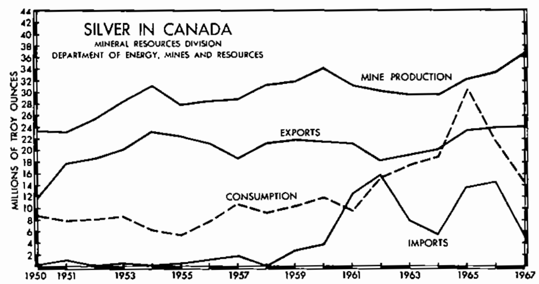
The continuing good demand and the substantial rise in silver prices acted as a spur to exploration and development of silver properties in 1967, especially in the major producing areas of Ontario, British Columbia, and the Yukon Territory.

YUKON TERRITORY AND NORTHWEST TERRITORIES

Silver production at United Keno Hill Mines Limited was almost one-half million ounces less than in 1966. As a result of curtailed operations, the Comstock Keno mine was closed in July, the Keno mine in October, and in September the Elsa mine was placed on a development basis. In the latter part of 1967 output came almost entirely from the Calumet mine. Results from diamond drilling on the company's Husky claims, in the vicinity of the Elsa mine, were encouraging and, in order to permit underground exploration and development of this favourable structure, a 500-foot shaft will be sunk starting in March 1968.

In August 1967, Anvil Mining Corporation Limited announced plans to bring into production its lead-zinc-silver property in the Vangorda Creek area in central Yukon Territory. Anvil is owned 60 per cent by Cyprus Mines Corporation of Los Angeles, California, and 40 per cent by Dynasty Explorations Limited. The $63-million project involves development of an open-pit mining operation and construction of a 5,500-ton-a-day concentrator. In 1967, construction of the concentrator and ancillary facilities began and stripping of waste rock from the open-pit mine was begun. Initial production is scheduled for late 1969 and, when the mill reaches full capacity, annual silver output could amount to some 2 million ounces. About mid-1967 Arctic Mining and Exploration Limited decided to bring into production its Arctic Caribou silver-gold property near Carcross, Y.T. A 300-ton-a-day mill was under construction and operations were expected to begin in the first half of 1968.

Virtually all the silver output of the Northwest Territories was again produced by Echo Bay Mines Ltd., which operated a silver-copper property near Port Radium on the east shore of Great Bear Lake. Controlling interest in the company was acquired by International Utilities Corporation.

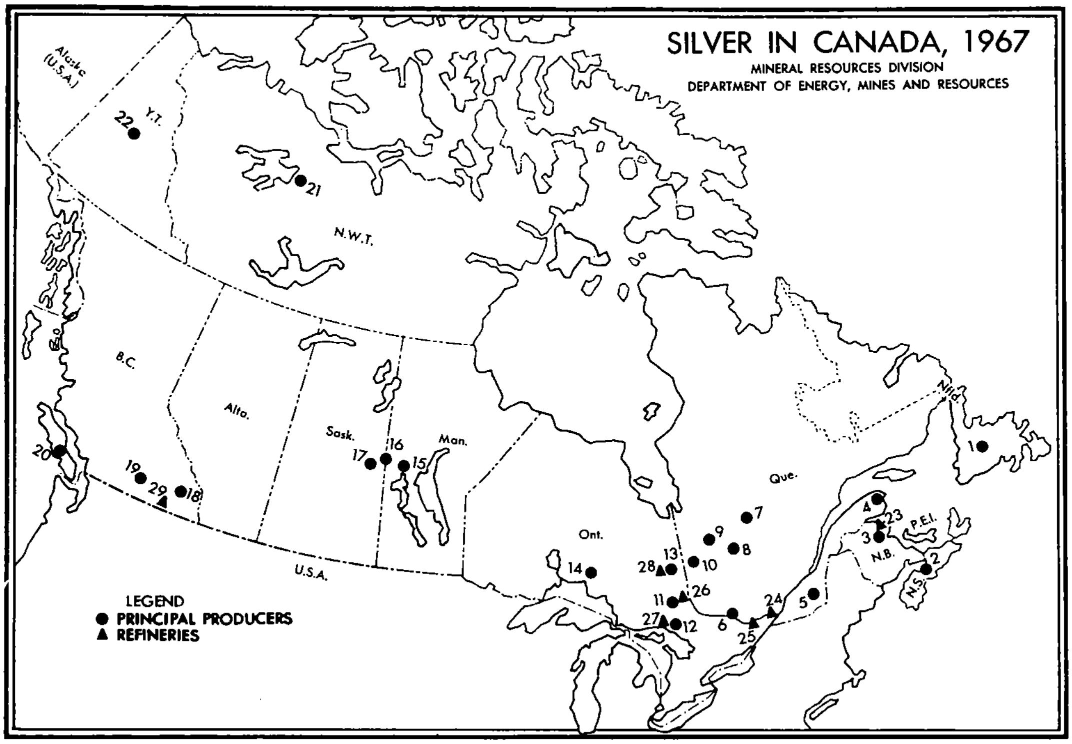


BRITISH COLUMBIA

The zinc-copper-lead-silver property of Western Mines Limited in central Vancouver Island was brought into production early in 1967. Tune-up operations began in August at the 450-ton-a-day concentrator and silver-gold mine of Utica Mines Ltd. near Keremeos. Late in 1967, operations were suspended at the Estella mine near Cranbrook and at the Mineral King mine in the Invermere district; both were zinc-lead mines with a small output of byproduct silver.

MANITOBA-SASKATCHEWAN

About mid-1967, Share Mines & Oils Ltd., in association with Western Nuclear, Inc. of Denver, Colorado, began tune-up operations at its Par zinc-lead-copper-silver property and 350-ton-a-day mill at Hanson Lake in northern Saskatchewan. When production began, ore reserves were estimated at some 250,000 tons grading 4.74 ounces of silver a ton. Most of the silver produced in Manitoba continued to come from the copper-zinc mines near Flin Flon and Snow Lake operated by Hudson Bay Mining and Smelting Co., Limited. The company operated 4 mines, and continued development of 3 new mines, the Osborne Lake and Anderson Lake mines near Snow Lake, and the Flexar mine 8½ miles southwest of Flin Flon.



PRINCIPAL PRODUCERS

(numbers refer to numbers on the map)

1. American Smelting and Refining Company (Buchans Unit)
2. Dresser Minerals, Division of Dresser Industries, Inc.
3. Brunswick Mining and Smelting Corporation Limited (Nos. 12 and 6 mines)
   Heath Steele Mines Limited
   Nigadoo River Mines Limited
4. Gaspé Copper Mines, Limited
5. Cupra Mines Ltd.
   Solbec Copper Mines, Ltd.
6. New Calumet Mines Limited
7. Campbell Chibougamau Mines Ltd.
   Opemiska Copper Mines (Quebec) Limited
8. The Coniagas Mines, Limited
9. Mattagami Lake Mines Limited
10. Lake Dufault Mines, Limited
    Manitou-Barvue Mines Limited
    Noranda Mines Limited (Horne mine)
    Normetal Mining Corporation, Limited
    Quemont Mining Corporation, Limited
11. Agnico Mines Limited
    Deer Horn Mines Limited
    Glen Lake Silver Mines Limited
    Hiho Silver Mines Limited
    Langis Silver & Cobalt Mining Company Limited
    Silverfields Mining Corporation Limited
    Silver Town Mines Limited
    Siscoe Metals of Ontario Limited
12. The International Nickel Company of Canada, Limited
13. Ecstall Mining Limited
14. Noranda Mines Limited (Geco Division)
    Willecho Mines Limited
    Willroy Mines Limited
15. Hudson Bay Mining and Smelting Co., Limited (Chisel Lake mine, Stall Lake mine)
16. Hudson Bay Mining and Smelting Co., Limited (Flin Flon mine, Schist Lake mine)
17. Share Mines & Oils Ltd.
18. Cominco Ltd. (Bluebell mine, Sullivan mine)
19. Mastodon-Highland Bell Mines Limited
    Utica Mines Ltd.
20. Western Mines Limited
21. Echo Bay Mines Ltd.
22. United Keno Hill Mines Limited

REFINERIES

23. East Coast Smelting and Chemical Company Limited
24. Canadian Copper Refiners Limited
25. Royal Canadian Mint
26. Kam-Kotia Mines Limited (Refinery Division)
27. The International Nickel Company of Canada, Limited
28. Hollinger Consolidated Gold Mines, Limited
29. Cominco Ltd.

TABLE 4

Principal Silver Producers in Canada, 1967

Company and Location	Mill Capacity (short tons ore/day)	Type of Ore Milled	Silver Grade 1967 (1966) (oz/ton)	Ore Produced 1967 (1966) (short tons)	Contained Silver Produced 1967 (1966) (troy ounces)	Remarks
British Columbia						
Cominco Ltd., Sullivan mine, Kimberley	10,000	Pb,Zn,Ag	. . (. .)	2,118,377 (2,135,660)	3,302,047 (3,190,431)	Cominco's total silver output was 5,211,761 ounces.
Bluebell mine, Riondel	700	Pb,Zn,Ag	. . (. .)	255,536 (246,390)	. . (347,369)	
Mastodon-Highland Bell Mines Limited, Beaverdell	100	Ag,Pb,Zn	20.99 (30.88)	34,020 (24,138)	713,911 (745,278)	Daily production increased to 120 tons.
Utica Mines Ltd., Keremeos	450	Ag,Au,Pb,Zn	. . (–)	38,442 (–)	422,158 (–)	Production started August 1967.
Western Mines Limited, Myra Falls, Vancouver Island	750	Zn,Cu,Pb,Ag	2.0 (–)	293,276 (–)	455,035 (–)	Production started early 1967.
Yukon Territory-Northwest Territories						
Echo Bay Mines Ltd., Port Radium, N.W.T.	100	Ag, Cu	. . (39.35)	. . (46,353)	. . (1,615,763)	
United Keno Hill Mines Limited, Calumet, Elsa, Keno and Comstock Keno mines, Mayo District, Y.T.	500	Ag,Pb,Zn	37.69 (36.56)	106,189 (120,374)	3,804,644 (4,235,678)	
Manitoba and Saskatchewan						
Hudson Bay Mining and Smelting Co., Limited	6,000 (treated at central mill at Flin Flon)	Cu,Zn,Pb,Ag	0.76 (0.66)	1,588,164 (1,685,635)	1,119,886 (1,055,565)	
Flin Flon mine, Flin Flon, Man.		Cu,Zn,Ag	0.71 (0.65)	943,811 (1,044,206)		

TABLE 4 (Cont'd)

Company and Location	Mill Capacity (short tons ore/day)	Type of Ore Milled	Silver Grade 1967 (1966) (oz/ton)	Ore Produced 1967 (1966) (short tons)	Contained Silver Produced 1967 (1966) (troy ounces)	Remarks
Manitoba and Saskatchewan (cont'd)						
Chisel Lake mine, Snow Lake, Man.		Zn,Cu,Pb,Ag	1.17 (0.95)	254,118 (250,524)		
Schist Lake mine, Flin Flon, Man.		Cu,Zn,Ag	1.24 (1.13)	121,506 (99,079)		
Stall Lake mine, Snow Lake, Man.		Cu,Zn,Ag	0.34 (0.29)	268,729 (291,826)		
Share Mines & Oils Ltd., Hanson Lake mine, Hanson Lake area, Sask.	350	Zn,Pb,Cu,Ag	5.25 (–)	41,898 (–)	75,662 (–)	Production started June 1967.
Ontario						
Ecstall Mining Limited (Texas Gulf Sulphur Company), Kidd Creek mine, Timmins	9,000	Zn,Cu,Ag,Pb	3.0 (. .)	3,039,219 (. .)	7,800,000 (. .)	
Noranda Mines Limited (Geco Division), Manitouwadge	3,700	Cu,Zn,Ag,Pb	2.02 (2.03)	1,461,000 (1,459,586)	2,193,940 (2,203,443)	No. 4 shaft project completed.
Willecho Mines Limited, Lun-Echo mine, Manitouwadge		Zn,Cu,Ag,Pb	1.91 (1.79)	338,437 (325,738)	359,992 (391,567)	Ore treated at Willroy mill.
Willroy Mines Limited, Manitouwadge	1,700	Zn,Cu,Ag,Pb	1.25 (2.03)	165,053 (219,400)	114,431 (311,003)	
The International Nickel Company of Canada, Limited, Sudbury, Ont., and Thompson, Man.	54,000	Ni, Cu	. . (. .)	20,410,000 (17,550,000)	1,592,000 [1] (1,513,000)[1]	Combined capacity and output for Sudbury and Thompson mills.
Agnico Mines Limited, Agnico 407 mine, Cobalt District	400	Ag, Co	13.67 (17.69)	37,315 (47,550)	668,921 (802,151)	
Deer Horn Mines Limited, Cross Lake property, Cobalt district	100	Ag, Co	12.4 (13.0)	11,224 (13,695)	132,794 (177,739)	
Glen Lake Silver Mines Limited		Ag, Co	28.31 (65.14)	5,397 (5,572)	152,770 (352,479)	

TABLE 4 (Cont'd)

Company and Location	Mill Capacity (short tons ore/day)	Type of Ore Milled	Silver Grade 1967 (1966) (oz/ton)	Ore Produced 1967 (1966) (short tons)	Contained Silver Produced 1967 (1966) (troy ounces)	Remarks
Ontario (cont'd)						
Hiho Silver Mines Limited	250	Ag, Co	25.80 (29.85)	34,273 (31,508)	874,709 (941,354)	Also leased 130-ton Bailey mill.
Langis Silver & Cobalt Mining Company Limited, Langis mine, Cobalt district	175	Ag, Co	10.09 (10.86)	31,244 (35,258)	276,292 (342,161)	Ore milled includes 7,395 tons old mill tailings.
Silverfields Mining Corporation Limited, Cobalt District	250	Ag, Co	17.40 (20.8)	65,275 (74,648)	1,132,622 (1,520,984)	Joint development program with neighbouring property of Silver Summit Mines Limited was renewed.
Silver Town Mines Limited, Cobalt district	ore custom-milled	Ag, Co	23.42 (–)	6,022 (–)	148,781 (–)	
Siscoe Metals of Ontario Limited, Miller-Lake O'Brien mine, Gowganda district	275	Ag, Co	18.55 (17.15)	50,917 (52,398)	917,333 (1,206,149)	
Quebec						
Campbell Chibougamau Mines Ltd., Main, Cedar Bay and Henderson mines, Dore Lake, Chibougamau District[2]	3,500	Cu,Au,Ag	0.266 (0.263)	980,536 (964,072)	194,242 (198,573)	Ore reserves were increased.
The Coniagas Mines, Limited Coniagas mine, Bachelor Lake	500	Zn,Ag,Pb	2.71 (3.14)	41,398 (140,093)	98,595 (340,608)	Closed May 1967.
Cupra Mines Ltd., Cupra mine, Stratford Place	1,500	Cu,Zn,Pb,Ag	1.344 (1.395)	308,347 (158,130)	346,077 (167,476)	
Gaspé Copper Mines, Limited, Gaspe mine, Murdochville	7,500	Cu	. . (0.19)	2,763,085 (2,731,700)	1,347,700 (528,100)	Continued construction of additional 3,750-ton mill capacity to treat Copper Mountain ore.
Lake Dufault Mines, Limited, Noranda	1,300	Cu,Zn,Ag	2.53 (. .)	492,938 (489,387)	941,302 (1,024,666)	
Manitou-Barvue Mines Limited, Golden Manitou mine, Val d'Or	1,300	Cu,Zn,Pb,Ag	1.34 (2.75)	181,350[3] (173,130)[3]	202,000 (392,187)	

TABLE 4 (Cont'd)

Company and Location	Mill Capacity (short tons ore/day)	Type of Ore Milled	Silver Grade 1967 (1966) (oz/ton)	Ore Produced 1967 (1966) (short tons)	Contained Silver Produced 1967 (1966) (troy ounces)	Remarks
Quebec (cont'd)						
Mattagami Lake Mines Limited, Mattagami Lake mine, Matagami	3,850	Zn,Cu,Ag	0.85 (1.04)	1,414,136 (1,411,100)	. . (. .)	
New Calumet Mines Limited, Calumet Island[4]	800	Zn,Pb,Ag	4.66 (4.03)	92,365 (95,761)	349,058 (318,491)	
Noranda Mines Limited, Horne mine, Noranda	3,200	Cu, Au	. . (. .)	855,534 (774,719)	164,779 (159,413)	
Normetal Mining Corporation, Limited, Normetal mine, Normetal	1,000	Zn,Cu,Ag	1.55 (1.38)	348,440 (335,666)	350,620 (326,891)	No ore found below bottom level and, if none materializes, mine will be exhausted by end of 1972.
Opemiska Copper Mines (Quebec) Limited, Chapais	2,000	Cu,Au,Ag	0.43 (0.43)	737,272 (766,128)	267,107 (282,251)	
Quemont Mining Corporation, Limited, Noranda	2,300	Cu,Zn,Au,Ag	0.78 (0.70)	443,774 (578,171)	202,471 (275,112)	Ore reserves declined again. If no important new ore is found, mining is expected to stop before end of 1971.
Solbec Copper Mines, Ltd., Stratford Place		Zn,Cu,Pb,Ag	1.694 (1.926)	75,310 (154,795)	77,932 (183,898)	Closed by labour lock-out from September 1966 to March 1967. Ore treated by Cupra Mines Ltd. which acquired Solbec mill in 1967.
New Brunswick						
Brunswick Mining and Smelting Corporation Limited, No. 12 mine, Bathurst	4,500	Zn,Pb,Cu,Ag	2.39 (2.21)	1,669,000 (1,650,100)	. . (. .)	Noranda Mines Limited took over control and management in June 1967.
No. 6 mine, Bathurst	2,250	Zn,Pb,Cu,Ag	1.79 (1.72)	867,400 (300,700)	. . (. .)	
Heath Steele Mines Limited, Newcastle	1,500[5]	Zn,Pb,Cu,Ag	2.64 (2.11)	308,866 (287,515)	479,066 (345,405)	
Nigadoo River Mines Limited, Bathurst	1,000	Pb,Zn,Cu,Ag	3.22 (–)	22,630 (–)	51,415 (–)	Production started November 1967.

TABLE 4 (Cont'd)

Company and Location	Mill Capacity (short tons ore/day)	Type of Ore Milled	Silver Grade 1967 (1966) (oz/ton)	Ore Produced 1967 (1966) (short tons)	Contained Silver Produced 1967 (1966) (troy ounces)	Remarks
Nova Scotia						
Dresser Minerals, Division of Dresser Industries, Inc., Walton	125	Ag,Pb,Cu,Zn	7.4 (12.0)	50,330 (50,213)	283,901 (489,338)	Name changed from Magnet Cove Barium Corporation.
Newfoundland						
American Smelting and Refining Company, (Buchans Unit), Buchans	1,250	Zn,Pb,Cu,Ag	4.04 (4.19)	378,000 (355,000)	1,326,711 (1,307,579)	

Source: Company reports.
[1] Silver delivered to markets. [2] Production for fiscal years ending June 30. [3] Production does not include copper ore milled in separate circuit.
[4] Production for fiscal years ending September 30. [5] Part of Heath Steele's mill capacity used to treat copper ore from nearby Wedge mine operated by Cominco Ltd.
– Nil; . . Not available.

ONTARIO

Ontario was again the leading silver-producing province. Its mine output of almost 15.6 million ounces in 1967 was 4.7 million ounces more than in 1966. The substantial increase resulted from the large byproduct output at the zinc-copper open-pit mine of Ecstall Mining Limited, 15 miles north of Timmins. Tune-up operations began late in 1966 at the company's 9,000-ton concentrator and full productive capacity was reached early in the following year. Before operations were initiated, ore reserves had been estimated at 55 million tons grading 7.08 per cent zinc, 1.33 per cent copper, and 4.85 ounces silver a ton. Other important sources of silver in Ontario were the silver-cobalt ores of the Cobalt-Gowganda area, the copper-zinc mine of Noranda Mines Limited (Geco Division) in the Manitouwadge area, and the nickel-copper ores of The International Nickel Company of Canada, Limited at Sudbury.

Although exploration and development activity continued at a high level in the Cobalt and Gowganda areas of northeastern Ontario, silver production in this district was more than one-half million ounces less than in 1966. Silverfields Mining Corporation Limited was again the leading silver producer in the area. Others with substantial output included Siscoe Metals of Ontario Limited, Hiho Silver Mines Limited, and Agnico Mines Limited. Siscoe concluded a lease-royalty arrangement with McIntyre Porcupine Mines Limited whereby exploration and development work would be done on the latter's Castle mine, which adjoins the main Siscoe mine on the north and east, that has not been in operation since 1964. Deer Horn Mines Limited, which suspended milling operations in August 1966, resumed production the following May. Silver Town Mines Limited, whose property had been idle since 1964, resumed underground operations in July 1967.

QUEBEC

Quebec's silver production, derived almost entirely from base-metal and gold ores, was about 300,000 ounces less than in 1966 mainly because of reduced output by The Coniagas Mines, Limited. The mine suspended operations in May 1967 because of exhaustion of known ore. Lake Dufault Mines, Limited, near Noranda, remained the province's largest single mine producer with output somewhat less than one million ounces. Sinking of the internal shaft and other preliminary development work continued at the property of D'Estrie Mining Company Ltd., a new affiliate of the Sullivan group of companies. Diamond drilling on the company's mineral deposit, located alongside the orebody of Cupra Mines Ltd. at Stratford Place in the Eastern Townships, has outlined an ore zone containing 300,000 tons of grade averaging 3.81 per cent copper, 4.25 per cent zinc, 0.94 per cent lead, 0.015 ounce of gold and 1.31 ounces of silver a ton.

NEW BRUNSWICK

Brunswick Mining and Smelting Corporation Limited and Heath Steele Mines Limited, each operating base-metal properties near Bathurst and Newcastle, respectively, continued to be the main silver producers. Brunswick's No. 6 mine completed its first full year's operation. Small production was recorded by Nigadoo River Mines Limited whose newly-constructed 1,000-ton-a-day concentrator, about 15 miles northwest of Bathurst, began tune-up operations on November 1, 1967. Controlling interest in Nigadoo is held by the Sullivan group of companies.

USES

Although the number of industrial applications and uses for silver has increased, one of the metal's greatest single uses is still in the manufacture of coinage. The quantity required for coinage, however, continued to decline as a result of the recent trend toward using silverless coins, or ones of reduced silver content. According to Handy and Harman*, non-communist world consumption of silver for coinage decreased from a high of 380.6 million troy ounces in 1965 to 78.2 million ounces in 1967. Silver is widely used in jewelry, sterling and plated silverware, and as a decorative material, because of its many valuable properties which include attractive colour and appearance, corrosion resistance, good alloying properties, high malleability, ductility, and ability to take a fine finish. The photographic industry, in which the use of silver is based on the light sensitivity and ease of reduction of certain silver compounds, remains the largest industrial outlet for the metal. The silvering of glass mirrors is a well-established industry which usually depends on the action of a chemical reducing agent such as invert sugar or formaldehyde on an ammoniacal silver solution.

Substantial quantities are consumed by the electrical and electronics industries because of the good demand for silver contacts, conductors, and other silver-bearing components which depend on silver's high thermal or electrical conductivity and corrosion resistance. Silver is important as a constituent of brazing and soldering alloys, mainly because of the low melting-point of silver-copper and silver-copper-zinc alloys, their resistance to corrosion, high tensile strength, and ability to join together nearly all nonferrous metals and alloys as well as iron and silver. These solders are extensively used in the manufacture of refrigeration, air-conditioning and automotive equipment, and electrical appliances. Another expanding outlet for silver is in storage batteries. Coupled with zinc or cadmium, these batteries have a high output and long life in relation to size and weight, and are rechargeable. They are preferred where weight and dependability are critical factors as in jet

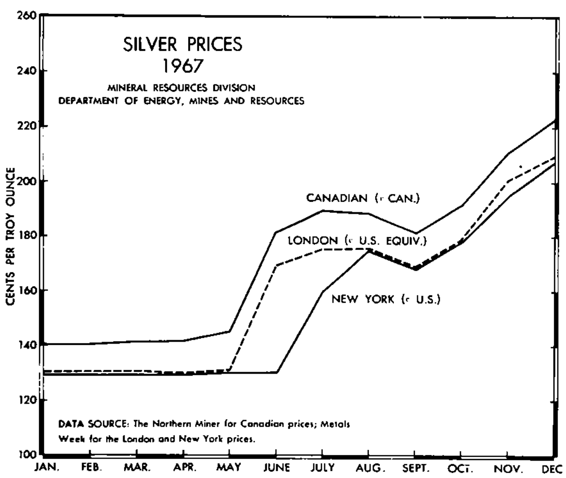
*Handy and Harman, op. cit.

MECHANIZATION: a trackless mucking machine at the copper-zinc-silver mine of Lake Dufault Mines, Limited, Noranda, Quebec, Quebec's second largest silver producer in 1967 with a mine output of 941,000 ounces.

aircraft, missiles, satellites, space capsules, and portable tools and appliances.

PRICES

The New York silver price remained at $1.29 from January until May 19. During the remainder of the year it rose sharply and at year-end was $2.10. The price of silver in Canada, as in the United States, rose sharply after May 1967 and throughout the year followed the trend of the United States price, the essential difference being the exchange rate. It fluctuated between a low of $1.3990 during the fourth week of January and an all-time high of $2.3440 reached on November 27. Average for the year was $1.7248 a troy ounce.



TARIFFS

	British Preferential (%)	Most Favoured Nation (%)	General (%)
CANADA			
Silver ores and concentrates	free	free	free
Silver anodes	5	7½	10
Silver in ingots, blocks, bars, drops, sheets or plates, unmanufactured; silver sweepings	free	free	free
Silver leaf	12½	25	30
Manufactures of silver, not otherwise provided for	17½	27½	45
Wire or strip, silver, silver-filled, nickel-silver for manufacture of jewelry	free	12½	25
UNITED STATES			
Silver ores and concentrates		free	
Silver bullion and silver dore		free	
Silver unwrought			
Platinum-plated		32.5%	
Gold-plated		50 %	
Other		21 %	
Rolled silver		21 %	
Silver scrap, waste, sweepings		free	

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in several countries with reductions beginning on January 1, 1968 and final reductions on January 1, 1972.

Sodium Sulphate

C.M. BARTLEY*

The sodium sulphate industry in Canada, based almost entirely in Saskatchewan, has undergone a substantial expansion over the past ten years with steady increases in production, exports and consumption. In 1967 Saskatchewan production increased some 20,000 tons to a new high of 425,033 tons valued at $6.6 million. Imports were lower than in 1966 but over the past ten years have remained fairly constant at about 30,000 tons per year. Exports increased more than 20,000 tons over 1966 and, over the past ten years, have increased more than 200 per cent. Consumption, at 333,550 tons in 1966, has increased almost 100 per cent over the past ten years.

Kraft (sulphate) pulp plants are the major consumers of sodium sulphate (often referred to as "salt cake" in commerce) and for this reason the demand for kraft paper products and the rates of activity and expansion in the kraft paper industry have a major influence on demand for sodium sulphate. Over the long-term demand for all paper products, and particularly kraft paper products, has increased substantially and consistently, resulting in the increased demand for sodium sulphate. Although demand in Canada and the United States, our main export market, fluctuates from year to year, the long-term trend has been consistently upward and this trend appears to be continuing. In addition, some sources of competitive material such as salt cake from byproduct sources in the United States appear to be diminishing gradually.

In 1967 two new plants began operating in Saskatchewan and construction was started on a third project which is scheduled to be in operation in 1968. The first substantial overseas export of Canadian sodium sulphate was made in 1967 and shipments were continuing early in 1968. The outlook for the industry continues to be favourable, both in domestic and export markets, although any slackening in kraft operations would be particularly noticeable in 1968 because of the expansion of sodium sulphate capacity.

The first increase in the price of sodium sulphate in 12 years was posted as of January 1, 1968 with an advance from $16.50 to $18.00 per ton f.o.b. works.

PRODUCTION AND TRADE

At the start of 1967 four companies were operating five plants in southern Saskatchewan at near-capacity rates. The plants are based on natural sodium sulphate deposits in alkali lakes. In addition, a relatively minor amount of artificial sodium sulphate is recovered as byproduct at a plant in Cornwall, Ontario. Data on production, trade and consumption are provided in Tables 1 and 2 and trends are illustrated in the graph.

In June a new plant built by Sodium Sulphate (Saskatchewan) Ltd. began operations at Alsask, Saskatchewan, and in August the Ingebrigt plant of Sodium Sulphate Division of Saskatchewan Minerals was officially opened.

Saskatchewan salt cake serves western and central Canadian markets and part of the market in eastern Canada. Imports, mainly from the United States, but also from European countries, serve some eastern Canadian markets. Canadian exports of sodium sulphate have been almost entirely to the United States and have ranged from one quarter to one third of production. However, in 1967 3,073 tons of sodium sulphate were exported to Australia and

*Mineral Processing Division, Mines Branch.

shipments were continuing in early 1968. This represents the first substantial overseas export of Canadian sodium sulphate. Efforts are being made to expand this particular market and to secure others.

Canadian producers have adequate reserves of raw material and efficient plants and for many years have produced high quality salt cake for the kraft pulp and other industries at relatively low prices. Marketing, however, is somewhat restricted by the great distance and consequent high rail freight costs to markets in eastern Canada and eastern and southeastern United States.

PRODUCING AND DEVELOPING COMPANIES

Table 3 lists the plants in operation and under construction in Saskatchewan in 1967 together with the operating company, location of the plant, source lake, approximate annual capacity and the status at the end of 1967. Plants in operation at the end of 1967, had a total capacity of about 700,000 tons per year and the completion of the Francana Minerals Ltd. plant at Cabri Lake in the latter part of 1968 will increase total capacity to about 800,000 tons of product per year. Plant capacities may not be an accurate measure of output in any particular year. The amount of precipitation, and summer temperatures, have a major influence on the volume of raw material which may form as crystal in any year. For this reason total plant capacity is normally somewhat in excess of expected demand.

Courtaulds (Canada) Limited, at Cornwall, Ontario, produces a few thousand tons of byproduct salt cake annually.

DEPOSITS

Sodium sulphate, as solid crystal or as a brine, is found in many of the lakes and ponds of southern Saskatchewan. Sulphates in the soil are dissolved by the water from rain and snow and where drainage is into closed basins, the high rates of summer evaporation in southern Saskatchewan removes the water and

TABLE 1

Sodium Sulphate – Production, Trade and Consumption, 1966-67

	1966		1967^p	
	Short Tons	$	Short Tons	$
Production (shipments)	405,314	6,471,795	425,033	6,615,494
Imports				
Total crude salt cake and Glauber's salt				
United States	22,871	445,000	17,725	394,000
Britain	7,824	123,000	6,239	102,000
Belgium and Luxembourg	–	–	3,601	68,000
West Germany	566	15,000	56	8,000
Total	31,261	583,000	27,621	572,000
Exports				
Crude, sodium sulphate				
United States	101,417	1,687,000	120,760	2,020,000
Australia	–	–	3,073	73,000
Total	101,417	1,687,000	123,833	2,093,000
	1965		1966	
Consumption (available data)				
Pulp and paper	261,610		321,115	
Glass, including glasswool	3,895		4,311	
Soaps	5,444		5,067	
Other products[1]	4,671		3,057	
Total	275,620		333,550	

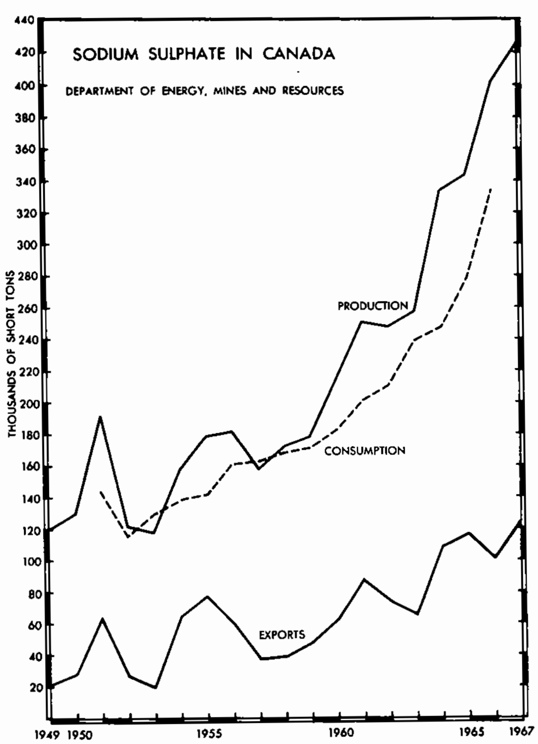
Source: Dominion Bureau of Statistics.
[1]Colours, pigments, gypsum products, textiles, medicinals and miscellaneous other uses.
^{p}Preliminary.

TABLE 2

Sodium Sulphate – Production, Trade and Consumption, 1958-67
(short tons)

		Imports				
	Production*	Salt Cake	Glauber's Salt	Total	Exports	Consumption
1958	173,217	25,813	1,217	27,030	39,763	168,067
1959	179,535	27,157	966	28,123	47,922	171,634
1960	214,208	24,706	1,151	25,857	63,831	183,062
1961	250,996	32,310	899	33,209	87,048	200,096
1962	246,672	31,347	426	31,773	74,049	210,691
1963	256,914	19,002	495	19,497	65,348	238,321
1964	333,263	. .	. .	30,833	107,318	244,592
1965	345,469	. .	. .	29,347	116,345	275,620
1966	405,314	. .	. .	31,261	101,417	333,550
1967[p]	425,033	. .	. .	27,621	123,833	

Source: Dominion Bureau of Statistics.
*Producers' shipments of crude sodium sulphate.
[p]Preliminary; . . Not available.



concentrates the brines. In the fall colder temperatures chill the concentrated brines to the point of crystallization and sodium sulphate (Glauber's salt crystals, $Na_2SO_4.10H_2O$) are deposited as a bed on the lake bottom. The seasonal repetition of this cycle over a long period of time has accumulated thick beds of sodium sulphate crystals in numerous lakes.

Sodium sulphate occurs naturally as Glauber's salt (mirabilite) and occasionally as thenardite (Na_2SO_4). Both minerals are soluble in water and the solubility increases as the temperature rises. The fact that solubility varies with temperature is used advantageously in Saskatchewan to recover a relatively pure product from the natural occurrences.

Reserves in Saskatchewan lakes have been estimated at more than 200 million tons. Fifteen deposits have been estimated to contain at least 1 million tons each and many smaller deposits are known. Some of the deposits, while large, are not suitable for recovery by the usual processes but probably will be recovered in the future. Some 30,000,000 tons are estimated to be economically available at present. Similar but generally smaller deposits occur in Alberta and British Columbia.

RECOVERY AND PROCESSING

The first recovery of sodium sulphate from Saskatchewan lakes, some 15 tons in 1919, was obtained by harvesting raw crystal from dried and frozen lake beds in the winter. Refinements of this method are

TABLE 3

Sodium Sulphate – Producers and Prospective Producers

Company	Plant Location	Source Lake	Approx. Annual Capacity	Remarks
Saskatchewan Minerals	Chaplin	Chaplin	150,000	Operating
" "	Bishopric	Frederick	70,000	Operating
" "	Fox Valley	Ingebrigt	150,000	Operating
Midwest Chemicals Limited	Palo	Whiteshore	120,000	Operating
Ormiston Mining and Smelting Co. Ltd.	Ormiston	Horseshoe	100,000	Operating
Sybouts Sodium Sulphate Co., Ltd.	Gladmar	East Coteau	50,000	Operating
Sodium Sulphate (Saskatchewan) Ltd.	Alsask	Alsask	50,000	Operating
Francana Minerals Ltd.	Cabri	Cabri	100,000	Under Construction

still used but most of the production is now obtained by pumping concentrated lake brine to prepared reservoirs in the late summer and recovering the crystal which is deposited when cold weather chills the brine in the fall. These operations are carefully timed and controlled so that brine is pumped from the lake at its highest estimated concentration for that particular season. Just before precipitation is complete the remaining liquid, which now contains a small amount of sodium sulphate and a concentration of some undesirable elements, is pumped back to the lake. This procedure concentrates the sodium sulphate in a clean-floored enclosure and removes much of the unwanted elements present in the natural brine, to provide a relatively high-grade product. The crystal bed is later removed to the plant by scrapers, shovels and draglines. One company, Ormiston Mining and Smelting Co. Ltd., uses a floating dredge to excavate crystal from the lake bottom and to pump it in brine through a 10-inch pipeline directly to the plant.

Processing consists essentially of removing water and dehydrating the natural crystal to an anhydrous powder using equipment such as submerged combustion units, evaporators and rotary kilns. In recent years rotary kilns have been used mostly for final drying of the product rather than for bulk dehydration. The end product is usually marketed as a bulk product grading about 97 per cent Na_2SO_4.

The availability of natural gas in Saskatchewan has had a favourable effect on efficiency and economics at several plants, mainly as savings on storage, maintenance and corrosion costs, which were appreciable when fuels such as low-grade coal or heavy oils were used.

INDUSTRY ACTIVITIES AND OUTLOOK

A comprehensive investigation of Saskatchewan sodium sulphate occurrences by L.H. Cole of the Federal Mines Branch, Ottawa, from 1921 to 1924, provided the basic information to initiate the industry and bring it to its present development. Cole's general exploration and technical studies encouraged early production and have been followed by detailed exploration and process development at various locations.

As paper consumption has increased, the demand for sulphate pulp has shown the greatest upward trend. This has increased the demand for sodium sulphate. At the same time other factors tend to reduce the demand for sodium sulphate, e.g., continual improvements in pulp-processing methods are reducing the amount of sodium sulphate required per ton of pulp produced and new pulping processes, such as that introduced by Dr. Rapson (using sulphur, salt and limestone), and the magnefite process, using magnesium sulphate, are being investigated. The possibility of other chemicals replacing sodium sulphate is of some concern to producers in Saskatchewan but in the case of the Rapson process, the shortages and rising cost of sulphur may discourage its use. The magnesium-based processes are attractive where polluting may be a problem. The new processes are being tested but it is not yet clear what effect they will have on the use of sodium sulphate. Although the increase in demand for sodium sulphate has not been directly proportional to the increases in kraft capacity, it has been continuous and substantial. For example, Canadian consumption in 1966 exceeded total Canadian production of 1964 and in each year exports were more than 100,000 tons.

In Saskatchewan the increasing demand for sodium sulphate resulted in the construction of new plants at Alsask and Ingebrigt, and the project under construction near Cabri. In addition, capacity has been expanded by Sybouts Sodium Sulphate Co., Ltd. at Gladmar, by the addition of a third kiln, and, at other plants by improvements in process and plant efficiency. At the end of 1967 production capacity in operation and under construction appeared to be adequate for demands over the next few years. A reduction in kraft pulp output in 1968 or 1969 could bring market problems for sodium sulphate producers, particularly with new producers vying for markets. Over the longer term, however, demands for sodium sulphate are expected to increase both in domestic and export markets and additional capacity, to supply new needs and to replace some current production which is decreasing or not dependable in seasons of unfavourable weather, will probably be required by 1975.

Although large reserves of sodium sulphate are available in Saskatchewan the more accessible and favourable deposits have been developed. Expansion of capacity probably will require careful and detailed investigation of a particular deposit and the design of a process and construction of equipment specifically for that deposit. In Canada, current production is obtained from beds of naturally formed crystal, but in the United States and other countries brines containing sodium sulphate are the source of production by evaporation-crystallization processes. Methods of producing sodium sulphate, and also magnesium sulphate, from brine deposits in Saskatchewan have been investigated. The Francana Minerals Ltd. project, near Cabri is the first in Canada to employ triple-effect evaporation to reduce raw crystal to anhydrous salt cake and processes such as this, perhaps following solar evaporation, may be applicable to future projects in Saskatchewan. On a smaller scale several producers have developed and introduced variations to standard processes to improve operating efficiency and quality of product.

The possibility of combining two Saskatchewan mineral products to manufacture a fertilizer not currently produced in Canada has been investigated by the Saskatchewan Research Council. Potassium chloride from Saskatchewan mines and sodium sulphate would be combined by one of several possible processes to produce potassium sulphate. Crops, such as tobacco, citrus fruit and potatoes, which require potash but are sensitive to chloride, consume large amounts of potassium sulphate. Several companies have shown interest in potassium sulphate production, notably Tombill Mines Limited.

Interest has been shown at various times in the production of sodium sulphate from occurrences in Alberta and New Brunswick. The Alberta occurrence, at Metiskow Lake, is similar to those in Saskatchewan. In New Brunswick, an underground deposit of glauberite, the mixed salt of sodium and calcium sulphate, has been investigated as a source of sodium sulphate. Both occurrences are potential sources but no current activity has been reported.

USES AND SPECIFICATIONS

About 95 per cent of sodium sulphate consumed goes into kraft paper, to which it adds strength and toughness. Some is used in the manufacture of newsprint, where an increase in wet strength permits the operation of production machinery at higher speed. Sodium sulphate is also consumed in the manufacture of glass, detergents, mineral-feed supplements, in base-metal smelting, in chemical and medicinal products and as a soil conditioner.

The physical and chemical specifications for sodium sulphate vary. Material of 95 per cent Na_2SO_4 content has been used for kraft paper but higher grades are desirable. Glass, detergent and chemicals require grades of about 98 per cent. Fine chemicals and medicinal products call for grades above 99 per cent. For detergents a high degree of whiteness is desired.

Uniform grain size, consistent quality and free-flowing characteristics are important in handling and use.

PRICES

The Canadian price of sodium sulphate (salt cake) bulk, carload, f.o.b. works as reported by *Canadian Chemical Processing* in October 1967 was $16.50 a ton.

As of January 1, 1968 one of the major Canadian producers increased the price to $18.00 and it was expected that the new price would hold.

According to the *Oil, Paint and Drug Reporter* of December 25, 1967, United States prices of sodium sulphate were:

	(per short ton)
Detergent, rayon-grade, car lots: bag	$38
f.o.b. works, bulk	34
Crude (salt cake), 100% Na_2SO_4, domestic bulk, f.o.b. works	28

TARIFFS

CANADA	
Crude (salt cake), per lb	
British Preferential	1/5¢
Most Favoured Nation	1/5
General	3/5
UNITED STATES	
Crude, or crude salt cake	free
Anhydrous, per long ton	$0.50
Crystallized, or Glauber's salt, per long ton	1.00
Reductions under Gatt (Kennedy Round)	
Salt cake, anhydrous, per long ton	25¢
Crystallized (Glauber's salt), per long ton	50¢

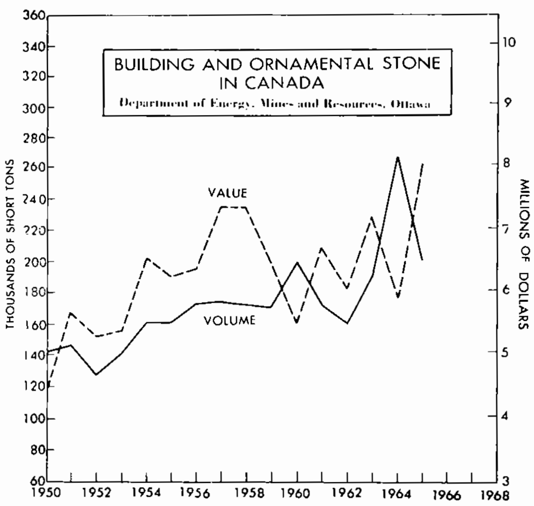
The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Stone, Building and Ornamental†

F.E. HANES*

Statistics for the production of building stone in Canada during 1966 are not available, however, production values for the following categories, i.e., total structural materials, total stone, total sand and gravel and total construction industries in Canada all show marked increases over 1965 statistics.

Because of the overall increases in every category of the construction industry during 1966, it is anticipated that certain types of dimension stone (if not all) will show increased production. The value of the year's production depends to a large extent on two principal factors. First, as an example, an increased production of 'rough building' stone concurrent with a decreased production of 'dressed monumental' stone can greatly affect the total value of the year's production. The second factor is the value per ton for each type of stone. Essentially, this is influenced by the quality of stone produced but can be varied by marketing and competitive price cutting. For example, the average value of rough building stone produced in 1964 amounted to $5.82 per short ton as compared with $19.79 per short ton in 1965. It is evident that such wide fluctuations in any one category of production make it impossible to estimate the following year's production.



The value of total structural materials increased 8.2 per cent in 1966 compared with 1965. Total stone production increased both in volume and value in 1966 over 1965 by 4.0 per cent and 5.1 per cent respectively. Sand and gravel likewise increased in volume and value by about 2 per cent and 10.3 per cent respectively. Total construction amounting to $11.2

*Mineral Processing Division, Mines Branch.

†This is a reprint of the 1966 review, subsequent information is not available.

billion in 1966 was an increase of 14.3 per cent compared with the 1965 value. It also represented an upward trend in annual increases when compared with the 13.3 per cent in 1965 over 1964 and the 12.1 per cent in 1964 over 1963.

Because of these increases and because of satisfactory reports from some of the larger dimension stone producers, an optimistic situation for dimension stone production in 1966 can be expected. Several large producers have indicated that large amounts of high-quality stone have been sold indicating that increases may be expected both in volume and value.

Table 1 shows the revised statistics for the Canadian Production of Building and Ornamental Stone for 1965 compared with 1964.

Table 1

Canadian Production of Building and Ornamental Stone

	1964		1965	
	Short Tons	$	Short Tons	$
By type				
Granite	158,733	3,632,507	96,726	5,360,572
Limestone	67,635	1,357,844	67,634	1,648,278
Marble	1,797	78,209	2,404	107,619
Sandstone	41,017	813,819	37,950	955,756
Total	269,182	5,882,379	204,714	8,072,225
By areas				
Atlantic provinces	4,943	395,949	5,392	376,126
Quebec	168,149	3,662,799	92,898	5,283,098
Ontario	82,647	1,438,091	85,608	1,543,553
Western provinces	13,443	385,540	20,816	869,448
Total	269,182	5,882,379	204,714	8,072,225

Source: Dominion Bureau of Statistics.

Table 2 shows the production of building and Ornamental Stone for 1965 and 1964.

Disposition of the building and monumental stones exploited across Canada can be seen by reference to the classification of stone by type and location (Table 2).

The development of the industry during 1965 resulted in the production of a better quality product of most types of stone compared with the 1964 production. The total volume of stone produced in 1965 was 24 per cent less than that produced in 1964. A large decrease in the volume of granite alone, amounting to 62,000 short tons, made up most of the 64,468 short ton total 1965 decreased-stone-production. A 37.2 per cent increase in total value was reported in 1965 while the value of the granite product alone increased by 47.6 per cent compared with 1964 values.

Total dimension stone production in Ontario in 1965 increased in volume by 3.6 per cent and in value by 7.3 per cent compared with 1964 figures. Quebec's production of dimension stone was reduced by over 75,000 short tons, however, the value of this production was 44.2 per cent greater than the 1964 value. The Western provinces show the greatest growth in the industry in 1965 by producing 55 per cent more stone increasing in value by 126 per cent over the 1964 value. These gains were due to increased production in granite and sandstone. However, only about one tenth of the total volume of stone was produced by the Western provinces as compared with approximately 88 per cent produced by Ontario and Quebec together. Quebec leads Ontario in total stone production by approximately 7,000 short tons in 1965.

TABLE 2

Production of Building and Ornamental Stone 1965.*

	Granite		Limestone		Marble		Sandstone		Total	
	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$
By type										
Building										
Rough	20,873	413,160	29,669	343,511	2,404	107,619	21,134	524,873	74,080	1,389,163
Dressed	20,409	2,588,336	33,563	1,258,840	–	–	6,925	296,250	60,897	4,143,426
Total	41,282	3,001,496	63,232	1,602,351	2,404	107,619	28,059	821,123	134,977	5,532,589
Monumental										
Rough	36,259	333,279	10	350	–	–	–	–	36,269	333,629
Dressed	10,739	1,805,298	100	4,000	–	–	–	–	10,839	1,809,298
Total	46,998	2,138,577	110	4,350	–	–	–	–	47,108	2,142,927
Flagstone	926	17,127	4,192	37,577	–	–	8,387	120,321	13,505	175,025
Curbstone	7,520	203,372	–	–	–	–	380	5,320	7,900	208,692
Paving	–	–	100	4,000	–	–	1,124	8,992	1,224	12,992
Total	8,446	220,499	4,292	41,577	–	–	9,891	134,633	22,629	396,709
Grand Total	96,726	5,360,572	67,634	1,648,278	2,404	107,619	37,950	955,756	204,714	8,072,225
By areas										
Atlantic provinces	1,226	183,416	491	2,460	–	–	3,675	190,250	5,392	376,126
Quebec	86,019	4,998,244	6,855	284,614	24	240	–	–	92,898	5,283,098
Ontario	1,981	28,912	49,597	761,972	2,380	107,379	31,650	645,290	85,608	1,543,553
Western provinces	7,500	150,000	10,691	599,232	–	–	2,625	120,216	20,816	869,448
Total, Canada	96,726	5,360,572	67,634	1,648,278	2,404	107,619	37,950	955,756	204,714	8,072,225

*Subject to revision.
– Nil.

TABLE 3

Average Prices of Stone By Type and Area*

By Type	Granite		Limestone		Marble		Sandstone		Total	
	1964	1965	1964	1965	1964	1965	1964	1965	1964	1965
Building										
Rough	5.82	19.79	9.95	11.58	44.50	44.77	14.64	24.84	8.27	18.75
Dressed	106.30	126.80	32.00	37.51	—	—	62.20	42.78	56.40	68.04
Monumental										
Rough	38.10	9.19	—	35.00	—	—	—	—	38.10	9.20
Dressed	126.80	168.11	—	40.00	41.70	—	—	—	123.00	166.93
Flagstone	14.50	18.50	6.10	8.90	25.00	—	14.06	14.35	10.00	12.96
Curbstone	32.30	27.04	—	—	—	—	—	14.00	32.50	26.42
Paving	—	—	—	40.00	—	—	14.44	8.00	14.40	10.61
By Area										
Atlantic Provinces	91.63	149.60	--	5.01	—	—	55.11	51.77	80.10	69.76
Quebec	21.61	58.11	31.81	41.52	11.63	10.00	9.19	—	21.78	56.87
Ontario	13.92	14.59	14.48	15.36	52.80	45.12	20.44	20.39	17.40	18.03
Western Provinces	18.88	20.00	32.71	56.05	—	—	30.13	45.80	28.68	41.77
Total	22.88	55.42	20.08	24.37	43.52	44.77	19.84	25.18	19.35	39.43

*Dollars per short ton.
— Not available.

The value of Quebec's share of granite-stone production amounted to \$5.3 million of the total \$8.1 million value reported for the industry. Ontario's share amounted to \$1.54 million. Granite, limestone and sandstone production in the Western provinces increased from 13,443 to 20,816 short tons and \$385,540 to \$869,448.

Quebec's share of the granite production decreased 4.6 per cent in 1965 compared with 1964 when its total production decreased from 93.5 per cent to 88.9 per cent. Quebec's share of the value increased to 93.2 per cent of the total value in 1965 compared with 88.2 per cent, an increase of 5 per cent, over 1964. The Western provinces with most of the remainder of the granite trade in 1965, approximately doubled their 1964 volume and value.

The production of dressed, monumental granite, increased in volume and value substantially while a large increase in volume from 8,311 to 36,259 short tons of rough monumental blocks (approximately 336.3 per cent) was produced during 1965 at approximately the same value.

Limestone production decreased in Quebec by almost 43 per cent in volume and 26 per cent in value during 1965. The Western provinces doubled the value of their limestone production from \$301,687 in 1964 to \$599,232 in 1965, an increase of 98.6 per cent.

Table 3 gives the average price of stone produced by type and area. Keeping in mind that volume production must be considered, information in this table gives a rapid means of comparing the trend for each type of stone and its economic value to the area from which it was produced. Average values for most types of stone showed increases. Marble was only slightly higher and dressed sandstone lower in 1965 compared with production in 1964. Quebec and the Western provinces show marked value increases suggesting increased quality stone production particularly since Quebec's granite production in 1965 dropped considerably. Ontario showed only a slight increase in average value per short ton while the Atlantic provinces showed a 12.9 per cent decrease in value.

IMPORTS AND EXPORTS

Table 4 shows the imports and exports for building and ornamental stone in 1965 and 1966.

The total import of stone decreased by 6.3 per cent from \$3,183,217 value in 1965 to \$2,983,000 in 1966. Imports of rough building stone in 1966 decreased by 32.8 per cent in volume and 34.9 per cent in value. Increased imports of dressed granite in 1966 amounting to 33.2 per cent were valued at \$310,000. Imports of rough marble increased from 1,515 to 7,003 short tons with an increase of 269 per cent in value for the raw material. Dressed marble imports decreased in value by 29.5 per cent. Rough building stone (n.e.s.) increased from 11,778 to 12,980 short tons for an increase in value of 20 per cent over the \$399,015 value of 1965. Natural stone basic products dropped from \$419,000 to \$358,000, a decrease of 14.6 per cent in 1966 compared with 1965.

Exports of rough building stone and natural stone basic products increased modestly in all categories with an overall increase in value of 8.9 per cent. The principal gain in exports was the improved value per ton of 14 per cent for only 3.9 per cent increase in volume of material.

CANADIAN DEPOSITS OF BUILDING AND ORNAMENTAL STONE

The following types of stone were produced or were potentially available for production during 1965. No major changes were noted in 1966.

TABLE 4

Building and Ornamental Stone,
Imports and Exports

	1965		1966	
	Short Tons	$	Short Tons	$
Imports				
Granite				
Rough	13,753	565,555	9,246	368,000
Dressed	..	232,793	..	310,000
Total		798,348		678,000
Marble				
Rough	1,515	121,830	7,003	450,000
Dressed	..	1,445,021	..	1,019,000
Total		1,566,851		1,469,000
Building stone, rough, n.e.s.	11,778	399,015	12,980	478,000
Natural stone basic products, n.e.s.*		419,003		358,000
Total imports		3,183,217		2,983,000
Exports				
Building stone, rough	20,611	605,374	21,409	690,000
Natural stone basic products**	..	532,348		549,000
Total exports		1,137,722		1,239,000

*Natural stone basic products including flagstones, floor tiles, roofing slate, slate mantels, etc.
**Shaped and dressed stone, granite, marble, slate.
. . Not available; n.e.s. Not elsewhere specified.

GRANITE

Nova Scotia. Grey granite is produced near Halifax, Middleton-Nictaux and Shelburne and black diorite is quarried in the Shelburne area. A hard, siliceous type of stone referred to as 'iron stone' is produced near Halifax, and quartzitic rocks referred to as 'blue stone' are produced in the Ostrea Lake and Echo Lake areas northeast of Dartmouth.

New Brunswick. A coarse- to medium-grained, grey-brown granite is sporadically quarried near St. Stephen, and fine- to medium-grained, grey, pink and blue-grey granites are quarried in the Hampstead (Spoon Island) district. A brown, pink-grey, coarse-grained granite is quarried sporadically near Bathurst. A deposit of light pink to salmon-coloured, medium-grained granite is quarried in the Antinouri Lake district. A black ferromagnesian rock containing plagioclase feldspar, augite, pyroxene, and hornblende is quarried in the Bocabec River area.

Quebec. Numerous quarries south of the St. Lawrence River supply fine- to medium-grained, grey and grey-white granites. These quarries are in the vicinities of Stanstead, St-Samuel-St-Sebastien and St-Gerard. Fine- and medium-grained, dark grey-blue essexite is quarried on Mont-St-Gregoire.

North of the St. Lawrence River, red, brown and black granites are quarried in the lake St. John-Roberval-Chicoutimi area; anorthositic black rocks are quarried north of Alma on the banks of the Peribonka River and from the St-Ludger-de-Milot area. Blue-grey, rose-grey, deeper pink-grey, dark green, black and grey gneissic granites come from the Riviere-a-Pierre district; pink, fine-grained granite is quarried at Guenette, near Mt-Laurier. St-Alban suppiies a pink-red granite and St-Raymond a banded gneiss. Brown-red to green-brown granites are quarried in the Grenville district. An augen-type, coarse-grained, rose-pink granite is potentially available south of Mont-Tremblant. A mauve-red granite is produced in the Ville-Marie area on Lake Timiskaming. A dark-coloured anorthositic-type rock is found in the Rouyn area.

Ontario. A salmon-pink, medium-grained granite is available near Kenora at Vermilion Bay. A black anorthosite is produced in the River Valley area near North Bay. Rough building blocks are quarried near Parry Sound from a multicoloured gneissic rock. Potential red granites are available in the Lynhurst and Gananoque areas. Deposits of black and red granite along the north shore of Lake Superior are potential producers of dimension stone. A pink granite deposit located near Belmont Lake is being quarried.

Manitoba. A durable, red granite of good quality is being quarried in the Lac du Bonnet area, 70 miles northeast of Winnipeg. Deposits of grey granite east of Winnipeg near the Ontario border are potential suppliers of building stone for local use.

British Columbia. A light grey and blue-grey, even-grained granite is potentially available from both Nelson Island and from Granite Island.

LIMESTONE

New Brunswick. Limestone for building construction is produced in the Saint John area.

Quebec. A fine- to medium-grained, fossiliferous, brownish grey limestone is produced in the vicinity of St-Marc-des-Carrieres; this stone can take a polish and is suitable for decorative use. Rough building stones are produced in small quantities from quarries located in the Montreal area. Small amounts of building blocks are quarried at scattered points in the province for local use.

Ontario. Much of Ontario's production comes from deposits of a dense, hard, grey-blue limestone in the Niagara Falls area. A thin-bedded, dense, buff to buff-grey limestone is quarried on the Bruce Peninsula near Wiarton and Owen Sound and some dark grey limestone is quarried near Ottawa.

Manitoba. A mottled, buff-brown to grey-brown dolomitic limestone is obtained from quarries in the Garson area. It is effectively used in rough and sawn finishes and can take a polish for use as a decorative stone.

SANDSTONE

Nova Scotia. A massive-textured, fine- to medium-grained, olive-buff stone is quarried in the Wallace area.

New Brunswick. A red, fine- to medium-grained sandstone is available from an old quarry in Sackville. Numerous local-use deposits are situated about the province.

Quebec. A deposit of buff and red sandstone is potentially available in the Trois-Pistoles area.

Ontario. From thin-bedded sandstone deposits, numerous quarries along the scarp face of the Caledon Hills, between Georgetown and Orangeville, produce a fine-grained, sometimes mottled or speckled building stone that is vari-coloured in light buff, brown and deep brown-red. Medium-grained, buff- to cream-coloured stone near Bells Corners is in limited supply. A highly coloured, medium-grained, banded and mottled sandstone is available from deposits located approximately 20 miles north of Kingston.

Alberta. A hard, very fine-grained, medium-grey sandstone, sometimes referred to as 'rundle stone', is quarried near Banff. It is used as rough building stone. Potential deposits of a buff-brown sandstone are located in the Province.

MARBLE

Quebec. A small quantity of light and dark grey, green-white mottled marble is quarried in the Philipsburgh area and Stukely area.

Ontario. Production of blue, blue-white, buff, white and grey, recrystallized limestone marbles is available in an area extending from Perth to Almonte. Also available from this area is a serpentinized marble. Potential sources of marble are being investigated as far west as Peterborough and as far north as Bancroft.

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1967

No. 52

Sulphur

P.R. COTE* and W.E. KOEPKE*

World output of sulphur in all forms increased over 5 per cent to an estimated 32 million metric tons in 1967 but for the fifth consecutive year production failed to keep pace with demand and prices continued to rise sharply. Suppliers in United States continued allocation of sales and shortages were once again met by releases from producer stockpiles. Beginning in the early 1960s, world sulphur consumption jumped from a historical growth rate averaging between 4 and 5 per cent annually to almost 8 per cent in the years 1963 to 1966. This sharp increase resulted mainly from the soaring demands by phosphate fertilizer manufacturers. Concerted efforts have been successful in boosting world sulphur output, but a production-consumption gap that developed in 1963 still exists. The 1967 gap has been estimated at between 400,000 and 600,000 tons of sulphur, slightly lower than in any of the three previous years. The sulphur shortage is not due to a lack of sulphur within the earth's crust but rather to a problem of economic recovery.

Since 1960, three years before the shortage developed, Canada changed from a net importer of sulphur to become the world's second largest producer and exporter of elemental sulphur surpassed only by the United States. About one third of the world's added output of elemental sulphur since the early 1960s has come from Canada. Domestic annual year-end capacity of sulphur in all forms by producers in 1967 (Table 2) amounted to 4.0 million tons. In terms of dollar value, sulphur ranked fourteenth among Canada's leading minerals in 1967 and is expected to be even higher in 1968, possibly among the top ten.

Sulphur is one of mankind's most important industrial chemicals and has a wide variety of uses. It is produced in one form or another in some 60 countries. Almost one half the world's output is produced in the elemental form from native sulphur deposits and from sour natural gas. Approximately equal proportions are recovered from metallic sulphides with minor quantities from sulphates. Nearly all sulphur is consumed in the form of sulphuric acid of which one half is used in the manufacture of fertilizers. The chemicals, and pulp and paper industries are the next largest consumers.

PRODUCTION AND DEVELOPMENTS IN CANADA

Canadian sulphur production in 1967 was almost 3.0 million tons** valued at $77.6 million, a tonnage increase of 10.6 per cent and a value increase of 63 per cent from 1966. Canadian sulphur production falls into three statistical classes: elemental, smelter gases and pyrite and pyrrhotite concentrates. Approximately 78 per cent of Canada's sulphur output in 1967 was in elemental form. Most of the latter was recovered from hydrocarbon sources for which sour natural gas in western Canada was by far the most important. Elemental sulphur was also recovered from crude oils at some oil refineries, the Athabasca oil sands, and minor quantities from the electrolytic refining of nickel-sulphide matte. As indicated by the statistical classification, the remainder of Canada's sulphur output came from metallic sulphides either in pyrites shipped or in smelter gases.

In 1967, most of the development and production activity was again directed toward hydrocarbon and metallic sulphide sources but considerable interest focussed on sedimentary occurrences of native sulphur in northern Alberta.

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*Mineral Resources Division, Branch.

**Short tons of 2,000 lbs used throughout unless otherwise noted.

TABLE 1

Canada, Sulphur Production and Trade, 1966-67

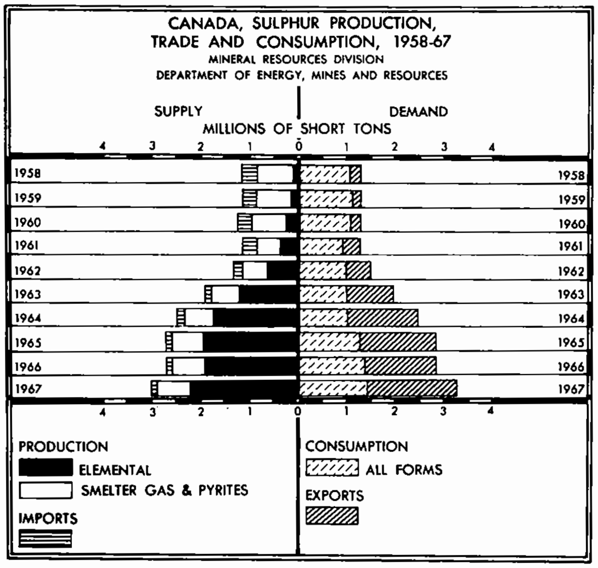
	1966		1967p	
	Short Tons	$	Short Tons	$
Production				
Pyrite and pyrrhotite[1]				
Gross weight	326,954		375,390	
Sulphur content	162,300	1,139,141	185,994	1,689,566
Sulphur in smelter gases[2]	500,338	6,050,750	482,614	5,860,631
Elemental sulphur[3]	2,041,528	40,253,685	2,322,223	70,021,487
Total sulphur content	2,704,166	47,443,576	2,990,831	77,571,684
Imports				
Sulphur, crude or refined				
United States	145,415	4,153,000	124,761	4,343,000
France	50	7,000	20	3,000
Total	145,465	4,160,000	124,781	4,346,000
Exports				
Sulphur in ores (pyrite)				
United States	. .	880,000	. .	952,000
Taiwan	. .	–	. .	115,000
Japan	. .	101,000	. .	–
Total		981,000		1,067,000
Sulphur, crude and refined				
United States	785,691	12,786,000	826,914	19,051,000
India	66,705	2,623,000	263,732	12,633,000
Australia	196,350	6,035,000	237,209	9,104,000
New Zealand	48,954	1,421,000	65,957	2,386,000
Taiwan	37,822	2,035,000	63,045	3,367,000
South Korea	4,079	196,000	61,444	2,420,000
Republic of South Africa	98,439	3,361,000	60,239	2,319,000
USSR	16,708	586,000	49,238	1,961,000
Hungary	44,477	1,177,000	35,894	1,001,000
Greece	11,760	409,000	27,231	1,026,000
Italy	11,592	331,000	16,665	778,000
Other countries	76,519	2,630,000	66,103	2,653,000
Total	1,399,096	33,590,000	1,773,671	58,699,000

Source: Dominion Bureau of Statistics.
[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 oils and from the treatment of nickel-sulphide matte.
p Preliminary; – Nil; . . Not available.

HYDROCARBON SOURCES

Most hydrocarbons contain sulphur. Minute sulphur contamination seldom presents a serious problem in marketing and utilization of hydrocarbons but when the sulphur content is unacceptably high it must be lowered. Sulphur present in natural gases is normally in the form of hydrogen sulphide (H_2S), a highly corrosive and noxious gas. Hydrogen sulphide is also a common constituent of sulphurous crude oils and coal. Sulphur recovered from hydrocarbons constitutes about one fifth of total world production.

Canada ranks as the world's largest producer of sulphur from hydrocarbons, followed by France and



United States. Canadian output, amounting to 2.3 million tons of elemental sulphur, represented over one third of the world's sulphur recovery from hydrocarbon sources in 1967.

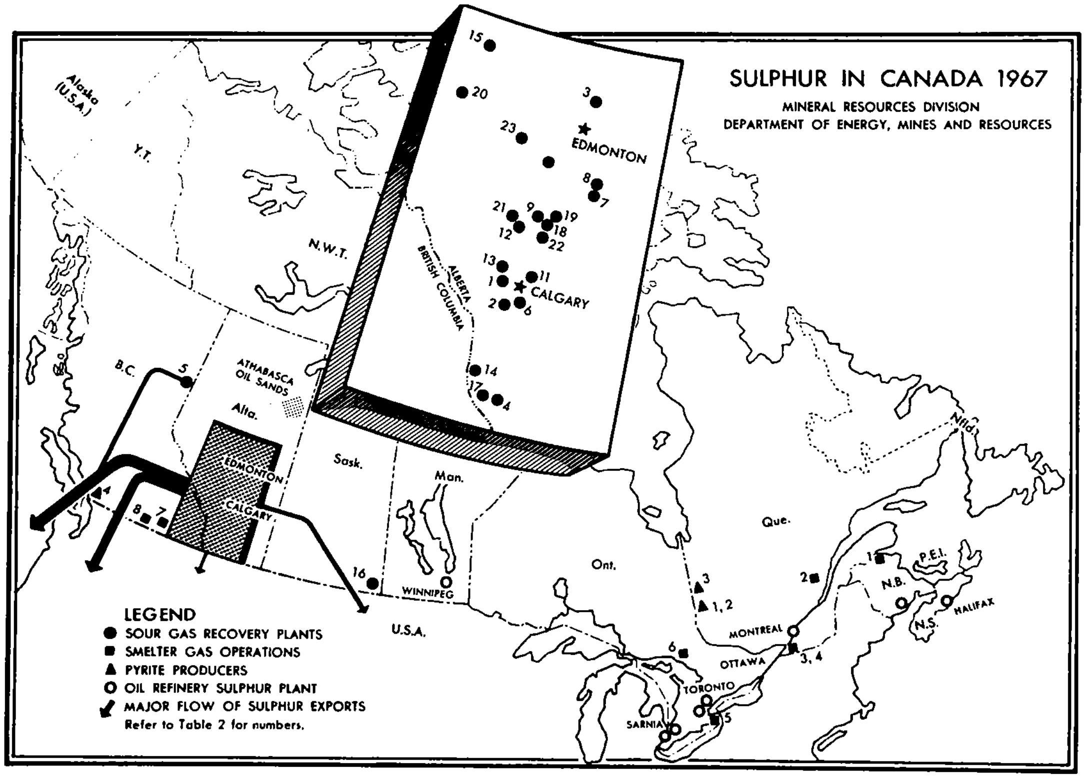
Sour Natural Gas

Many of the natural gas fields in western Canada contain hydrogen sulphide. Although the H_2S content of these 'sour gas' fields ranges as high as 87 per cent by weight of the total raw gas in place, most of the producing fields contain from 1 to 10 per cent H_2S. One field brought into production in 1966 contains 53 per cent H_2S.

The extraction process is reasonably simple. Raw sour gas is passed through a solution, normally monoethanolamine, which has an affinity for hydrogen sulphide. Concentrated H_2S is distilled off and passed into a Claus furnace where it is burned in a controlled air flow to form a mist of elemental sulphur droplets. The mist is condensed to molten sulphur and pumped to storage.

Canada's first sour gas sulphur plant came on stream in Alberta in 1951. By the end of 1967, 21 recovery plants were operating in Alberta and one each in British Columbia and Saskatchewan. Cumulative production to the end of 1967 in Alberta, as reported by the Oil and Gas Conservation Board, was 10,240,000 long tons of elemental sulphur. About 615,000 long tons of sulphur were in stockpiles at the end of the year. According to the Board, Alberta's recoverable reserves of sulphur from sour gas fields amount to an estimated 110 million long tons. Combined daily capacity of the sour gas plants in the three provinces was 9,488 long tons at the end of 1967. This daily capacity, which is based upon the designed maximum raw gas throughput, is never sustained throughout the year as gas sales are subject to seasonal fluctuations. If one makes an allowance for these fluctuations in gas processing, an annual operating rate of about 2.9 million short tons becomes realistic. Sulphur shipments from sour gas plants in 1967 were 2.3 million tons valued at $70 million. During 1967 one new plant was brought on stream, four expansions were completed, one plant was readied for start-up in early 1968, construction was started on five new plants scheduled for start-up in late 1968, and contracts were arranged for one expansion to be completed for late 1968. Several other projects were in the planning stages. The new plant brought on stream in 1967 by Canadian Delhi Oil Ltd. is designed to recover 20 long tons of sulphur daily from the Minnehik-Buck Lake field. Plant expansions in 1967 totalling 1,388 long tons of sulphur daily are indicated by a double asterisk in Table 2.

In February 1968, Pan American Petroleum Corporation brought a 1,480-long-ton-a-day plant on stream at Crossfield, Alberta; sour gas feed comes from the East Crossfield field. Five new plants in Alberta are scheduled for completion by the end of 1968. They will have a combined capacity of 1,482 long tons of sulphur daily and are (bracketed figures showing respective daily rated capacities of sulphur in long tons): Pan American, Bigstone gas field (315); Banff Oil Ltd., Rainbow Lake field (75); Hudson's Bay Oil and Gas Company Limited (HBOG), Caroline field (18); HBOG, Kaybob South field (1,044); and



HBOG, Brazeau River field (30). HBOG has also contracted for a 30-long-ton-a-day expansion at the Lone Pine Creek plant to be completed by late 1968.

Athabasca Oil Sands

The Athabasca oil sands constitute a vast deposit of relatively unconsolidated sandstone, impregnated with bitumen, covering some 30,000 square miles of northeastern Alberta. The Oil and Gas Conservation Board of Alberta estimated that oil reserves in place exceed 600 billion barrels. The bitumen averages 4.5 per cent by weight sulphur, thereby constituting an extremely large reserve of sulphur.

In late 1967, Great Canadian Oil Sands Limited (GCOS) completed the first commercial oil sand oil extraction plant at a cost of $240 million. The approved scheme allows GCOS to produce 45,000 barrels of synthetic crude daily. The sulphur plant is designed to produce 300 long tons of sulphur daily.

Oil Refineries

Some crude oils contain as much as 5 per cent sulphur either as hydrogen sulphide or in some other compound. Domestic crudes generally contain less than 1 per cent sulphur. The sulphur may either be removed in the form of H_2S or treated to form non-deleterious disulphides. Recovery techniques employed during oil refining are similar to those used in the removal of sulphur from sour gas.

In Canada, sulphur is recovered from imported crudes at oil refineries in Nova Scotia, New Brunswick, and Quebec. Output from these refineries (estimated at 60,000 tons in 1967) is not included in Canadian sulphur production statistics. Sulphur, recovered from domestic crudes at oil refineries near Toronto, Sarnia and Winnipeg, amounted to an estimated 40,000 tons in 1967.

During 1967, Shell Canada Limited began construction of a 16-ton-a-day sulphur plant at its refinery near Vancouver, British Columbia; it is scheduled for completion in 1968.

Coking Operations

Coke oven gases generally contain some hydrogen sulphide, the quantity being dependent upon the sulphur content of the coal being carbonized. Ordinarily, the H_2S is removed in 'iron oxide boxes' but it can also be recovered and converted to elemental sulphur.

TABLE 2

Principal Sulphur Plants and Operations in Canada, 1967

Operating Company	Source Field or Plant Location	% H_2S or Raw Material	Daily Capacity Long Tons	Annual Recovery Short Tons	Principal Product
HYDROCARBON SOURCES					
Sour Gas	(numbered on map)		(Rated)*	(Estimated)*	
1. Shell Canada**	Jumping Pound, Alta.	3–5	240	75,000	S
2. Royalite Oil Co.	Turner Valley, Alta.	4	35	7,000	S
3. Imperial Oil Limited	Redwater, Alta.	3	13	2,500	S
4. British American Oil	Pincher Creek, Alta.	10	675	85,000	S
5. Jefferson Lake Petro.	Taylor Flats, B.C.	3	325	60,000	S
6. Texas Gulf Sulphur	Okotoks, Alta.	33	370	160,000	S
7. British American Oil	Nevis, Alta.	3–7	123	35,000	S
8. Chevron Standard	Nevis, Alta.	7	140	48,000	S
9. Shell Canada	Innisfail, Alta.	14	100	25,000	S
10. British American Oil	Rimbey, Alta.	1–3	326	105,000	S
11. Petrogas Processing	Crossfield, Alta.	31	1,940	630,000	S
12. Home Oil**	Carstairs, Alta.	1	48	11,000	S
13. Canadian Fina Oil	Wildcat Hills, Alta.	4	137	45,000	S
14. Jefferson Lake Petro.	Savannah Ck., Alta.	13	375	34,000	S
15. Texas Gulf Sulphur	Windfall, Alta.	16	1,350	450,000	S
16. Steelman Gas	Steelman, Sask.	1	12	2,000	S
17. Shell Canada**	Waterton, Alta.	18–25	1,650	500,000	S
18. Amerada Petroleum	Olds, Alta.	11	180	68,000	S
19. Mobil Oil Canada	Wimborne, Alta.	14	295	90,000	S
20. Hudson's Bay Oil & Gas	Edson, Alta.	3	229	44,000	S
21. Canadian Superior	Harmattan-Elkton, Alta.	53	805	290,000	S
22. Hudson's Bay Oil & Gas	Lone Pine Ck., Alta.	8–17	102	28,000	S
23. Canadian Delhi Oil	Minnehik-Buck L., Alta.		18	5,500	S
Total sour gas sulphur			9,488	2,900,000	
Athabasca Oil Sands					
Great Canadian Oil Sands	Fort McMurray, Alta.	Oil sand	300	115,000	S
Crude Oil Refineries					
Various oil refineries	Eastern Canada	Imported crude	160	63,000	S
	Ont. and Man.	Domestic crude	200	79,000	S
SULPHIDE SOURCES					
Smelter Gases					
1. Belledune Acid	Belledune, N.B.	SO_2, lead-zinc		80,000	H_2SO_4
2. Alcan	Arvida, Que.	SO_2; zinc conc.		25,000	H_2SO_4
3. Allied Chemical	Valleyfield, Que.	SO_2, zinc conc.		25,000	H_2SO_4
4. Can. Electrolytic Zinc	Valleyfield, Que.	SO_2, zinc conc.		20,000	H_2SO_4
5. Sherbrooke Metallurgical	Port Maitland, Ont.	SO_2, zinc conc.		30,000	H_2SO_4
6. Canadian Industries	Copper Cliff, Ont.	SO_2, pyrrhotite		290,000	H_2SO_4
7. Cominco Ltd.	Kimberley, B.C.	SO_2, pyrrhotite		110,000	H_2SO_4
8. Cominco Ltd.	Trail B.C.	SO_2, lead-zinc		175,000	H_2SO_4
Total contained sulphur in smelter gases				755,000	
Pyrite and Pyrrhotite					
1. Noranda Mines	Noranda, Que.	sulphide ore			pyrite conc.
2. Normetal Mining	Normetal, Que.	sulphide ore			pyrite conc.
3. Quemont Mining	Noranda, Que.	sulphide ore			pyrite conc.
4. Anaconda Company	Britannia B., B.C.	sulphide ore			pyrite conc.

*Sour gas plants: daily rated capacities in long tons of 2,240 pounds as reported by respective operators; yearly estimates in short tons are based on past performance; **Sour gas plants expanded in 1967.

Beginning in mid-1967, Dominion Foundries and Steel, Limited, at Hamilton, Ontario, began producing elemental sulphur from coke oven gas using the British-developed Stretford Process. Capacity of the plant allows for the recovery of 8 tons of sulphur daily.

METALLIC SULPHIDE SOURCES

In Canada, the use of metallic sulphides for their sulphur content dates back to 1866. Early operations consisted essentially of roasting pyrite for the direct manufacture of sulphuric acid. In the 1920s, the use of base metal smelter gases for the manufacture of byproduct H_2SO_4 began near Sudbury, Ontario, and at Trail, British Columbia. Virtually all of Canada's sulphur production came from metallic sulphides prior to 1951 at which time the first sour gas plant was built. In 1967, metallic sulphides provided almost 670,000 tons of contained sulphur and accounted for 22 per cent of Canada's total sulphur production.

Smelter Gases

The recovery of sulphur from smelter gases is accomplished in the following manner. Effluent gas, normally containing from 1 to 12 per cent sulphur dioxide, is cleaned and the SO_2 is purified and cooled. Concentrated SO_2 is then used directly for the manufacture of H_2SO_4 via the contact-acid process. Occasionally, the SO_2 gas is compressed to liquid sulphur dioxide and in some cases is used for the manufacture of oleum (fuming sulphuric acid, $H_2S_2O_7$).

For this review, sulphur in smelter gases includes sulphur values recovered from metallurgical SO_2 gases and converted directly to H_2SO_4, liquid SO_2 and oleum. These metallurgical works include base metal and iron ore recovery plants located in New Brunswick, Quebec, Ontario and British Columbia. Production in 1967 was 483,000 tons of contained sulphur representing 16 per cent of Canada's total sulphur output.

During 1967, the first sulphuric acid was shipped from Belledune, New Brunswick; a 1,200-ton-a-day acid plant was placed on stream at Copper Cliff, Ontario; and some older acid units were replaced by a new 600-ton-a-day plant at Trail, British Columbia. The Belledune plant is operated by Belledune Acid Limited, a subsidiary of Brunswick Mining and Smelting Corporation Limited; the acid is shipped to the nearby plant of Belledune Fertilizer Limited, also a subsidiary of Brunswick. The plant at Copper Cliff is the third acid plant to be built by Canadian Industries Limited (CIL) dependent upon SO_2 gas from The International Nickel Company of Canada, Limited's (Inco) iron ore recovery plant. Combined daily output from the three acid units is 2,225 tons of H_2SO_4. In addition, at the nearby Copper Cliff nickel smelter CIL has an acid plant and a liquid sulphur dioxide (SO_2) plant. Much of the acid is shipped about 475 miles by unit-train to CIL's newly-completed fertilizer works near Sarnia, Ontario.

Pyrite and Pyrrhotite

Pyrite and pyrrhotite concentrates produced as a byproduct from base metal mining operations are sometimes marketed for their sulphur content. The distinction between the category of sulphur in pyrite and pyrrhotite and that in smelter gases used in this review is based upon this concept. For example, although most of the acid production at Copper Cliff, Ontario, and Kimberley, British Columbia, is dependent upon the roasting of iron sulphides, the sulphur production is reported as smelter gases. In other instances, however, the iron sulphide concentrates are sold and shipped for roasting elsewhere, so this production is reported as pyrite and pyrrhotite.

Four companies are engaged in producing and shipping pyrite and pyrrhotite concentrates (Table 2). Other companies are stockpiling concentrates pending future use. In 1967, Canada's pyrite and pyrrhotite shipments amounted to 375,000 tons of concentrates valued at $1.7 million; nearly all was exported.

Others

Minor tonnages of elemental sulphur are recovered during the electrolytic refining of nickel sulphide matte at Inco refineries at Port Colborne, Ontario, and Thompson, Manitoba.

Elemental sulphur will be produced from iron sulphides by Allied Chemical Canada, Ltd. at Falconbridge, Ontario, some 20 miles east of Sudbury. Sulphur dioxide (SO_2) gases will be supplied from Falconbridge Nickel Mines, Limited's proposed iron ore recovery plant. Other companies, notably Brunswick Mining and Smelting, have been conducting feasibility studies on the production of elemental sulphur from metallic sulphides.

SEDIMENTARY SOURCES

Native sulphur deposits such as those associated with salt dome structures in the Gulf Coast region of the United States and Mexico, and bedded deposits in Poland, the USSR and Sicily account for about one third of the world's sulphur production. Although numerous occurrences of native sulphur are known in Canada, none of them have been worked. Rising sulphur prices in recent years and increased demand sparked renewed interest in surface showings in northern Alberta. By the end of 1967, some fifty-two sulphur prospecting permits covering 2.5 million acres in the vicinity of Fort Vermilion were taken out. The native sulphur showings may be associated with Middle Devonian Elk Point evaporites. Should substantial reserves of sulphur be proven, costs associated with transporting production to markets will constitute a major factor in determining the economic feasibility of development. Native sulphur has been found in association with anhydrite near Truro, Nova Scotia.

TABLE 3

Canada, Sulphur Production and Trade, 1958-67
(short tons)

	Production[1]				Imports	Exports	
	In Pyrites	In Smelter Gases	Elemental Sulphur	Total	Elemental Sulphur	Pyrite[2] $	Elemental Sulphur
1958	512,427	241,055	94,377	847,859	375,331	1,879,251	7,608
1959	465,611	277,030	145,656	888,297	332,430	1,018,608	26,526
1960	437,790	289,620	274,359	1,001,769	328,765	1,259,151	143,040
1961	255,376[3]	277,056	394,762	927,194	329,556	899,755	217,866
1962	257,084	292,728	695,098	1,244,910	195,089	890,055	400,026
1963	235,410	353,243	1,249,887	1,838,540	150,637	937,883	820,929
1964	173,182	443,448	1,788,165	2,404,795	149,567	878,545	1,294,587
1965	186,960	444,758	2,068,394	2,700,112	162,201	978,828	1,497,947
1966	162,300	500,338	2,041,528	2,704,166	145,465	981,000	1,399,096
1967p	185,994	482,614	2,322,223	2,990,831	124,781	1,067,000	1,773,671

Source: Dominion Bureau of Statistics.
[1]See footnotes for Table 1. [2]Dollar value of pyrite exports. [3]Excludes pyrite used to make byproduct iron sinter beginning in 1961; pPreliminary.

CANADIAN CONSUMPTION AND TRADE

Canadian consumption of sulphur in all forms amounted to an estimated 1,400,000 tons in 1967. Elemental sulphur accounted for approximately 60 per cent of domestic consumption with the remaining 40 per cent being supplied from metallic sulphides.

Production of sulphuric acid in Canada totalled 2,749,000 tons, up 7.9 per cent from 1966. Although this increase is well below that in 1966, it compares favourably with the average annual growth rate of 7.4 per cent experienced since 1961. In 1967, sulphuric acid was produced at 19 plants across Canada in all provinces except Saskatchewan and Newfoundland. Difficulties in handling and transportation costs allow for very little international trade in sulphuric acid. The fertilizer industry, much of which is statistically classified with industrial chemicals, is by far the largest consumer of sulphuric acid.

In 1967, Canada's exports of elemental sulphur reached a record 1,773,671 tons valued at $58.7 million, a tonnage increase of 12.7 per cent from 1966. Almost one half of elemental sulphur exports went to the United States. Reflecting the sharp rise in world sulphur prices, the average value of Canada's elemental sulphur exports in 1967 increased to $33.09 from $24.00 in 1966 and $17.68 in 1965. Exports of pyrites for the manufacture of sulphuric acid were valued at $1,067,000 in 1967, up 10.9 per cent from 1966. Exports of sulphuric acid also rose to 84,280 tons, a 150-per-cent increase from 1966.

As shown in Table 3, Canada's imports of sulphur declined sharply over the past 10 years. In 1967, imports amounted to 124,781 tons of elemental sulphur, down 14 per cent from 1966. Sulphuric acid imports were negligible.

TABLE 4

Canada, Sulphur Consumption, 1958-67
(short tons)

	From Pyrites and Smelter Gases[e]	Elemental Sulphur*	Total[e]
1958	524,953	515,047	1,040,000
1959	606,518	483,482	1,090,000
1960	552,190	507,810	1,060,000
1961	406,952	513,048	920,000
1962	427,097	522,903	950,000
1963	451,550	558,450	1,010,000
1964	485,608	544,392	1,030,000
1965	490,777	739,223	1,230,000
1966	516,889	823,111	1,340,000
1967e	550,000	850,000	1,400,000

Source: Dominion Bureau of Statistics.
[e] Estimated. *As reported by consumers.

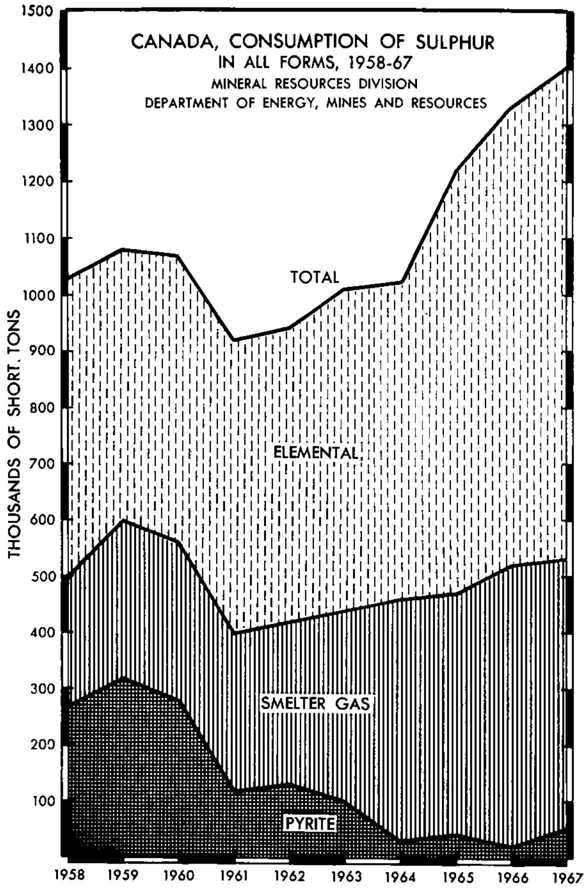


TABLE 5

Canada, Consumption of Elemental Sulphur by Industry, 1965-66 (short tons)

	1965	1966
Chemicals	162,008	192,135
Pulp and paper	424,523	463,086
Rubber products	3,158	3,362
Fertilizers	113,746	116,643
Foundry	13,106	14,433
Other industries*	22,682	23,452
Total	739,223	813,111

Source: Dominion Bureau of Statistics.
*Includes production of titanium pigments. pharmaceuticals and medicinals, starch, soaps and detergents, explosives, food processing, sugar refining and other minor uses.

TABLE 6

Canada, Sulphuric Acid Production, Trade and Apparent Consumption, 1958-67 (short tons – 100% acid)

	Production	Imports	Exports	Apparent Consumption
1958	1,586,000	39,345	23,252	1,602,093
1959	1,739,000	18,489	27,863	1,729,626
1960	1,673,000	9,526	43,430	1,639,096
1961	1,614,000	7,275	38,914	1,582,361
1962	1,696,000	7,162	34,960	1,668,202
1963	1,790,000	5,634	37,316	1,758,318
1964	1,941,000	4,209	67,409	1,877,800
1965	2,165,000	3,075	57,113	2,110,962
1966	2,546,000	6,948	54,948	2,498,000
1967p	2,749,000	3,626	84,280	2,668,346

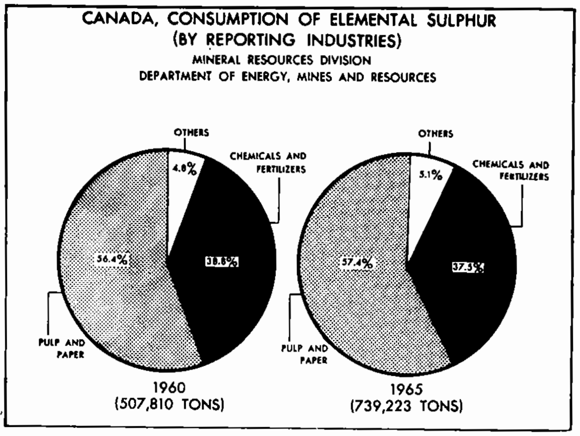
Source: Dominion Bureau of Statistics.
pPreliminary.

TABLE 7

Canada, Available Data on Consumption of Sulphuric Acid by Industry, 1965 (short tons – 100% acid)

Iron and steel mills	60,966
Other iron and steel	14,493
Electrical products	7,737
Vegetable – oil mills	216
Sugar refineries	273
Leather tanneries	2,506
Textile dyeing and finishing plants	56
Pulp and paper mills	59,346
Processing of uranium ore	70,795
Manufacture of mixed fertilizers[1]	404,095
Manufacture of plastics and synthetic resins	24,304
Manufacture of soaps and cleaning compounds	17,767
Other chemical industries	14,980
Manufacture of industrial chemicals[2]	1,041,401
Petroleum refining	18,359
Mining[3]	47,549
Miscellaneous[4]	91,367
Total accounted for	1,876,210

Source: Dominion Bureau of Statistics.
[1]Includes consumption for production of superphosphates in this industry. [2]Includes consumption of own make or captive acid by firms, classified to these industries. [3]Includes metal mines, non-metal mines, mineral fuels and structural materials.[4] Includes synthetic textiles, explosives and ammunition, and other petroleum and coal products.



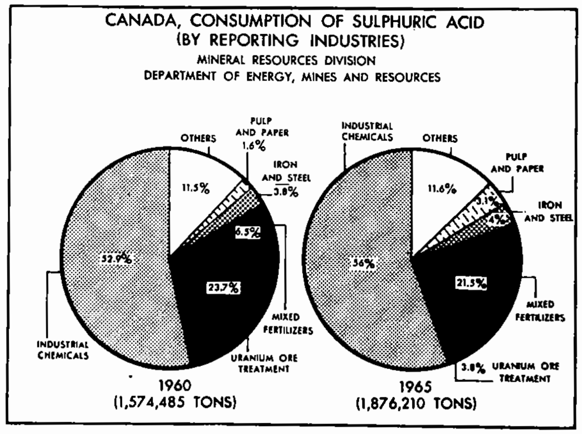


TABLE 8

World Production of Sulphur in All Forms, 1966-67
('000 metric tons)

	1966					1967e
	Frasch	Other Elemental	In Pyrites	In Other Forms*	Total	All Forms
USA	7,114	1,262	361	567	9,304	9,450
USSR	–	1,430	1,748	870	4,048	4,400
Canada	–	1,852	147	454	2,453	2,713
Japan	–	283	1,432	590	2,305	2,500
Mexico	1,637	68	–	21	1,726	1,900
France	–	1,519	32	134	1,685	1,775
Spain	–	75	1,130	23	1,228	1,275
Italy	–	95	630	210	935	950
China (Mainland)	–	170	500	70	740	780
Poland	–	477	105	110	692	770
W. Germany	–	84	206	270	560	630
Cyprus	–	–	475	–	475	485
Norway	–	1	325	31	357	360
E. Germany	–	120	115	130	365	380
Finland	–	74	71	130	275	290
Others	–	260	1,935	1,170	3,365	3,342
Total	8,751	7,770	9,212	4,780	30,513	32,000

Sources: US Bureau of Mines, The Journal of World Sulphur, Dominion Bureau of Statistics, and Canadian Minerals Yearbook 1966.
*Sulphur from smelter gases, gypsum-anhydrite, spent oxide, and others.
eEstimates except Canada and USA; – Nil.

WORLD REVIEW

In 1967, world production of sulphur in all forms was an estimated 32 million metric tons, about 26.3 million metric tons of which were produced by non-communist countries. United States, followed by Canada, Mexico and France continued to dominate the world scene, supplying 14 million metric tons of elemental sulphur. Consumption of sulphur in all forms by non-communist countries was an estimated 27 million metric tons.

Almost one third of the total world output of sulphur in all forms is produced in the United States with most of it being in the elemental form from Frasch mines in the Gulf Coast area. These deposits, when developed in the early 1900s, made large tonnages of low-cost sulphur available to world markets and drastically changed the pattern of international sulphur trade. In 1967, Frasch sulphur output in the United States was 7.1 million metric tons, virtually unchanged from the previous year. During 1967, development and construction work either continued or was initiated at a number of new and previously worked sulphur domes. Although these developments will result in significant increases in sulphur production during 1968 and subsequent years, exploration programs, measured in tens of millions of dollars, have failed to substantially increase sulphur reserves. Producer stocks of Frasch sulphur at the end of 1967 were 1.9 million metric tons, down 0.7 million metric tons from a year earlier. Also in the United States, Elcor Corporation was planning to extract sulphur from gypsum deposits in West Texas, at a rate of 350,000 tons annually beginning in late 1968.

Frasch sulphur production in Mexico increased approximately 11 per cent in 1967 to a record 1.8 million metric tons. Although exploration programs have failed to outline any new deposits of commercial importance, larger shipments of sulphur by current producers and from stockpiles are anticipated in 1968.

In France, the recovery of sulphur from sour natural gas amounted to 1.6 million metric tons in 1967, up 7 per cent from 1966. Additional sour gas discoveries in the Lacq area are expected to increase France's sulphur output during the next few years.

A number of other countries are expected to make worthwhile gains from 1968 to 1970. Poland is continuing to expand output from the native sulphur deposits near Tarnobrzeg. Production there, which began in 1960, reached an estimated 500,000 metric tons in 1967. Projects currently under study should double Poland's output from these deposits by 1970. In Japan, sulphur recovery from metallurgical gases and from sulphurous crude oils is being expanded; forecasts indicate that output from these sources will boost Japan's sulphur productive capacity to some 500,000 metric tons in excess of consumption. Spain, the largest producer of pyrites in Europe, plans to expand output to 3.4 million metric tons of pyrites, some 34 per cent greater than 1966 production. In the Middle East, construction is underway on six sulphur recovery plants based on hydrocarbon sources; two were scheduled to begin operation in 1968 with the remainder in 1969. Combined capacity of all six plants will be in the order of 1.0 million metric tons annually.

OUTLOOK

World sulphur production and consumption is expected to reach a near-balance in 1968. However, it is anticipated that a tight supply situation will continue until at least 1970 and prices will remain at high levels. Exploration programs conducted in the Gulf Coast area have so far failed to substantially increase reserves of low-cost Frasch sulphur. No large reserves of sour natural gas have been discovered recently. In addition, sulphur stockpiles that have been drawn upon to fill the production-consumption gap during the past few years are at a critically low level. A combination of these three factors and high price levels have made the recovery of sulphur from other sources, particularly pyrite, more economically viable. Other sulphur sources such as anhydrite and coal are being considered. However, higher prices would be required to allow large-scale sulphur extraction from these sources, and the inherent danger of product substitution would then arise. Even though it may be economically unattractive, the need to remove sulphur from metallurgical and industrial waste gases in combatting air pollution will contribute significant quantities of sulphur to world markets in the years ahead.

The outlook for Canadian sulphur is favourable. Production of elemental sulphur is expected to increase almost 40 per cent to reach 3.2 million tons in 1968. With this anticipated increase in production, Canada could become the world's largest exporter of elemental sulphur, displacing the United States.

PRICES

The Canadian price for sulphur and sulphuric acid as quoted in *Canadian Chemical Processing,* October 1967, were as follows:

	$	$
Sulphur, elemental, carloads, f.o.b. works, per long ton	30.00	35.10
Sulphuric acid, 66° Be, tanks, f.o.b. plants, East, per short ton	29.35	

United States prices as quoted by the *Oil, Paint and Drug Reporter* of December 25, 1967, were as follows:

Sulphur, crude, domestic dark, bulk, f.o.b. cars mines, per long ton	38.00
Sulphur, crude, domestic dark, f.o.b. vessels, gulf ports (for US and Canada), per long ton	38.00
Domestic bright $1.00 per long ton extra	
Sulphuric acid, 66 Be, tanks, works, per ton	31.15

TARIFFS

	British Prefer-ential	Most Favoured Nation	General
CANADA			
Sulphur and brimstone crude or in roll or flour	free	free	free
Sulphuric acid, per 100 lbs	17 1/2¢	22 1/2¢	25¢
Sulphuric acid, not including containers when in packages weighing not more than 100 lbs per 100 lbs	free	22 1/2¢	25¢

UNITED STATES	
Pyrites	free
Elemental sulphur	free
Sulphuric acid	free
Sulphur dioxide	12 1/2% ad val
Sulphur compounds	10.5% ad val

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Talc and Soapstone; Pyrophyllite

D.H. STONEHOUSE*

Total production of talc and soapstone in Canada during 1967 remained steady at 29,400 tons. Since 1965 output from Quebec province has increased slightly while that from Ontario has increased by about 70 per cent. An arrangement between the Ontario producer and an American firm whereby crude, white, flaky talc is exported to the United States for processing, was a factor in maintaining increased output from Ontario during 1967.

Imports of talc, from the United States and Italy, were slightly less than domestic production. High-grade cosmetic talc is imported from Italy for use in a growing industry. The material brought in from the United States is of relatively high quality and is used in the paint, ceramics and paper industries.

All production of pyrophyllite is exported to the United States.

PRODUCERS

QUEBEC

At South Bolton, 60 miles southeast of Montreal, talc and soapstone are produced from an underground operation by Baker Talc Limited. The mined talc is milled at Highwater, about 10 miles south of the mine site. The processing consists of primary and secondary crushing, fine grinding and air classification. The products are shipped in sacks or in bulk and are relatively low grade. Rough and sawn blocks of soapstone are sold for sculpturing. With the support of the Federal Department of Industry, the company is currently conducting a test program which is aimed at the production of a high-grade product for use in paints and plastics. Installation of new beneficiating equipment is expected to permit production of high-grade talc during 1968.

Broughton Soapstone & Quarry Company, Limited quarries talc and soapstone from two separate deposits near Broughton Station in the Eastern Townships. Several low-priced grades of ground talc are produced and soapstone is sawn into metal workers' crayons and blocks for sculpturing and refractory use.

ONTARIO

Underground operations at Madoc produce crude talc from which several low-quality grades of ground talc are obtained. The mine is operated by Canada Talc Industries Limited. Shipments of a high-grade, flaky talc, from a zone developed in 1965, were sent to the northeastern United States for processing to cosmetic- and pharmaceutical-grade products.

NEWFOUNDLAND

Pyrophyllite of relatively high quality is quarried at Long Pond near Manuels by Newfoundland Minerals Limited. Their entire output is shipped to American Olean Tile Company, Inc. at Lansdale, Pennsylvania, where it is processed and used in the manufacture of ceramic wall tile.

TECHNOLOGY

Talc is a hydrated silicate of magnesium, which occurs as a secondary mineral formed by the alteration

*Mineral Processing Division, Mines Branch.

TABLE 1

Talc and Soapstone; Pyrophyllite Production, Trade and Consumption

	1966		1967[p]	
	Short tons	$	Short tons	$
Production (shipments)				
Talc and soapstone				
Quebec[1]	16,087	208,306	15,800	229,000
Ontario[2]	13,509	219,924	13,600	240,000
Total	29,596	428,230	29,400	469,000
Pyrophyllite				
Newfoundland	40,548	608,220	30,000	450,000
Imports (talc)				
United States	23,906	1,097,000	25,275	1,161,000
Italy	994	70,000	1,207	88,000
France	18	1,000	–	–
Total	24,918	1,168,000	26,482	1,249,000
	1965		1966	
Consumption (ground talc, available data)				
Ceramic products	11,897		8,412	
Paints and wall-joint sealers	6,678		6,587	
Roofing	6,157		6,315	
Paper and paper products	954		2,164	
Rubber	1,905		1,617	
Insecticides	809		860	
Toilet preparation	1,294		719	
Cleaning compounds	711		685	
Pharmaceutical preparations	471		451	
Linoleum and tile	541		1,967	
Other products[3]	3,254		5,264	
Total	34,671		35,041	

Source: Dominion Bureau of Statistics.
[1]Ground talc, soapstone blocks and crayons; [2]Ground talc; [3]Chemicals, foundries, gypsum products, and other uses. [p] Preliminary; – Nil.

of other magnesium silicates such as serpentine, and pyroxene, or by the alteration of carbonates such as dolomite. Commercial ground talc sometimes contains small amounts of the original, unaltered minerals. Talc is soft and flaky, has a greasy feel or "slip" and grinds to a near-white powder. It is relatively inert chemically, has a high fusion point and low electrical and thermal conductivity. The distinction between different types is often vague. The end use to which a talc is put is sometimes a means of identifying its grade, e.g., cosmetic grade, pharmaceutical grade, paint grade or ceramic grade.

The deposits in southern Quebec were formed by the alteration of serpentinized peridotite and contain, in addition to talc, serpentine, magnesite and iron-bearing minerals such as chlorite. The ground products are somewhat off-white but can be used where colour specifications are not exacting. Higher quality products are possible if impurities are removed by some beneficiation process. The Madoc deposits are altered, near-white, dolomitic marble consisting principally of talc, tremolite and dolomite in various proportions. Ground products are near-white and naturally low in iron but are limited in use because of variable amounts of dolomite. Control of the dolomite content could result in widely acceptable high-quality products. Tremolite and similar fibrous minerals contribute desirable properties to some applications of commercial talc.

TABLE 2

Production and Trade 1958-67
(short tons)

	Production*		Imports	Exports
	Talc and Soapstone	Pyrophyllite (All exported)	Talc	Talc
1958	27,951	7,454	16,593	1,931
1959	24,733	14,443	18,501	2,053
1960	21,411	20,225	19,153	1,660
1961	23,691	24,425	20,205	2,000^e
1962	23,367	22,794	24,148	2,300^e
1963	22,467	31,783	27,539	2,200^e
1964	25,316	32,816	31,598	2,600^e
1965	22,703	30,134	27,858	3,500^e
1966	29,596	40,548	24,918	. .
1967^p	29,400	30,000	26,482	. .

Source: Dominion Bureau of Statistics.
* Producers' shipments.
e Estimated, not available as a separate trade class after 1960; p Preliminary; . . Not available.

The processing of talc in Canada is relatively simple, the important step being grinding and particle-size classification. Some beneficiation is achieved during grinding but high-quality products would require the application of electromagnetic separation or flotation. Micronizing has become a fairly common means of supplying extremely fine-ground talc to the paint, rubber and paper industries.

Soapstone is essentially an impure talcose rock from which blocks and crayons can be readily sawn. The grey soapstone in southern Quebec was altered from serpentinized peridotite.

Pyrophyllite, a hydrous aluminum silicate, is physically similar to talc. An alteration product of siliceous rocks, it is often accompanied by sericite and quartz. The colour, near-white, is generally acceptable to industry but the content of impurities must be controlled.

USES AND SPECIFICATIONS

Commercial talc is used mostly in a fine-ground state, although soapstone and steatite are used to a limited extent in the massive or block form. There are many industrial applications for ground talc but major consumers are limited to less than a dozen.

Higher-quality talc is used as an extender pigment in paints, a filler and coater in the manufacture of papers and an important raw material in the ceramics industry. Specifications for a talc pigment, as established in ASTM Designation D605-66T, relate to chemical limits, colour, particle size, oil absorption and consistency of, and dispersion in, a talc-vehicle system. A low content of such minerals as the carbonates, a near-white colour, a fine particle size with controlled distribution and a specific oil-absorption are important. However, because of the variety of paints and, therefore, of talc pigments, precise specifications are generally based on agreement between consumer and supplier. Paint features influenced by the use of talc as an extender are gloss, adhesion, flow, hardness and hiding power.

Paper manufacturers require talc free from chemically active substances and having high reflectance, high retention in the pulp and low abrasiveness. Micronized talc provides a high-gloss finish on coated paper for printing.

The ceramics industry specifies talc of fine particle size containing no impurities that would discolour the fired product. Both translucence and toughness of ceramics are increased by the use of talc.

Talc of high purity is demanded for use in cosmetic and pharmaceutical preparations. In this application, properties of fluidity and absorption permit mixing with the vegetable constituents used in cosmetics, and therefore fine, flaky particles are necessary.

Lower-grade talc is used as a dusting agent for asphalt roofing and gypsum board; a filler in joint-sealing compounds for dry-wall construction, floor tile, asphalt pipeline enamels and auto-body patching compounds; a diluent for dry insecticides; and a filler and dusting agent in the manufacture of rubber products. Particle size is the main specification; colour and impurity content are generally of little importance, although for asphalt pipeline enamels, a low carbonate content is specified to avoid a reaction with soil acids.

Because of its unusual characteristics, talc has a number of minor applications, including use in cleaning compounds, polishes, electrical cable, plastic products, foundry facings, adhesives, linoleum, textiles and oil-absorbent preparations.

Particle-size specifications for most uses require the talc to be basically minus 325 mesh. The paint industry demands from 99.8 to 100 per cent minus 325 mesh. For rubber, ceramics, insecticides and pipeline enamels, 95 per cent minus 325 mesh is usual. In the wall-tile industry 90 per cent minus 325 mesh is generally required. For roofing grades the specification is about minus 80 mesh with a maximum of 30 to 40 per cent minus 200 mesh.

Soapstone has now only very limited use as refractory brick or block but, because of its resistance to heat and its softness, it is still used by metal-workers as marking crayons. The ease with which it can be carved makes it an excellent artistic medium.

Pyrophyllite can be ground and used in much the same way as talc but at present the use of the Canadian material is confined to ceramic tile. It must be basically minus 325 mesh and contain a minimum of quartz and sericite.

Accurate and complete consumption statistics are difficult to obtain because of the many grades of talc products and the great variety of uses to which they are put. Traditional suppliers seem to dominate the market but, because talc is a comparatively low-cost commodity, increased prices can result in the use of substitutes. Alternative materials for many applications are:kaolin, fuller's earth, limestone, feldspar, mica, gypsum, kyanite, quartz and wollastonite.

PRICES

Quoted prices for talc vary greatly and are generally based on a wide range of specifications. A product of high purity, fine particle size and a high degree of whiteness would command a greater price than darker, coarser material. There is no published Canadian price list for talc products.

Talc prices in the United States as quoted in *Metals Week* of December 25, 1967, were as follows:

per short ton, f.o.b. mine or mill, containers included unless otherwise specified:

New Jersey: mineral pulp, ground (bags extra)	$10.50 – $12.50
Vermont: 100% through 200 mesh, extra white	12.50
99.5% through 200 mesh, medium white	11.50 – 12.50
New York: 96% through 200 mesh	29.00
99.9% through 325 mesh	40.00
100% through 325 mesh (fluid energy ground)	80.00
California:	
Standard	$35 – $41
Fractionated	35 – 68.50
Micronized	60 – 98.50
Cosmetic/steatite	42.50 – 59

TARIFFS

Tariffs in effect at the time of writing include:

	British Preferential %	Most Favoured Nation %	General %
CANADA			
Talc or soapstone	10	15	25
Pyrophyllite (expires 31 Oct. 1968)	free	free	25
Micronized talc (expires 30 June 1968)	free	5	25
UNITED STATES			
Talc, steatite or soapstone:			
crude and unground		0.05¢ per lb	
cut or sawed, or in blanks, crayons, cubes, disks or other forms		0.5¢ per lb	
Ground, powdered, pulverized or washed		12 1/2%	
Other, not specially provided for		24%	

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Tin

W.H. JACKSON*

DOMESTIC INDUSTRY

All Canadian industrial requirements of tin are purchased abroad as there are no domestic smelters and production of concentrate is negligible. Imports of tin in 1967 were 4,548 long tons valued at $16.6 million. The major consumers require high quality tin and Straits brand from Malaysia continues to be the main source. Metal of comparable quality, Thaisarco brand, is produced in a new smelter in Thailand and imports from this source have increased.

Cominco Ltd. is the only Canadian producer of tin concentrate. Byproduct production from the milling of lead-zinc ores at Kimberley, British Columbia, is exported for smelting to Mexico, Britain and the United States. In addition, a lead-tin alloy is obtained from the treatment of lead bullion dross in the indium circuit of the Trail, British Columbia, smelter of Cominco Ltd.

Exploration for tin was minimal during the year but, in New Brunswick, a diamond drilling program was carried out by Sullico Mines Limited on the Mount Pleasant prospect which has characteristics of the sub-volcanic type of lode tin deposit. The Geological Survey of Canada investigated tin-bearing silicates in skarns of northern British Columbia which are of scientific interest.

Possible further recovery of cassiterite from lead-zinc ores depends on advances in ore treatment techniques and the economics of processing. Fine-grained cassiterite, which cannot be recovered at present, is a mineralogical component of some sections of the copper-zinc-lead-silver orebody near Timmins, Ontario, of Ecstall Mining Limited, and is also present in minor quantities in the zinc-lead ores of Brunswick Mining and Smelting Corporation Limited in New Brunswick.

Consumption of primary tin declined slightly to 4,812 tons from 4,972 tons in 1966. The decrease was distributed among all major uses as shown in Table 1. Consumer stocks totalled 568 tons on December 31, 1967, a decrease of 89 tons from 1966.

Tinplate accounts for 52 per cent of tin consumption in Canada. There are two producers: Dominion Foundries and Steel, Limited and The Steel Company of Canada, Limited, both at Hamilton, Ontario. Improvements in the quality of steel used in tinplate manufacture and control of the electroplating process resulted in a better product requiring less tin which led to the cessation of hot-dip tinplate production at the end of 1966. All Canadian output of tinplate, estimated at 383,000 tons for 1967, is now electrolytic. Approximately 1 ton of tin is used for 160 tons of tinplate. The manufacture of solder accounts for 34 per cent of consumption, the two main producers being The Canada Metal Company, Limited and Federated Metals Canada Limited.

*Mineral Resources Branch.

TABLE 1

Canada, Tin Production, Imports and Consumption 1966-67

	1966		1967p	
	Long Tons	$	Long Tons	$
Production				
Tin content of tin concentrates and lead-tin alloy	317	916,870	237	908,865
Imports				
Blocks, pigs, bars				
Malaysia	3,052	12,110,000	2,886	10,508,000
Thailand	400	1,494,000	1,020	3,714,000
United States	771	3,153,000	636	2,359,000
Britain	31	127,000	6	21,000
Total	4,254	16,884,000	4,548	16,602,000
Tinplate				
United States	3,997	815,000	3,730	644,000
Britain	146	70,000	239	117,000
Total	4,143	885,000	3,969	761,000
Tin, fabricated materials, not elsewhere specified				
United States	9	36,000	15	61,000
Britain	...	1,000	...	3,000
Total	9	37,000	15	64,000
Consumption				
Tinplate and tinning	2,531		2,516	
Solder	1,651		1,643	
Babbitt	254		235	
Bronze	249		194	
Galvanizing	1		1	
Other uses (including collapsible containers, foil etc.)	286		223	
Total	4,972		4,812	

Source: Dominion Bureau of Statistics.
pPreliminary; . . . Less than one ton.

WORLD DEVELOPMENTS

The main centres of tin mining are situated in developing countries but consumption is concentrated in the major industrial countries. A common interest in market stability in the postwar period led first to a Study Group then to the First International Agreement in 1956 under the auspices of the United Nations. A characteristic of the tin industry is a low long-term growth trend in consumption and a fluctuating price for the metal. This characteristic is related to the long supply pipeline and the recurrent effects on supply of national or international events.

The Third International Tin Agreement is operative for a five-year period beginning July 1, 1966. Its main object is the consideration of short-term problems of price and supply. Decisions that affect price and supply are made with due regard to long-term trends. Consumer and producer members have an equal number of votes in a governing body, the International Tin Council. Canada is a signatory to the Agreement and, in proportion to its consumption, has 61 out of the total of 1,000 votes allocated to consumer members. The 17 consumer members account for 81,000 tons or almost 50 per cent of consumption. The United States and West Germany are the main non-member countries among western consuming nations. Producer members are Bolivia, Congo (Dem. Rep.), Indonesia, Malaysia, Nigeria, and Thailand. Counted together, producer and consumer members of the Council account for 95 per cent of the non-communist production of tin-in-concentrate.

For the Third Agreement producer members agreed to contribute £20 million to a Buffer Stock. In addition, a bank credit of £10 million was arranged. The ranges of permissible prices are set by the Tin Council and within this framework the manager of the Buffer Stock may use discretionary judgment to buy or sell tin metal but not concentrates on major markets to modify price fluctuations. Council may impose export controls to curtail metal supply if tin in the Buffer Stock and other conditions appear to warrant such action.

TABLE 2

Canada, Tin Production, Imports and Consumption 1958-67 (long tons)

Year	Production[1]	Imports[2]	Consumption[2]
1958	355	3,461	3,292
1959	334	4,183	4,233
1960	278	3,768	3,880
1961	500	3,525	3,953
1962	291	2,274	4,507
1963	414	4,193	4,942
1964	157	4,849	4,822
1965	168	4,993	4,892
1966	317	4,254	4,972
1967p	237	4,548	4,812

Source: Dominion Bureau of Statistics.
[1]Tin content. [2]Tin metal.
pPreliminary.

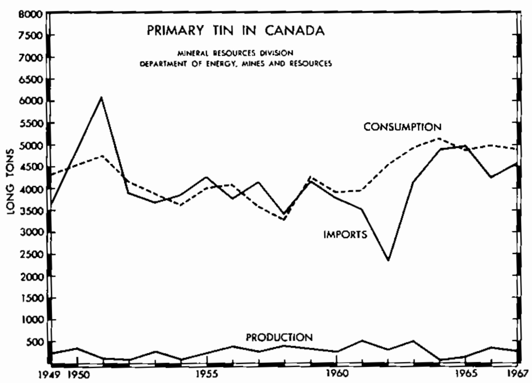
TABLE 3

Estimated World* Production of Tin-in-Concentrates, 1960, 1966-67 (long tons)

	1960	1966	1967
Malaysia	51,979	68,886	72,121
Bolivia	19,407	25,522	26,918
Thailand	12,801	22,565	22,299
Indonesia	22,599	12,526	13,597
Federation of Nigeria	7,675	9,534	9,340
Congo (Dem.Rep.)	8,900	6,925	7,013
Australia	2,202	4,486	5,379
Total, including countries not listed	136,000	163,500	171,100

Source: International Tin Council, Statistical Bulletin.
*Excludes communist countries, except Czechoslovakia.

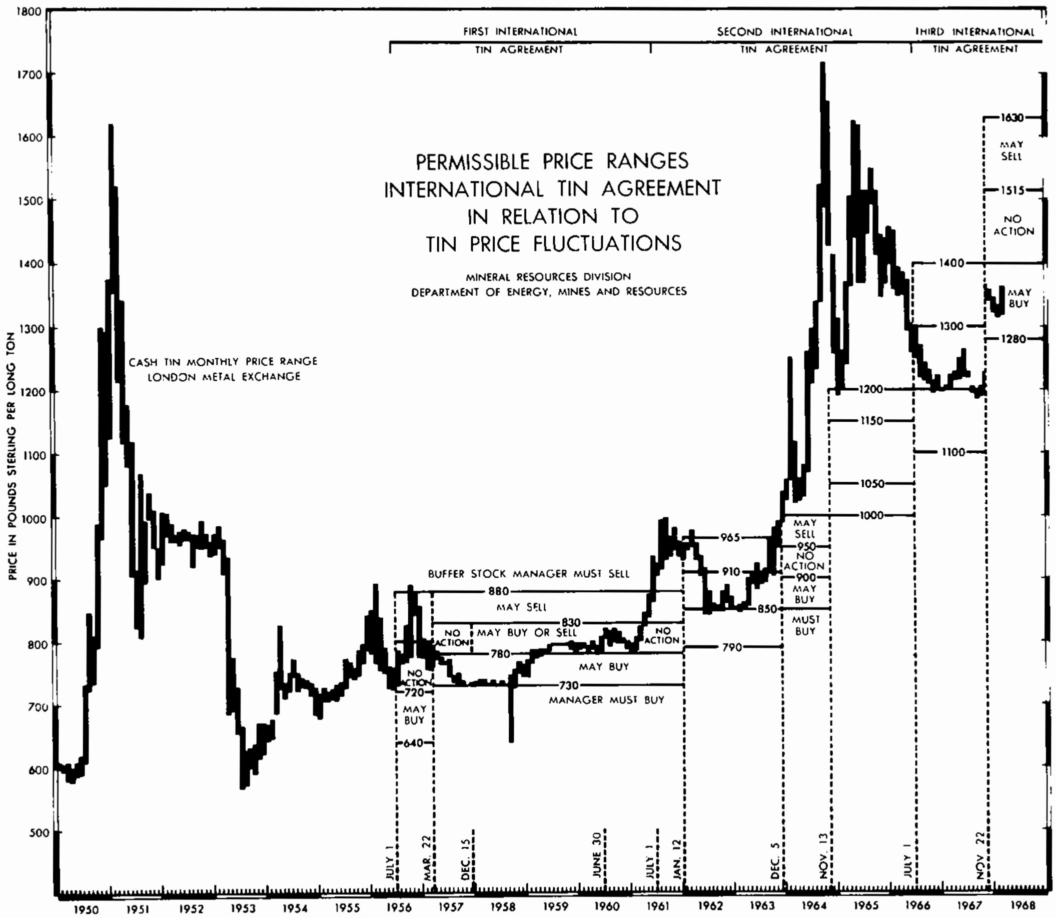
The accompanying graph shows tin price fluctuations from 1950 to 1967 in relation to price ranges considered desirable by Council at various periods. Throughout 1964 and 1965 prices exceeded these ranges and problems were mainly those of increasing supply. The shortfall between production and demand was met in various ways, including decreases in consumer stocks, sales from governmental stockpiles and improved utilization of tin by consumers. The tin position in 1967 reflected developments of the preceding year as shown in Table 5. In 1966, a 7,000-ton backlog of tin-in-concentrates accumulated in Thailand. These were subsequently processed and sold on the market in 1967. At the same time, the prolonged stimulation of price resulted in increases in mine production which exceeded non-communist world consumption. Sales from the US stockpile declined in 1966 and declined again in 1967 to minimal amounts as prices declined in November, 1967 below the effective General Services Administration selling price of $1.54 (US) a pound. The US stockpile objective remains at 200,000 tons. At the end of 1967, 61,324 tons were surplus to this requirement.



Price maintenance by Buffer Stock action resulted in purchases of 35 tons in the last quarter of 1966, rising to 4,755 tons by the end of 1967 and 7,165 tons as of January 18, 1968. To exactly reflect the devaluation of Sterling, price ranges in the Third International Tin Agreement were raised on November 20, 1967.

The position of communist countries is an uncertain factor in predicting the supply-demand balance. Net exports to these countries appear to be increasing. China (People's Rep.) is a major producer whose output is in the order of 25,000 tons annually. East Germany produces 1,200 tons annually. The USSR produced 33,000 tons in 1967, imported 4,000 tons and exported 10 tons.

In Indonesia, efforts to rehabilitate tin mining continued. A new sea-going dredge was turned over to Indonesian operation in April and foreign firms were allowed additional prospecting rights. The Pelim smelter at Muntock on Bangka Island was opened in February with first shipments in August. In Nigeria, tin production was maintained during civil disorders. Tin mining in the Congo (Dem. Rep.) was partially



disrupted by rebellion. Production in Bolivia, Malaysia and Thailand remained at high levels. In Malaysia, half of the 66 tin dredges treated ground below and up to 0.25 katty per cubic yard (one katty equals 1.33 1/3 lb). Further examples of dredging operations in southeast Asia serve as an indication of mineable grades. Pacific Tin Consolidated Corporation records that recovery was 0.26 pound tin per cubic yard, average price per pound was $1.47 US and that 65 per cent of pre-tax income, or a total of $1.15 million was paid in various taxes. The Siamese Tin Syndicate recovered 0.33 pound concentrate (approximately 72 per cent tin) per cubic yard.

As placer tin is unlikely to be found in Canada, examples of grades mined at various small-to-medium-sized underground mines in other countries are of general interest. In Britain, Geevor Tin Mines Limited recovered 20.25 pounds of 65 per cent concentrate per long ton treated and South Crofty Mines 22.7 pounds. Both are situated favourably to smelters. Pahang Consolidated, the sole underground mine in Malaysia, recovered 22.4 pounds of concentrate (70-75%) per ton treated. In Australia, Renison Ltd. treated 145,943 tons grading 0.84 per cent tin and recovered 867 tons of concentrate containing 543 tons of tin. Cleveland Tin N.L. is mining a deposit in Tasmania grading 0.91 per cent tin and 0.38 per cent copper. A tin concentrate of 60 per cent is produced with a 60 per cent recovery. The Union tin mine in South Africa reports plant feed in the order of 2 per cent tin after heavy-media separation to reject 0.1 per cent tin-content material. The fine grain size of the ore results in 65 per cent recovery. Fabulosa Mines, in Bolivia, mines ore grading 1.54 per cent tin.

TABLE 4

Estimated World* Production of Primary Tin Metal 1960, 1966, 1967 (long tons)

	1960	1966	1967
Malaysia	76,130	71,049	76,328
Britain	27,404	17,499	23,317
Thailand	nil	16,990	26,407
Netherlands	6,393	12,551	13,739
Federation of Nigeria	nil	9,933	9,131
Belgium	7,947	4,978	4,193
United States	13,500	3,825	3,049
Australia	2,254	3,665	3,594
Brazil	1,312	2,250	2,100
Congo (Dem. Rep.)	3,500	1,800	1,800
Total, including countries not listed	146,000	156,300	173,900

Source: International Tin Council, Statistical Bulletin.
*Excludes communist countries, except Czechoslovakia.

TABLE 5

Estimated World* Tin Position, 1965-67 (long tons)

	1965	1966	1967
Ore Supply			
Production of tin-in-concentrates	152,100	163,600	171,100
Stocks at year's end	19,500	24,800	23,300
Primary Metal Supply			
Smelter production of tin metal	148,700	156,300	173,900
Net sales to centrally-planned countries	3,000	2,000	5,000
Government stockpile sales	23,365	16,800	6,146
Buffer stock, sales +, purchases –	nil	35-	4,755-
Commercial stocks at year's end	52,100	51,300	53,800
Primary metal consumption	165,100	166,300	165,900

Source: International Tin Council, Statistical Bulletin.
*Excludes communist countries, except Czechoslovakia.

USES

Tin metal is unequalled for a protective hygienic coating on steel. The manufacture of tinplate represents the largest market for tin. Available world data indicates that 74,200 tons were used in 1967 to produce 11 million tons of tinplate. The tin coating on the steel varies with the product mix of tinplate plants from 0.25 pound per base box for electrolytic tinplate up to 1.25 pounds for the hot-dip process. Tinplate is sold by the base box (31,360 square inches). There is currently no substitute for tinplate in most container applications involving food processing but for beverages chrome-plated steel or aluminum are increasingly competitive.

The chemicals, stannous chloride and stannous sulphate as well as sodium stannate and potassium stannate, are used as an electrolyte in the tinplate process. The chloride stabilizes the colour and perfume in soap. Stannic oxide is an opacifier in enamels. Stannic chloride is the basic chemical in the manufacture of organotin compounds. Such compounds are used as fungicides and to stabilize chlorinated transformer oils and rubber base paints. The di-octyl and di-butyl compounds are stabilizers in polyvinyl chloride plastics, which have growing importance in container applications.

In recent years, a change in glass technology resulted from the development of a method of making plate glass by floating molten glass on a bath of tin.

The alloy applications of tin have a long tradition. The solders are indispensable for joining the side-seam on cans, for motor-car radiator cores, and for ensuring continuity in electrical contacts. Babbitt and white metal alloys are used for bearings and so are aluminum-tin alloys, which have a higher fatigue strength. The tin bronzes containing over 12 per cent tin are mainly used for castings; wrought alloys contain less tin. The gun-metals contain copper, tin, zinc, and sometimes lead to improve machinability. Continuous casting of standard shapes has reduced fabrication costs and caused renewed interest in bronze as an engineering material. Fusible alloys of tin, bismuth, lead, and cadmium are used in safety devices. Die-casting alloys of tin, antimony and copper have applications in jewellery. Modern pewter is essentially Britannia metal containing 90-95 per cent tin 4.8 per cent antimony and 1-2 per cent copper. As a minor alloying agent in other metals tin has a wide use. While aluminum has replaced tin in most foil and tube applications it is still used in some condensers and also in containers for pharmaceutical products.

PRICES

The average price in cents (US) for a pound of tin in 1967 on major markets was as follows: 1) Straits brand, delivered ex-works, Penang, Malaysia, 147.03 equivalent to £1371.8 per long ton; 2) Prompt tin, New York, 153.41 (£1431.8); and 3) Cash tin, 145.0 (£1353.3) and Forward tin, 145.18 (£1355.1), London, England, following Sterling devaluation. The difference in these market prices is nominally transportation and insurance costs plus the cost of financing. Straits ex-works is deliverable in 60 days and London Forward in three months. The other prices are for immediate delivery.

TARIFFS

	British Preferential	Most Favoured Nation	General
	%	%	%
CANADA			
Tin in blocks, pigs, bars or granular form for use in Canadian manufactures	free	free	free
Tin-strip waste and tinfoil	free	free	free
UNITED STATES			
Tin ore and black oxide of tin	free		
Tin, other than alloys of tin	free		
Tin alloys			
Containing, by weight, over 5% lead	1.0625¢ per lb on lead content		
Other	free		
Tin waste and scrap	free		

In Canada, larger consumers put their requirements to tender, and over a period the price paid is the equivalent of the New York price.

Tin concentrate prices are negotiated between the mine producer and the smelter operator. Smelting charges increase rapidly as the concentrate grade declines and are affected also by such impurities as Fe, WO_3, S, As and others. The *Metal Bulletin* quotes nominal values for concentrate delivered to smelters in Britain, specifying that for concentrate assaying 70 to 75 per cent tin, payment is made for the metal content less 1 unit (22.4 lb), less a smelting charge of £15 to £12 per long ton of concentrate treated. For concentrate assaying 40 to 65 per cent tin the unit deduction varies from 1.6 to 1.0 units and the smelting charge from £29 to £23. For concentrate assaying 20 to 35 per cent tin the smelter charge is £70 to £65, which includes the unitage deduction.

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in some countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Titanium

G.P. WIGLE*

Ilmenite ($FeOTiO_2$) and rutile (TiO_2) are the only commercial mineral sources of world production of white titanium-dioxide pigment and of titanium metal.

Canada's titanium industry is based principally on the mining and processing of ilmenite for the production of titanium dioxide (TiO_2) slag used in the pigment industry. Minor amounts of ilmenite are mined intermittently for use as heavy aggregate in special concrete.

Quebec Iron and Titanium Corporation (QIT) established a new annual production record in 1967 with an output of 537,906 long tons of titania slag (70-72 per cent TiO_2) and 366,660 long tons of co-product specialty iron (Sorelmetal).

Pigment producers are the major consumers of the growing output of the titanium mineral industry but titanium metal production continues to expand in response to requirements of the commercial and military aircraft industries.

PRODUCTION

CANADA

Ilmenite is mined by conventional open-pit methods in the Lac Tio-Allard Lake area of Quebec by Quebec Iron and Titanium Corporation. The ilmenite, crushed to minus 3 inches, is transported 27 miles by rail to Havre St. Pierre and shipped up the St. Lawrence River to the company's beneficiation plant and smelter at Sorel near Montreal. The company owns one of the world's largest known reserves of ilmenite, with indicated reserves averaging 35 per cent TiO_2 and 40 per cent iron. The ilmenite occurs with finely disseminated hematite (Fe_2O_3) as dykes, irregular lenses, and sill-like bodies within a large mass of anorthosite; it averages 86 per cent total oxides of titanium and iron and is upgraded, using spirals and cyclones, to 93 per cent combined oxides in the beneficiation plant. The upgraded product is calcined in rotary kilns to lower the sulphur content, cooled, and mixed with powdered anthracite. Electric arc smelting of the calcine-coal mix yields two grades of titania slag, and molten iron. Pigment-grade slag contains 70 to 72 per cent TiO_2 and metal-grade slag from 74 to 76 per cent TiO_2. The slag is tapped into slag-lined cars, cooled, solidified and then crushed to minus 1/2-inch. The iron, after tapping from the smelting unit, is superheated in an induction furnace, and desulphurized and carburized by a special ladle technique. Manganese and silicon may be added to make various grades of foundry pig iron. The iron is cast into forty- and sixty-pound pigs.

*Mineral Resources Branch.

TABLE 1

Canadian Titanium Production, Imports and Exports to the US, 1966-67

	1966		1967p	
	Short Tons	$	Short Tons	$
Production[1], shipments				
Titanium dioxide	..	20,505,484	..	23,704,420
Imports				
Titanium dioxide, pure				
United States	820	459,000	681	376,000
Britain	661	265,000	324	146,000
Spain	–	–	265	85,000
West Germany	109	43,000	259	107,000
Other countries	37	17,000	87	35,000
Total	1,627	784,000	1,616	749,000
Titanium dioxide, extended				
United States	9,774	1,856,000	9,763	1,860,000
Titanium metal				
United States	1,376	7,049,000	2,078	10,655,000
Britain	42	156,000	82	299,000
Japan	1	7,000	7	22,000
Total	1,419	7,212,000	2,167	10,976,000
Exports to the United States			1st 11 months	
Titanium, unwrought, waste and scrap, wrought and alloyed[2]	64	105,837	184	772,629
Titanium dioxide[2]	1,334	519,997	1,598	630,915

Source: Dominion Bureau of Statistics.

[1] Producers shipments of slag, TiO_2 content. [2] As reported by the US Department of Commerce, US Imports for Consumption, Report FT 125. No identifiable classes are available from Canadian export statistics.

p Preliminary; – Nil; .. Not available.

TABLE 2

Titania Slag and Iron Production, Quebec Iron and Titanium Corporation, 1966-67

(long tons)

	1966	1967
Ore mined	901,835	1,630,589
Ore beneficiated	1,129,181	1,287,713
Ore smelted	951,221	1,091,651
Titania slag produced	468,547	537,906
Iron produced	315,606	366,660

Source: QIT.

Canadian Titanium Pigments Limited, a wholly-owned subsidiary of National Lead Company, New York, operated its titanium dioxide plant at Varennes, Quebec, at capacity throughout 1967. Improvements in quality were made on market grades of pigment and new grades were introduced for specific applications. The major raw material, titanium dioxide slag, was purchased from Quebec Iron and Titanium Corporation. Liquid sulphur for the manufacture of sulphuric acid, the other principal raw material, was obtained from Laurentide Chemicals & Sulphur Ltd. of Montreal East. While the bulk of the pigment output was sold in the domestic market, substantial quantities were exported, particularly to Britain. Construction of the company's new chloride process unit began in the spring of 1967 and completion is scheduled for late 1968. The chloride unit will add about 10,000 tons a year to the capacity of the Varennes plant which is currently producing 30,000 tons a year using the sulphate process.

TABLE 3

Canadian Titanium Production, Trade and Consumption, 1958-67
(short tons)

	Production		Imports			Consumption	
	Ilmenite[1]	Titanium Dioxide Slag[2]	Titanium Dioxide Pure	Titanium Dioxide Extended	Total Titanium Dioxide Pigment[3]	Titanium Dioxide Pigments[4]	Ferro-Titanium[5]
1958	420,932	161,312	..	..	29,439	35,795	210
1959	626,310	234,670	..	..	30,598	35,865	101
1960	967,373	386,639	..	..	26,896	36,394	257
1961	1,155,977	463,316	..	..	26,621	37,098	198
1962	745,753	301,448	12,620	12,323	24,943	37,213	94
1963	915,360	379,320	3,367	9,319	12,686	37,480	78
1964	1,388,262	544,721	1,839	10,443	12,282	41,539	42
1965	1,318,402	545,916	1,565	9,534	11,099	39,682	65
1966	1,264,683	524,773	1,627	9,774	11,401	..	49
1967p	1,442,238	602,455	1,616	9,763	11,379	..	..

Source: Dominion Bureau of Statistics and company annual reports.

[1] Producers' shipments of ilmenite from Allard Lake and St. Urbain area. [2] TiO_2 content of slag for 1958 from D.B.S.; from 1959, gross weight of 70-72% slag produced, from company reports. [3] 1958 to 1961, titanium and other oxide pigments containing not less than 14% by weight of TiO_2; from 1962 on, includes pure and extended TiO_2, usually in the order of 35 per cent TiO_2. [4] Includes pure and extended TiO_2 pigments. [5] For 1968, gross weight; from 1959, Ti content.

p Preliminary; .. Not available.

Tioxide of Canada Limited is a wholly-owned subsidiary of British Titan Products Company Limited, London, England. The company's productive capacity was increased from 22,000 tons to 27,000 tons of pigment a year in 1966 and the plant was operated close to capacity during 1967. Most of the output was sold in Canada but significant quantities were exported to Britain, Europe and the United States.

Atlas Titanium Limited, Welland, Ontario, a subsidiary of Rio Algom Mines Limited, melts titanium and its alloys in a consumable electrode vacuum arc (CEVAM) furnace and processes the metal into various mill products for sale in domestic and foreign markets. Titanium baskets are widely used in the nickel plating industry and its mill products are directed to both military and industrial uses. The company's production in 1967 was at a level originally forecast for 1969.

Macro Division of Kennametal Inc., Port Coquitlam, British Columbia, manufactures titanium carbide and tungsten titanium carbide powders and granules that are extensively used in cutting, grinding and drilling equipment and processes. The company specializes in a refining process in which hard metal carbides are precipitated from a metal melt and recovered by leaching the acid soluble matrix.

Dominion Magnesium Limited, near Haley, Ontario, produces magnesium, calcium, and other mineral products. The company's production of co-products included 18,059 pounds of titanium in 1967.

UNITED STATES

The United States is the largest producer and consumer of ilmenite; it is also the largest consumer of rutile with 99 per cent of its supply coming from Australia, the principal of the few producers of rutile.

Ilmenite is produced in the United States at six mining operations in New York, Florida, Georgia, Virginia and New Jersey. Over half is produced in New York state and about one third in Florida. Domestic and imported ilmenite is consumed by some 100 firms of which six titanium pigment producers in the eastern United States use 95 per cent of the total. Rutile production in 1967 came from one company in Virginia. About 85 per cent of titanium metal used went into products for military and civilian aircraft, missiles, and spacecraft; the remainder was used in the chemical industry (7.5%), and in marine and other applications.

TABLE 4

Salient Titanium Statistics, United States, 1966-67

	Ilmenite		Rutile		Titanium[2]	
	1966	1967[e]	1966	1967[e]	1966	1967[e]
	(short tons)		(short tons)		(short tons)	
Production	965,000	965,000	..	..	..	..
Imports	187,000	180,000	151,482	150,000	5,676	7,800
Consumption	1,095,000	1,100,000	135,883	160,000	19,677	21,000
Price per pound	na	na	5.5¢[1]	6.0¢[1]	$1.32	$1.32
Price per long ton	$23-26	$23-26	na	na	na	na

Source: United States Bureau of Mines, Commodity Data Summaries, January 1968.

[e] Estimated; .. Not available; na Not applicable.

[1] f.o.b. Atlantic Seaboard, December 31. [2] Short tons of sponge metal.

TABLE 5

Australian Production of Ilmenite and Rutile, 1965-66
(long tons)

	1965		1966	
	Concentrate	TiO_2 Content	Concentrate	TiO_2 Content
Ilmenite[1]				
Production	441,514	239,191	517,716	284,908
Exports	360,719	198,395	356,462	195,965
Rutile				
Production	217,330	209,127	244,528	235,866
Exports	239,454	230,594	231,289	223,101

Source: Australian Mineral Industry, Quarterly Review, Vol. 19, No. 4, June 1967.
[1] Includes leucoxene.

AUSTRALIA

Preliminary estimates indicate that Australia's rutile production for 1967 could be some 270,000 long tons compared with 244,528 long tons in 1966.

SIERRA LEONE

The world's largest single rutile mining operation was prepared for production in 1967 by Sherbro Minerals Limited on large alluvial deposits in Sierra Leone. The cutting-head suction dredge and plant of Sherbro are reported to have a capacity of 100,000 tons of rutile concentrates a year. Some 40,000 tons of rutile concentrates were produced in 1967. Sherbro Minerals is jointly owned by Pittsburgh Plate Glass Company and British Titan Products Company Limited.

TITANIUM MINERALS

Ilmenite and rutile are the only commercially important minerals of titanium. The titanium-dioxide content of pure ilmenite is 53 per cent and that of rutile is 100 per cent. Titanium-bearing minerals such as anatase, leucoxene and brookite are associated with ilmenite and rutile and often comprise part of the marketed mineral concentrates. Ilmenite is recovered from alluvial and beach sands and from massive mineral deposits. The most important occurrences of rutile are in beach and alluvial sands but it is also found as a minor accessory mineral in rocks.

TABLE 6

Non-communist Production of Ilmenite Concentrates, 1966-67

(thousand short tons)

	1966	1967p
United States	965	965
Australia	578	600
Canada	525*	575*
Norway	408	400
Malaysia	130	..
Finland	130	..
Other countries	153	..
Total	2,889	2,940

Source: For 1966, US Bureau of Mines, Minerals Yearbook, 1966; for 1967, US Bureau of Mines, Commodity Data Summaries, January 1968.

*Titania slag containing 72% TiO_2.

p Preliminary; .. Not available.

PROCESSES, CONSUMPTION, USES

The sulphate process is the process most commonly used in producing titanium dioxide pigment but the chloride process is gaining importance in recent new production installations. The accompanying table outlines the capacity of the two processes in non-communist countries.

Manufacturers of white titanium-dioxide pigments use the major part of titanium mineral production. Titanium dioxide owes its superior whiteness to its high index of refraction which accounts for its opacity. Pigment-grade TiO_2 is manufactured principally by the sulphate process in which finely ground ilmenite or titania slag (70 per cent TiO_2) is treated in sulphuric acid in large lead-lined concrete "digesters". The product is dissolved in water to give a solution of titanyl sulphate that contains iron sulphate and other soluble impurities, and unreacted solids in suspension. Following clarification and filtration, the titanyl sulphate solution is boiled in tanks to precipitate hydrated titanium oxide in a very fine crystalline state. The precipitated titanium oxide pulp is calcined in oil-fired rotary kilns reaching a final closely controlled temperature approaching 1,000° Centigrade. The calcined oxide is ground and classified to ensure fine particle size then dried and packaged. Ilmenite mined by Quebec Iron and Titanium Corporation does not lend itself directly to the sulphate process because of the associated fine hematite in the ilmenite that would consume an excessive amount of acid. The pyrometallurgical process carried out by QIT at Sorel removes iron and produces the high-titania slag that can be processed with low acid consumption.

TABLE 7

Non-communist Production of Rutile Concentrates, 1966-67

(short tons)

	1966	1967p
Australia	274,172	290,000
Sierra Leone	–	40,000
India	2,002	..
Brazil	400e	..
Total	276,600	332,000

Source: For 1966, US Bureau of Mines, Minerals Yearbook, 1966; for 1967, US Bureau of Mines, Commodity Data Summaries, January 1968.

p Preliminary; e Estimated; .. Not available; – Nil.

TABLE 8

Estimated TiO_2 Pigment Production Capacity
Annual Capacity by Countries, 1968

	Sulphate Process	Chloride Process		Sulphate Process
	(short tons)			(short tons)
United States	633,000	198,000	Netherlands	12,000
Canada	57,000	10,000	Norway	16,500
Britain	179,200	(partly)	Mexico	7,700
France	55,100	27,500	Argentina	4,400
West Germany	215,000	19,000	Brazil	4,400
Belgium	16,500		South Africa	14,000
Italy	54,000		India	16,500
Spain	10,500		Japan	109,100
Portugal	6,600		Australia	41,400
Finland	17,600		GRAND TOTAL	1,725,000

Sources: Industrial Minerals, No. 4, January 1968 published by Metal Bulletin Ltd., London; Australian Mineral Industry, Vol. 19, No. 4, June 1967; Mining Engineering, February 1967.

The newer chloride process for producing titanium dioxide pigments uses titanium-bearing raw material mixed with carbon. The mixture is chlorinated to produce titanium tetrachloride, a volatile colourless liquid, which is oxidized to form titanium dioxide. The chlorine is recovered and recycled. Pigment production capacity using the chloride process has increased considerably since 1959.

Consumption of ilmenite is almost wholly confined to the manufacture of TiO_2 pigments, which have largely replaced materials formerly used as white pigments. Minor amounts of ilmenite are used in the production of ferrotitanium, titanium carbide, and as a coating for welding rods.

Consumption of TiO_2 pigments in Canada was an estimated 45,000 tons in 1967. Consumption, by industry in percentage terms, is shown in an accompanying table. Prices of titanium dioxide pigment increased about 6 per cent on April 1, 1967, to $25.00/100 lb for anatase pigment and to $27.00/100 lb for rutile pigment.

Rutile (TiO_2) is favoured as the raw material in the production of titanium tetrachloride, which is the intermediate compound in the production of titanium metal, and of TiO_2 pigment made by the chloride process. United States, in 1967, imported about 150,000 tons of rutile concentrates, 99 per cent from Australia.

TABLE 9

TiO_2 Pigment Use in Canada, 1967

Industry	Per Cent
Paint	66
Floor coverings	10
Paper	10
Rubber and plastics	7
Ink	1
Ceramics	2
Textiles	2
Others	2

TITANIUM METAL

Titanium metal is a low-density, silver-grey metal and is important for its combination of lightness, strength, and resistance to corrosion. The density of titanium is 0.164 pound per cubic inch compared with 0.28 for stainless steel. It is 60 per cent heavier than aluminum (0.10 lb/in^3) but only 58 per cent as heavy as alloy steel. Titanium alloys have strength and hardness approaching that of many alloy steels and the strength-to-weight ratio exceeds that of aluminum or stainless steel. The principal disadvantages in making use of this light metal are cost, fabrication difficulties, and reactivity at high temperature.

Titanium ingot production in the United States reached a new record, 25,960 tons in 1967 compared with 24,253 tons in 1966. Net shipments of titanium mill products were 27,271,629 pounds in 1967 and 28,034,566 pounds in 1966. Titanium sponge, the intermediate product in titanium metal ingot production, is also produced for domestic and export markets by Japan, Britain, USSR and other countries.

TABLE 10

Consumption of Titanium Concentrates in the United States, by Products, 1966
(short tons)

Products	Ilmenite[1]		Titania Slag		Rutile	
	Gross Weight	Estimated TiO_2 Content	Gross Weight	Estimated TiO_2 Content	Gross Weight	Estimated TiO_2 Content
Pigments	959,343	505,592	132,233	93,683	2	–
Titanium metal	–	–	–	–	2	–
Welding-rod coatings	2	–	3	–	23,904	22,656
Alloys and carbide	2,876	1,500	3	–	935	869
Ceramics	2	–	–	–	4	–
Fiberglass	–	–	–	–	909	884
Miscellaneous	487	287	–	–	110,135	105,782
Total	962,706	507,379	132,233	93,683	135,883	130,191

Source: United States Bureau of Mines, Minerals Yearbook 1966.

[1] Includes mixture containing rutile, leucoxene and ilmenite. [2] Included with miscellaneous to avoid disclosing confidential data. [3] Included with pigments. [4] Included with alloys and carbide to avoid disclosure. – Nil.

PRICES

United States prices quoted in *Metals Week* of December 1967, were:

Titanium ore	
f.o.b. cars, Atlantic ports,	
Rutile, 96%, per short ton, delivered within 12 months	\$119–\$121
Ilmenite, imported, long ton, shiploads, 54%	\$ 21–\$ 24
Slag, per long ton, 70%, f.o.b. shipping point	\$ 43
Titanium metal	
per lb, delivered, maximum 115 Brinell, 99.3%, 500 lb	\$ 1.32
Japanese sponge, 99.3%	\$ 1.23–\$ 1.25
Russian sponge, 99.6%, 100–500 tons	\$ 0.97–\$ 1.10
Ferrotitanium	
Delivered	
Low-carbon, per lb Ti, 25–40% Ti	\$ 1.35
Medium-carbon, per net ton, 17–21% Ti	\$375.00
High-carbon, per net ton, 15–19% Ti	\$310.00

TARIFFS

	British Preferential	Most Favoured Nation	General
CANADA			
Titanium ore	free	free	free
Titanium oxide, and white pigments containing not less than 14% TiO_2 by weight	free	12 1/2 %	15%
Titanium sponge and sponge briquettes, ingots, blooms, slabs, billets of titanium, or titanium alloys for use in Canadian manufactures (expires June 30, 1968)	free	free	25%
Ferrotitanium	free	5%	5%
UNITED STATES			
Titanium ore crude	free		
Titanium metal, unwrought waste and scrap*	20% ad val		
Titanium, wrought	18% ad val		
Ferrotitanium	10% ad val		
Titanium dioxide	15% ad val		
Titanium compounds	15% ad val		

*Duty temporarily suspended on scrap to June 30, 1969.

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT) that was convened in 1964 to consider reductions in tariffs submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968 and final reductions on January 1, 1972.

Tungsten

G.P. WIGLE*

Canada Tungsten Mining Corporation Limited, Canada's only tungsten producer, resumed operation in November 1967 after rebuilding its crushing and concentrating plant which had been destroyed by fire in December 1966. The open-pit mine and plant is in the Northwest Territories, near the Yukon border, about 135 miles north of Watson Lake. A leaching and roasting plant in North Vancouver provides final treatment of concentrates. From startup in November to the end of the year the new 350 ton-a-day concentrator treated 7,778 tons of ore averaging 2.36 per cent WO_3 and 0.40 per cent copper. Production was at near-capacity during 1966 to the time of the fire and for the year totalled 213,022 short-ton units† of tungstic oxide (WO_3) in scheelite ($CaWO_4$) concentrates. Ore reserves, at the end of 1967, available to open-pit mining, were estimated at 934,000 tons having an average grade of 1.71 per cent WO_3 and 0.45 per cent copper. The orebody is a replacement-type zone in limestone and lends itself to open-pit mining.

Demand for tungsten in 1967 was reduced from the record high of 1966 but remained above that of prior years. The price of tungsten in the United States remained at or near $43 a short-ton-unit of WO_3, c.i.f. US ports, duty paid, at which basic price some 6.4 million pounds were sold from stockpile by the United States General Services Administration.

WORLD PRODUCTION

World mine production of tungsten ores and concentrates in 1967 contained an estimated 59 million pounds of tungsten of which about 34 million pounds was from communist countries.

Production of tungsten in the United States was an estimated 8.2 million pounds in 1967. There are three major producers, two of which produce tungsten as a byproduct. Climax Molybdenum Company produced 1.4 million pounds of byproduct tungsten in 1967.

CONSUMPTION AND USE

United States consumption of tungsten in 1967 was an estimated 15 million pounds, 2.7 million pounds less than in 1966. The major consumers are the producers of tungsten carbides and metal powders, and the steel producers.

Tungsten carbide (WC) is the basic material for a great variety of cemented (or sintered) carbide cutting tools, dies and wear-resistant parts. The carbides are used for such tools as milling cutters, reamers, punches and drills; as dies for wire- and tube-drawing; and for wear-resistant parts of gauges, valve seats and guides. Large amounts are used by the mining industry as carbide-tipped rock-drill bits. The use of sintered carbide tire studs is contributing to the growing market for tungsten products. Flame-plating and plasma-plating of coatings of tungsten carbide and cobalt are used to provide wear-resistant facings on metal parts. Tungsten carbide in tiny spherical pellets is used in ball-point pens.

In high-temperature nonferrous and superalloy fields, where temperature resistance requirements are beyond the ability of highly alloyed steels, tungsten is

*Mineral Resources Branch.
†1 short-ton unit is 20 pounds of WO_3, and contains 15.862 pounds of W.

TABLE 1

Canadian Tungsten Production, Imports and Consumption, 1966-67

	1966		1967[p]	
	Pounds	$	Pounds	$
Production (shipments WO_3)	..	..	..	..
Imports				
Tungsten in ores and concentrates				
United States	147,500	279,000	141,500	352,000
Britain	–	–	51,400	116,000
China (communist)	258,100	414,000	22,500	27,000
Republic of South Africa	–	–	18,200	25,000
Other Countries	118,000	208,000	–	–
Total	523,600	901,000	233,600	520,000
Ferrotungsten[1]				
Britain	154,000	233,000	114,000	306,000
Portugal	–	–	74,000	178,000
United States	6,000	11,000	4,000	16,000
Other Countries	32,000	43,000	–	–
Total	192,000	287,000	192,000	500,000
Consumption, W content				
Tungsten ore	450,211	..	..	..
Tungsten metal and metal powder	402,716	..	..	..
Tungsten wire	7,412	..	..	..
Other[2]	80,868	..	..	..
Total	941,207			

Source: Dominion Bureau of Statistics.
[1] Gross weight. [2] Includes ferrotungsten, tungsten carbide powder, tungsten wire and rod, tungstic oxide and sodium tungstate.
[p] Preliminary; – Nil; .. Not available for publication.

TABLE 2

Canadian Tungsten Production, Trade and Consumption, 1958-67
(pounds)

	Production[1]	Imports		Exports	Consumption
	WO_3 Content	Tungsten Ore[2]	Ferro-tungsten[3]	Scheelite (W Content)	W Content
1958	690,976	884,100	199,000	477,079	316,738
1959	–	840,000	828,600	–	659,991
1960	–	1,156,900	980,700	–	947,222
1961	–	501,800	518,300	–	843,228
1962	3,580	2,854,300	285,600	..	1,039,628
1963	–	645,500	624,100	..	903,924
1964	–	389,800	172,000	..	740,410
1965	3,736,324	357,400	354,000	..	877,614
1966	..	523,600	192,000	..	941,207
1967[p]	..	233,600	192,000	..	..

Source: Dominion Bureau of Statistics.
[1] Producers' shipments of scheelite (WO_3 content). [2] Prior to 1964 reported in gross weight; commencing with 1964 reported in W content. [3] Gross weight.
[p] Preliminary; .. Not available; – Nil.

used as a base-alloy with varying amounts of cobalt, chromium, molybdenum, nickel or other refractory metals to produce a series of hard, heat- and corrosion-resistant alloys. High-temperature alloys are used in structural components in temperature environments of 1,700°F and higher. High-tungsten alloys are used in jet and rocket engine parts, missile nose cone inserts, nozzle inserts, guidance vanes, turbine blades and combustion chamber liners. Examples of such applications are nose cone insert castings made of an alloy containing 85 per cent tungsten and 15 per cent molybdenum and rocket-engine nozzle inserts of 98 per cent tungsten and 2 per cent molybdenum. Stellite, a nonferrous alloy containing from 5 to 20 per cent tungsten with cobalt and chromium, is used in welding rods for hard-facing and in high-speed tools.

TABLE 3

World Production of Tungsten Ore and Concentrates, 1965-67
(short tons, 60 per cent WO_3 basis)

	1965	1966	1967[e]
China (mainland)	18,700[e]	18,700[e]	..
USSR	12,700[e]	12,700[e]	..
United States	7,949	8,912	8,620
North Korea	4,900[e]	4,900[e]	..
South Korea	4,935	4,762	4,700
Canada	3,114	3,550	–
Bolivia	2,043	2,902	2,950
Australia	2,197	2,439	2,200
Portugal	1,811	2,222	2,300
Other Countries	4,751	4,453	5,530
Total	63,100	65,500	62,300

Source: US Bureau of Mines, Minerals Yearbook 1966, and US Bureau of Mines, Commodity Data Summaries, January 1968; and company reports.
[e] Estimate; .. Not available; – Nil.

Ferrotungsten, used principally as an additive in the manufacture of alloy steels, usually contains from 70 to 80 per cent tungsten. Alloy tool steel classifications range through relatively low-alloy tool steels to intermediate and high-speed tool steels. The low-alloys generally contain little or no tungsten, the intermediate class contains from 2 to 4 per cent tungsten and the high-speed tool steels contain from 1.5 per cent to 18 per cent tungsten and other carbide-forming elements such as chromium, molybdenum and vanadium.

Pure, or substantially pure, tungsten is important in electric lighting, electronics and electrical contact applications. Tungsten chemicals are used in textile dyes, paints, enamel and glass manufacture.

Scheelite concentrate of sufficiently high grade and low in undesirable impurities can be used for direct addition to steel melts. Copper, arsenic, antimony, phosphorus, sulphur and manganese are the impurities that most often present a problem in meeting concentrate specifications. Some scheelite contains chemically combined copper and/or molybdenum which can be removed only by chemical treatment. Scheelite concentrates for direct addition to steel should have a minimum tungstic oxide (WO_3) content of 70 per cent. United States stockpile specifications for scheelite concentrates are outlined in Bulletin 630, issued by the US Bureau of Mines in 1965; they call for a minimum WO_3 content of 65 per cent and low limits on the allowable content of many unwanted elements.

TABLE 4

Consumption of Tungsten in Canada, by Use, 1966
(lb of contained W)

Carbides	525,597
Alloy steels	366,575
Electrical and electronic	19,091
Other[1]	29,944
Total	941,207

Source: Compiled in Mineral Resources Division from data supplied by Dominion Bureau of Statistics.
[1] Includes nonferrous alloys, chemicals and pigments.

Among the principal consumers of tungsten in Canada are: *in Quebec,* Crucible Steel of Canada Ltd., Sorel; Shawinigan Chemicals Limited, Montreal; *in Ontario,* Atlas Steels Division of Rio Algom Mines Limited, Welland; Canadian General Electric Company Limited, Toronto; A.C. Wickman Limited, Toronto; Canadian Westinghouse Company Limited, Hamilton; Fahralloy Canada Limited, Orillia; *in British Columbia,* Macro Division of Kennametal Inc. Port Coquitlam; Staymet Alloys Limited, Pitt Meadows.

Macro Division of Kennametal Inc. is the only Canadian manufacturer of tungsten-carbide powders, matrix powders for diamond cutting-tools, cemented carbide alloy powders and tungsten carbide hardfacing and cutting granules. The company specializes in a refining process in which hard metal carbides are precipitated from a high-temperature metal melt and recovered by leaching the acid soluble metal binder. The raw materials used are scheelite and wolframite concentrates. Other Canadian consumers use partially processed and semi-fabricated tungsten products.

PRICES

According to *Metals Week,* December 25, 1967, tungsten prices in the United States were:

	$US
Tungsten ore, per short-ton unit of WO_3 (20 lb), basis 65%, foreign, c.i.f. US ports	
Wolfram	43.00
Scheelite	43.00

(50¢ per lb W duty included)

Tungsten metal, per lb		Ferrotungsten, per lb contained	
98.8% min., 1,000-lb lots	2.75	W 70-80%	
Hydrogen reduced, 99.99%	4.60 to 5.44	Regular	3.00 (nominal)
		"UCAR"	2.03

TARIFFS

	British Preferential	Most Favoured Nation	General
CANADA			
Tungsten ore and concentrates	free	free	free
Tungsten oxide in powder or lumps or in briquettes made with binding material used in steel manufacture	free	free	5%
Tungsten carbide, in metal tubes for use in Canadian manufacturing	free	free	free
Ferrotungsten	free	5%	5%
Tungsten rod and tungsten wire when used in Canadian manufacture	free	free	25%
Tungsten metal, in lumps, powder, ingots, blocks, or bars and scrap of alloy metal containing tungsten, for use of alloying purposes	free	free	free

UNITED STATES	During 1967
Tungsten ore	50¢ a lb on W content
Tungsten metal, unwrought, other than alloys,	
Lumps, grains and powders	42¢ a lb on W content plus 25% ad val
Ingots and shot	21%
Other	25.5%
Alloys	
Containing by weight not over 50% tungsten	42¢ a lb on W content plus 12.5% ad val
Containing by weight over 50% tungsten	25.5%
Waste and scrap	
Containing by weight not over 50% tungsten	42¢ a lb on W content plus 12.5% ad val
Containing by weight over 50% tungsten	21%
Wrought	25.5%
Ferrotungsten	42¢ a lb on W content plus 12.5% ad val

The Kennedy Round of tariff negotiations, completed in 1967, provided for the reduction of the US import tariff of 50 cents a pound of contained tungsten in ore and concentrates in five annual steps of five cents a pound until the tariff is reduced to 25 cents a pound on January 1, 1972. The import duty on tungsten ore and concentrates is as follows:

Effective date		Duty/ short-ton unit WO_3
Through 31/12/67	(15.862 @ 50¢)	$7.93
on 1/1/68	(15.862 @ 45¢)	7.14
1/1/69	(15.862 @ 40¢)	6.34
1/1/70	(" @ 35¢)	5.55
1/1/71	(" @ 30¢)	4.76
1/1/72	(" @ 25¢)	3.97

Uranium and Thorium

R.M. WILLIAMS*

URANIUM

Events in the uranium industry during 1967 provided convincing evidence that a commercial market for uranium has come to stay. Orders for the construction of nuclear power stations around the world were made at an increasing rate, necessitating upward revisions of nuclear capacity forecasts made only one year ago. In response to these prospective markets for uranium, exploratory effort has become intense and new mine development a reality. For example, development work is proceeding on three new uranium mines in Canada and plans for the reactivation of some past producers are underway. Three of Canada's four uranium producers negotiated significant new commercial contracts and prospects are encouraging for additional sales in the near future. In the nuclear field, construction permits were approved by the Atomic Energy Control Board for the construction of two additional 540 megawatt (MWe) units at Canada's second, full-scale nuclear power plant at Pickering, Ontario. As a result of these many developments, both foreign and domestic, the outlook for uranium producers in the medium term is promising indeed. So promising in fact, that the Canadian Nuclear Association, in November 1967, predicted that uranium demand in the non-communist world will exceed the capability to produce by 1973 unless immediate steps are taken to generate programs to increase capacity.

TABLE 1

Uranium Production in Canada, by Province
1966-67

	1966		1967p	
	Pounds	$	Pounds	$
Production (U_3O_8 shipments)				
Ontario	5,875,698	42,758,135	5,448,471	39,237,508
Saskatchewan	1,987,992	11,576,652	2,000,000	10,000,000
Total	7,863,690	54,334,787	7,448,471	49,237,508

Source: Dominion Bureau of Statistics.
p Preliminary.

*Mineral Resources Branch.

		1950	1951	1952	1953	1954	1955	1956	1957	1958
Gross National Product-current prices	$ millions	17,995	21,640[r]	24,588[r]	25,833[r]	25,918[r]	28,528[r]	32,058[r]	33,513[r]	34,777[r]
Gross National Product-1961 prices	"	23,809	25,673[r]	27,968[r]	29,408[r]	29,047[r]	31,788[r]	34,474[r]	35,283[r]	36,098[r]
Value of manufacturing Industry shipments	"	. .	. .	. .	. .	. .	19,513	21,637	22,178	22,171
Value of mineral production	"	1,045	1,245	1,285	1,336	1,488	1,795	2,085	2,190	2,101
Merchandise exports	"	3,104	3,897	4,282	4,097	3,860	4,258	4,760	4,789	4,791
Merchandise imports	"	3,125	4,005	3,916	4,248	3,967	4,568	5,547	5,473	5,050
Balance of trade Current account	"	−316	+517	+151	+443	+432	+698	+1,366	+1,455	+1,131
Corporation profits before taxes	"	2,506	2,800	2,640	2,611	2,290	2,965	3,345	3,056	3,075
Capital investment, current prices	"	3,862	4,424	5,424	5,968	5,802	6,531	8,196	8,813	8,488
Capital investment, 1961 prices	"	5,029	5,047	6,073	6,682	6,458	7,068	8,439	8,944	8,634
Population	000's	13,712	14,009	14,459	14,845	15,287	15,698	16,081	16,610	17,080
Labour force	"	5,163	5,223	5,324	5,397	5,493	5,610	5,782	6,008	6,137
Employed	"	4,976	5,097	5,169	5,235	5,243	5,364	5,585	5,731	5,706
Unemployed	"	186	126	155	162	250	245	197	278	432
Unemployment rate	%	3.6	2.4	2.9	3.0	4.6	4.4	3.4	4.6	7.0
Employment index	1961=100	86.1	92.3	94.7	96.2	93.2	95.4	101.9	100.0	100.4
Labour income	$ millions	8,629	10,103	11,208	12,110	12,432	13,215	14,719	15,825	16,180
Index industrial production	1961=100	57.3	6.72	65.3	70.1	70.0	77.7	85.8	87.2	86.7
Index manufacturing production	"	63.4	68.9	71.5	76.6	74.9	82.2	89.9	89.7	88.0
Index mining production	"	38.7	43.6	46.5	50.6	56.1	66.4	77.1	84.6	86.0
Index real domestic product	"	62.4	67.3	72.5	75.5	74.3	82.1	89.1	89.5	91.0
General wholesale price index	1935-39=100	211.2	240.2	226.0	220.7	217.0	218.9	225.6	227.4	227.8
Consumer price index	1961=100	79.6	88.0	90.2	89.4	89.9	90.1	91.4	94.3	96.8

. . Not available; [p]Preliminary; [r]Revised.

Indicators, 1950-1971

1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971[p]
36,846[r]	38,359[r]	39,646[r]	42,927[r]	45,978[r]	50,280[r]	55,364[r]	61,828[r]	66,409[r]	72,586[r]	79,749[r]	85,449[r]	93,094
37,470[r]	38,553[r]	39,646[r]	42,349[r]	44,531[r]	47,519[r]	50,685[r]	54,207[r]	56,016[r]	59,292[r]	62,363[r]	63,941[r]	67,449[r]
23,353	23,444	24,428	26,713	28,741	31,560	33,889	37,303	38,955	41,997	45,110[r]	45,991	49,243
2,409	2,493	2,603	2,881[r]	3,027	3,365	3,715	3,981	4,381[r]	4,722	4,736	5,713	5,924
5,022	5,256	5,755	6,179	6,799	8,094	8,525	10,071	11,112	13,251[r]	14,890[r]	16,820	17,744
5,509	5,482	5,769	6,258	6,558	7,487	8,633	9,866	11,075	12,358	14,130	13,952	15,607
+1,504	-1,243	-982	-830	-521	-424	-1,130	-1,162	-499	-107	-952[r]	+1,060	+262
3,504	3,359	3,427	3,819	4,188	4,819	5,199	5,145	5,020	6,142[r]	6,527[r]	5,943	6,822
8,500	8,328	8,292	8,769	9,398	10,980	12,935	15,088	15,348	15,455	16,927	17,798	19,788
8,568	8,281	8,292	8,632	9,020	10,253	11,515	12,820	12,993	12,880	13,560	13,840	14,692
17,483	17,870	18,238	18,583	18,931	19,290	19,644	20,015	20,405	20,744	21,061	21,377	21,681
6,242	6,411	6,521	6,615	6,748	6,933	7,141	7,420	7,694	7,919	8,162	8,374	8,631
5,870	5,965	6,055	6,225	6,375	6,609	6,862	7,152	7,379	7,537	7,780	7,879	8,079
372	446	466	390	374	324	280	267	315	382	382	495	552
6.0	7.0	7.1	5.9	5.5	4.7	3.9	3.6	4.1	4.8	4.7	5.9	6.4
102.2	100.7	100.0	102.2	104.4	108.2	114.3	120.7	122.6	122.7	126.9	127.1	127.5
18,309	19,303	20,136	21,597	23,057	25,219	28,181	31,907	35,275	38,493	43,203	47,036	51,712
94.2	96.2	100.0	108.3	115.2	126.6	137.0	146.0	150.8	161.1[r]	168.7[r]	172.3	177.6
94.5	96.1	100.0	109.0	116.2	127.4	138.8	148.7	152.3	162.5[r]	171.0[r]	169.5	173.5
97.3	97.4	100.0	106.2	112.1	126.0	131.9	134.2	142.1	152.4[r]	150.8[r]	174.8	182.5
95.7	98.0	100.0	106.9	112.7	120.4	129.0	138.0	142.4	149.8[r]	156.6[r]	160.4	167.6
230.6	230.9	233.3	240.0	244.6	245.4	250.3	259.5	264.1	269.9	282.4	286.4	289.9
97.9	99.1	100.0	101.2	103.0	104.8	107.4	111.4	115.4	120.1	125.5	129.7	133.4

TABLE 3

Exports of Uranium Concentrates from Canada 1957-67
(thousands of dollars)

Year	United States	Britain	West Germany	Japan	Switzer-land	India	Others	Total
1957	127,935	–	–	–	–	–	–	127,935
1958	262,675	13,503	314	14	–	–	–	276,506
1959	278,913	32,603	129	107	122	20	10	311,904
1960	236,594	25,905	294	147	1	570	30*	263,541
1961	173,914	18,256	513	40	–	–	–	192,723
1962	149,165	16,598	206	40	–	–	–	166,009
1963	96,879	40,509	–	130	–	–	13**	137,531
1964	34,863	39,627	159	4	–	–	–	74,653
1965	14,749	38,948	–	–	–	–	–	53,697
1966	13,761	22,605	–	–	–	–	–	36,366
1967P	1,047	22,772	–	55	–	–	–	23,874
Total	1,390,495	271,326	1,615	537	123	590	53	1,664,739

Source: Dominion Bureau of Statistics, exports as reported in Trade of Canada radioactive concentrates that cleared customs.
* Includes Sweden ($27,720); ** Brazil; P Preliminary.

NEW MINE DEVELOPMENTS

ONTARIO

The resurgence of exploration and development activity in the uranium industry that began in earnest in 1966 was responsible for a few rather significant projects. Of particular importance is the development of an Elliot Lake-type uranium deposit in the north part of Hyman township about 45 miles east of Elliot Lake. The property, initially explored in 1955-56 by Quebec Mattagami Minerals Limited, is being developed by Kerr Addison Mines Limited, which acquired an 80-per-cent interest in the claims in early 1965. Sufficient tonnage to warrant underground development was indicated by early 1967 and a new company, Agnew Lake Mines Limited, was incorporated. By year-end a seven-mile access road was completed, the shaft was collared, the construction of the associated surface plant and facilities was well underway, and the preliminary design of a 3,000-ton-a-day mill was in progress. Shaft sinking, to a depth of 3,000 feet, was scheduled for early 1968. Some 10.4 million tons of ore grading 1.54 pounds of U_3O_8 a ton have been indicated by diamond drilling of which 3.4 million tons grade 2.25 pounds of U_3O_8 a ton. The total cost required to put the mine into production, scheduled for early 1971, was estimated at $33,200,000.

At Elliot Lake, Rio Algom began sinking a new five-compartment production shaft 1.4 miles southeast of the Quirke mill in January 1967. Designed to hoist 5,200 tons of ore a day, the shaft had been sunk to almost 90 per cent of its planned 2,260-foot depth by year-end; construction of the necessary surface facilities was also well advanced. Shaft sinking, mine development and mine-plant facilities will cost an estimated $7,500,000. The new mine will be brought into full production over a four-year period beginning in 1968, and, concurrently, it is planned to gradually decrease production from the old Quirke mine.

Dewatering of Consolidated Canadian Faraday Limited's† mine, in the Bancroft area of eastern Ontario, was virtually completed in 1967. The shaft was rehabilitated, and a new underground development program began in early 1968. The mine, and 1,500-ton-a-day mill, produced from 1957 to 1964 and is being reactivated under an option agreement with Federal Resources Corporation of Salt Lake City, Utah. Federal, a major uranium producer in the Gas Hills area of Wyoming, will acquire a 51 per cent interest in the mine by financing its return to production. Contingent on favourable development results and market conditions, the mine is scheduled to be in operation by late 1969.

SASKATCHEWAN

At Beaverlodge, preparation of the surface facilities for Eldorado's new Hab mine, about 7 miles northeast of the Eldorado mill, was essentially completed. With

†The result of a consolidation, in May 1967, of The Canadian Faraday Corporation Limited, Augustus Exploration Limited, and Metal Mines Limited.

minor exceptions, most of the facilities were completely excavated below surface and are accessible by a 105-foot service adit and a 128-foot haulage adit. The shaft will be sunk to 720 feet, midway between two orebodies which contain an estimated total of 320,000 tons grading 0.30 per cent U_3O_8. Shaft-sinking will begin early in 1968; production is scheduled for early 1969 with the ore being trucked to the Eldorado mill. The cost of bringing the mine into operation on the basis of 250 tons of ore a day was estimated at $2.5 million.

Late in 1967 an agreement was reached between Hurley River Mines Ltd. and Dickenson Mines Limited whereby the former will acquire a major interest in Dickenson's Lake Cinch uranium mine, in the Beaverlodge area. Subsequently, Hurley River Mines, reorganized to form Hurley Uranium Ltd., in early 1968 requested tenders for dewatering the mine workings. The property produced from 1957 to 1960 at an average rate of about 150 tons of ore a day.

EXPLORATION

Canadian exploration for uranium, essentially dormant since 1956, has again reached significant proportions. Land acquisition which became increasingly apparent throughout 1966, primarily in the Elliot Lake area of Ontario and the Beaverlodge area of Saskatchewan, continued in 1967. As these areas became solidly staked, attention focussed on other areas of uranium potential located during the exploration surge of the 1950's but never fully investigated. One such area is the Agnew Lake area, mentioned earlier, where Kerr Addison staked a number of claims adjoining the property of Agnew Lake Mines Limited, in which it holds an 80-per-cent interest. Numerous other companies also acquired ground in the area, staking in townships to the south and west, hoping for additional discoveries in 'Elliot Lake-type' conglomerate horizons.

Most of the drilling for uranium during 1967 was concentrated in the Agnew Lake and Elliot Lake areas of Ontario. Considerable exploratory activity also took place west of Elliot Lake toward Sault Ste. Marie and in the Wanapitei area, about 40 miles north of Sudbury. In both these areas the objective is a broad belt of favourable Huronian sediments including Mississagi quartzites and quartz pebble conglomerates. The Bancroft area also drew some interest sparked by activity at the Faraday mine and at the Cavendish township property of Amalgamated Rare Earth Mines Limited. Minor activity was noted in Butt township on the west boundary of Algonquin Park; in Dysart township near Haliburton; in the Favourable Lake area about 110 miles north of Red Lake; in the Gogama area some 40 miles south of Timmins; and in Bridges township about 40 miles east of Kenora.

While most of the activity in northern Saskatchewan was concentrated in the general Uranium City – Stony Rapids area, some reports came from the Lac La Ronge area, 120 miles north of Prince Albert; the Foster Lake area, 100 miles north of Lac La Ronge; and the Frobisher Lake area, about 200 miles south of Uranium City. Of particular interest was the granting of exploration permits to Scoteire Exploration Ltd. and Dome Petroleum Limited for the recovery of uranium-bearing lignite coal in the Cypress Hills and Wood Mountain areas of southwestern Saskatchewan. Scoteire holds 1.75 million acres of land in its own right and an additional 250,000 acres held in partnership with Dome. At year-end considerable activity was also noted in the Wollaston Lake area, of northeast Saskatchewan, where the uranium potential of the Athabasca sandstone is being investigated.

In Quebec, the most active area during the new period of exploration has been the Johan Beetz area on the north shore of the St. Lawrence River, about 440 miles downstream from Quebec City. The major claim holder in the area is a syndicate headed by Consolidated Morrison Explorations Limited which staked a large 'granite' stock just northwest of Baie Johan Beetz. M.J. Boylen interests are also major claim holders in the area with ground on the north fringe of the stock. Preliminary investigations indicate that the stock is a highly complex pegmatitic granite and that the uranium mineralization is associated with magnetite. Pegmatite dykes are also common in the area and much ground has been taken to investigate the radioactivity associated with them. Most of the work carried out during 1967 field season consisted of geological mapping, trenching, and airborne radiometric and magnetic surveys, although some drilling got underway before the end of the year. Considerable activity was also noted at year-end in an area some 75 miles east of Johan Beetz.

Another area of significance in Quebec is just north of Lake Mistassini, some 420 miles north of Montreal, where more than 5,000 claims were staked to cover the basin of the Papaskwasati Formation. Some drilling was underway at year-end to test the uranium potential of the formation, which is not unlike the Gowganda Formation at Elliot Lake. A similar area was being investigated in the Otish Mountains, about 100 miles northeast of Lake Mistassini.

Other noteworthy activity in Quebec was in the St. Simeon area, on the north shore of the St. Lawrence about 120 miles downstream from Quebec City, where several companies were investigating the potential of uranium-bearing pegmatities. Minor activity was also noted in the Lac Forestier area, some 50 miles north of Mont Laurier; in Lytton township, North Gatineau County; in the Hunter's Point area, 25 miles northeast of Temiscaming; in various townships from 30 to 90 miles north of Ottawa; in Maisonneuve township, 125 miles northeast of Montreal; and on the west edge of the Labrador trough, southwest of Ungava Bay.

Foreign participation in Canadian uranium exploration has become increasingly evident. Of particular significance was the entrance of American Metal Climax, Inc., Federal Resources Corporation, Homestake Mining Company, Kerr-McGee Corporation, and Western Nuclear Inc., all major uranium producers in the United States. Kerr-McGee and Western Nuclear have both acquired a great deal of acreage in Canada and Federal, as mentioned earlier, has optioned the old Faraday mine. Two other United States majors, Newmont Mining Corporation and Phelps Dodge Corporation, are also participating in the search for uranium in Canada. Mokta (Canada) Ltée, a wholly-owned subsidiary of Compagnie de Mokta of France, began prospecting for uranium in Canada in 1964 and four West German firms entered into a uranium exploration program with British Newfoundland Exploration Limited in the Makkovik area on the east coast of Labrador early in 1967. Japanese interests are participating in exploratory work in the Beaverlodge and Yellowknife areas and have been negotiating with Kerr-McGee for an interest in the latter's large Elliot Lake holdings.

While some United States companies have come to Canada to search for uranium, Rio Algom Mines Limited, Denison Mines Limited and other Canadian companies have become active in the western United States. Rio Algom has developed a Triassic-sandstone deposit in the Lisbon Valley area, about 30 miles southeast of Moab, Utah, and is also participating in an extensive exploration program in Wyoming with Mitsubishi Metal Mining Company. Denison has established an exploration office in Denver and is active in all of the principal uranium areas of the Western states, especially in the Tallahassee Creek area of Colorado.

With the increase in uranium exploration activity in Canada, the Geological Survey of Canada has initiated a new uranium program in an effort to provide guidance in the search for additional uranium deposits. Investigations of favourable geological horizons in various areas of Canada which were begun in 1966 continued in 1967, and research in geochemical and geophysical prospecting techniques was accelerated. Foremost in this latter effort is the Survey's work in airborne gamma-ray spectrometry.

REFINING

Eldorado's refinery at Port Hope, Ontario, continued to be Canada's only producer of refined uranium products. Until early 1967 the bulk of Eldorado's refinery operation has been connected with the conversion of mine concentrates to orange oxide (UO_3), almost entirely on a refining contract for the USAEC. Substantial quantities of uranium metal and natural ceramic UO_2 powder as well as smaller quantities of enriched and depleted UO_2 powders and various uranium alloys, such as uranium carbide and uranium silicide, have also been produced for both domestic and export markets. Production of UO_3 is now confined largely to the conversion of concentrates delivered under the Canadian government stockpile program. Production of natural ceramic UO_2 powder doubled in 1967 and is expected to double again in 1968, primarily due to contracts with Ontario Hydro. With the expanding market for this product, output by 1972 is expected to reach 350 tons a year thus necessitating a conversion of the refinery's solvent extraction circuit from a batch process to a more efficient continuous circuit.

Research and development work on a process to produce zirconium* for use in the nuclear industry culminated in 1967 with a decision to proceed with the construction of a $7.6-million plant for its production at the Port Hope refinery. Also announced at year-end were plans to expand the Port Hope facilities to produce uranium hexafluoride (UF_6), used as feed material for the gaseous diffusion, uranium-enrichment process. The plant has been in a position to produce uranium tetrafluoride (UF_4), or green salt, from UO_3 for some time. Production of UF_6 would involve the addition of one further step, that of reacting the green salt with elemental fluorine in the form of fluorine gas. A decision to proceed with the project, which would cost from $10 million to $16 million depending on capacity, will follow completion of intensive market studies that were still under way early in 1968.

SALES

In January 1967, Eldorado completed its allotted deliveries under the 'master' contracts to the United States Atomic Energy Commission (USAEC) and the United Kingdom Atomic Energy Authority (UKAEA). Consequently, Rio Algom was the only operation still producing under the 'master' contract, making deliveries at the rate of 1,200 tons of U_3O_8 a year to the UKAEA until October 1971. All four producers are in a position to deliver to the Canadian government stockpile at a basic price of $4.90 a pound U_3O_8 until June 1970, and have negotiated permissive annual delivery rates for the period. Deliveries to the government stockpile during 1967 have not approached the maximum permissible quantities, Denison being the only producer that delivered its full permissible quota. The value of the uranium in the government stockpile at the end of 1967 was about $70 million.

The year 1966 marked the beginning of a new era for Canadian uranium, with the negotiation of two significant commercial contracts. The first, completed in August 1966, was between Rio Algom and the UKAEA for 8,000 tons of U_3O_8 to be delivered over an eight-year period beginning in January 1973. In May 1967, under the option provisions of the contract, the amount was increased to 10,000 tons. Other

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*See 1967 Mineral Review No. 60, Zirconium, by G.P. Wigle.

options provide for adjustments in the delivery rate of up to 15 per cent a year which could increase the total amount delivered under the contract to 11,500 tons of U_3O_8. The second involved sales to The Hydro-Electric Power Commission of Ontario, covering its uranium supply to the end of 1983. The contracts were announced in December 1966 and formalized late in 1967. They call for the delivery of some 1,300 tons of U_3O_8 from Eldorado, probably in the form of ceramic nuclear-grade UO_2 pellets, between 1968 and 1977, and the delivery of 6,300 tons of U_3O_8 from Rio Algom from 1970 to 1983.

In 1967, four additional contracts were announced. Denison will supply 10,500 tons of U_3O_8 to The Tokyo Electric Power Co., Inc., The Kansai Electric Power Co., Inc. and six other Japanese electrical utilities over a ten-year period beginning in 1969. Rio Algom will supply 5,000 tons to the same utility group over the same period. Eldorado will supply 500 tons to Tokyo Electric over a 5-to 6-year period, also beginning in 1969, as well as 1,000 tons of U_3O_8 to a West German utility, Kernkraftwerk Obrigheim (KWO), over an unspecified period, beginning in late 1968. Denison announced early in 1968 that it was completing two small uranium contracts for a total of 400 tons of U_3O_8 with private concerns in West Germany.

Prices under the new contracts have not been disclosed. Allowances were made in them, however, for adjustments to cover increased costs of labour and supplies, and in some cases, provisions were included for advance payments. The only price published in 1967 was a weighted average sales price of $7.14 a pound U_3O_8 for Rio Algom's three new contracts from 1969 to 1983. Prices being paid for U_3O_8 by electrical utilities in the United States are now in excess of $7.00 a pound for early deliveries.

Although Eldorado Mining and Refining Limited handled all marketing of Canadian uranium in the past, producers are now at liberty to negotiate their own sales contracts consistent with the Government's policy on peaceful uses announced in 1965.

TABLE 4

Canadian Uranium Sales Commitments, by Year, 1968-80
(short tons of U_3O_8)

Year	Tons	Year	Tons
1968	2,800	1975	3,900
1969	3,500	1976	3,950
1970	3,600	1977	4,000
1971	2,800	1978	4,000
1972	2,000	1979	2,200
1973	3,550	1980	2,200
1974	3,550	Total	42,050

Source: Canadian Nuclear Association, November 1967.

TABLE 5

Major Canadian Uranium Sales Commitments, by Country, as of December 1967
(short tons of U_3O_8)

Country	Tons
Canada (Ontario Hydro)	7,600
Japan (eight utilities)	16,000
Britain (UKAEA)	14,533
West Germany (KWO)	1,000

NUCLEAR DEVELOPMENTS

In April 1967, the Atomic Energy Control Board granted construction permits for two additional 540-MWe units at Ontario Hydro's Pickering, Ontario site. Construction of the first two units is well underway with completion scheduled for 1970 and 1971. Although the site has been designed for a total of eight units, it is expected that the next plant in Ontario Hydro's 500-MWe-a-year plan may be located elsewhere, possibly at a site now under consideration just west of Port Hope, Ontario. Construction proceeded during 1967 on Quebec Hydro's 250-MWe nuclear station, on the south shore of the St. Lawrence River near the village of Gentilly, Quebec.

Canada's first full-scale nuclear power station produced its first electricity on January 7, 1967. The 200-MWe Douglas Point Nuclear Power Station, on the east shore of Lake Huron near Kincardine, Ontario, is fueled with natural uranium and moderated and cooled with heavy water. It will produce electricity at about 6 mills a kilowatt hour. Unfortunately, the station has experienced 'teething' difficulties, primarily associated with the pumps which circulate the cooling heavy water, and the station had not reached full capacity by year-end.

In spite of the disappointment felt when, in May 1967, Finland cancelled its immediate plans to construct a nuclear power plant, Canada's heavy-water reactor systems continue to show a strong competitive position on the world market. In early 1967, financing arrangements were completed, allowing India to go ahead with its second Canadian nuclear power reactor. A third Canadian nuclear plant is under construction in Pakistan. Several other countries have indicated a preference for the Canadian design and in anticipation of these markets three Canadian engineering firms have formed a consortium, Canatom Limited, to compete in the growing international market. At year-end a consortium of Canatom, Canadian General Electric Company Limited and Hitachi Ltd. had submitted a bid to build a 350-MWe Canadian-designed nuclear power plant in Argentina.

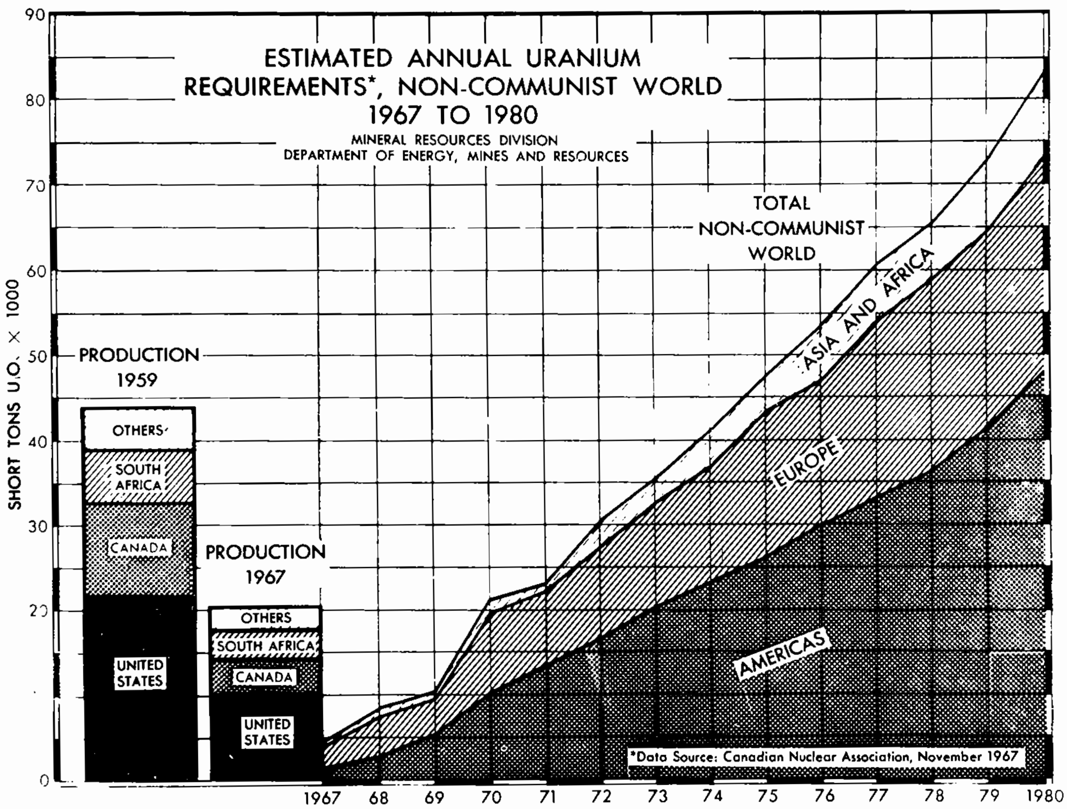
Canada's first heavy water production plant, at Glace Bay, Nova Scotia, was officially opened in May 1967. The plant, owned by the Government of Nova

Scotia and operated by Deuterium of Canada Limited, will produce initially at the rate of 200 tons a year and later at an expanded rate of 400 tons a year. The plant has not yet begun production. A second heavy water production plant is being constructed by Canadian General Electric Company Limited at Point Tupper, on the Strait of Canso between Cape Breton Island and mainland Nova Scotia. It is scheduled for production at a rate of 400 tons a year beginning in 1969.

OUTLOOK

At the end of 1967, the Atomic Industrial Forum reported that some 72,540 MWe of nuclear electric generating capacity was either operable, under construction, or ordered in the non-communist world. Of this total, some 50,240 MWe was in the United States and is scheduled for completion in the early 1970's. The U_3O_8 requirements of reactors capable of producing 72,000 MWe, for initial loading and for replacement over a 30-year operating life, will be in excess of 320,000 tons. In May 1967, the USAEC estimated that the installed nuclear capacity in the United States by 1980 would be 120,000 to 170,000 MWe and that an annual uranium requirement of 35,000 to 40,000 tons of U_3O_8 would be necessary to support this capacity. Subsequently, the Canadian Nuclear Association completed a similar study covering the non-communist world and concluded that the total annual uranium requirement in 1980 would be 82,370 tons of U_3O_8. In order to appreciate the magnitude of the requirement, this prediction should be compared with the peak year in 1959 when 43,350 tons of U_3O_8 were produced of which Canada contributed 15,892 tons. (See graph.)

An estimate of currently known uranium supply was published in December 1967 jointly by the European Nuclear Energy Agency and the International Atomic Energy Agency. This study shows that Canada, South Africa and the United States control almost 85 per cent of the 700,000 ton U_3O_8 'reasonably assured' reserve available in the non-communist world, recoverable at prices up to $10(US) a pound U_3O_8.



A realistic measure of supply, however, is attained not by an examination of reserves alone, but by an examination of the capability of the industry to produce such ore at a given point in time. When determining the effective production capacity of the industry at some point in the future many factors must be considered such as the capability of reserves to support additional capacity, the lead time required to construct such capacity, the availability of supplies and skilled labour, the availability of sufficient funds for financing, and the existence of firm contracts necessary to generate the investment. Furthermore, resource figures such as those prepared by the ENEA should not be taken as a measure of the ultimate available supply but merely as a measure of the resources known at the present time. Geologically, there is every indication that uranium will follow the experience of other mineral commodities and, in response to market demand, continual exploratory effort will result in an ever-increasing expansion of reserves.

Canada is currently producing about 4,000 tons of U_3O_8 a year, somewhat below its capacity. Present facilities at full capacity could deliver about 5,700 tons a year with an additional 5,300 tons a year being available by reactivating some former producers. Such an expansion would require a substantial investment and would take anywhere from 2 to 5 years to complete, assuming all other factors were favourable. As discussed earlier, some reactivation work is already underway and development work is proceeding on three new production facilities not included in the above capability estimate. Further, at least one producer is experimenting with methods which would appreciably increase its mill capacity. Reactivation of certain other former producers, however, must await favourable prices as well as markets and the development of additional new mines will necessitate new discoveries.

Canadian domestic uranium requirements during the next 10 years will be such that uranium production will be primarily for the export market. With the major portion of its presently known, low-cost uranium resources uncommitted at this time together with a promising potential for increasing these reserves Canada is in a good position to supply a large proportion of the ever-growing world markets. The domestic and foreign sales contracts completed in 1966 and 1967 are probably the first in a series of many long-term contracts to be negotiated by Canadian producers. Japan, West Germany and Britain as well as several other West European countries are potential customers. The United States market, potentially one of the largest markets, is temporarily cut off from Canadian producers by USAEC regulations which restrict the enrichment of foreign uranium in USAEC enrichment plants for domestic use. However, the output of many uranium producers in the United States is becoming fully committed and the USAEC has announced that it is considering removing the restrictions on June 30, 1973, or possibly earlier, instead of 1975 as initially envisaged.

Clearly, the demand for uranium on a world-wide basis during the 1970's will be large. Preparation of the production capacity capable of meeting this heavy demand will require substantial investments, and the time available is short. Further, the development of additional reserves necessary to support the increased capacity will require significant discoveries of uranium in the very near future. Indeed, the world's uranium industry faces a challenge that may be difficult to meet in such a short period of time. In an effort to meet this challenge, the Canadian uranium industry has begun expansion in every phase of uranium production from exploration to refining. Canada's potential for uranium is large, and the expertise of its mining fraternity is well known around the world. There is every reason to anticipate that uranium will once again take a prominent place in Canada's mineral industry, and that Canada will maintain a leading position in uranium supply as the world moves swiftly into the atomic age.

THORIUM

The Nuclear Products Department of Rio Algom Mines Limited continues to be Canada's only producer of thorium concentrates. The operation, which is located at Rio Algom's Nordic mine in Elliot Lake, Ontario, has a capacity of 150 to 200 tons of thorium concentrates a year. Thorium oxide (ThO_2)† is recovered as a byproduct together with a rare-earth* concentrate from the barren effluent solutions following removal of uranium by ion exchange in the Nordic mill. Production of these two byproducts increased during 1967, although total sales were somewhat less than that reported in 1966. Savings experienced through process improvements, however, more than compensated for the decrease in sales.

Thorium occurs at Elliot Lake associated with the ore minerals uraninite, brannerite and monazite; the average grade of the ore is 0.05 per cent ThO_2. Following the extraction of uranium from the leach

†1 short ton ThO_2 = 795 kilograms of thorium metal.

*See 1967 Mineral Review No. 43, Rare-Earth Elements, by W.H. Jackson.

solutions at the Nordic mill, the barren liquor contains about 0.13 gram of thorium per litre. Thorium is extracted in a solvent extraction process using an immiscible organic phosphorus compound, dissolved in kerosene. The thorium is recovered from the pregnant organic solvent by stripping with moderately strong sulphuric acid. The thorium sulphate thus produced is insoluble in sulphuric acid and therefore precipitates. The 'thorium cake' is then filtered and dried, resulting in a product that grades from 35 to 40 per cent ThO_2.

TABLE 6

Thorium Production in Canada, by Province, 1966-1967

	1966		1967p	
	Pounds	$	Pounds	$
Production				
(ThO_2 shipments)				
Ontario	87,393	210,528	117,388	222,983

Source: Dominion Bureau of Statistics.
p Preliminary.

Essentially all 1967 production was shipped to Thorium Limited, in Britain. However, small quantities of thorium cake are transferred, as required, to the Nuclear Products Department's Quirke refinery, where it is refined to metallurgical-grade thorium oxide (99.8 + ThO_2) and shipped to Dominion Magnesium Limited, Haley, Ontario. At Haley, Dominion Magnesium produces sintered pellets of pure thorium, thorium powder, and thorium-magnesium master alloy (40% Th). Although the plant has a capacity of 200,000 pounds of thorium metal a year production in 1967 was only 835 pounds compared with 1,275 pounds in 1966.

Prices for thorium products in the United States, as quoted periodically in *Metals Week*, were fairly steady during 1967. Thorium metal, pellets and powder were priced at $15.00 a pound, thorium nitrate at $3.50 a pound and thorium oxide at $6.00 to $12.30 a pound. Thorium-magnesium hardener (30-40% Th) was quoted at $11.50 to $12.00 a pound, slightly more than the 1966 price. The higher price probably reflects the cessation of production of thorium-magnesium hardener in the United States, with the result that United States alloy-makers had to depend on imported master alloy produced in Britain by Thorium Limited.

USES

The use of thorium nitrate as an essential ingredient in the manufacture of gas lamp mantles began in the period 1890 to 1911, and continues to account for a substantial consumption of thorium. Because of its great tensile strength at high temperatures (730°F) thorium is alloyed with magnesium for use in the skin and structural components of supersonic aircraft. Nickel-thorium alloys have proved to have great strength and resistance to corrosion at temperatures as high as 2400°F; similar properties have been demonstrated in tungsten-thorium alloys. Thorium is also used as a deoxidant in the production of molybdenum and its alloys, as a catalyst in the chemical and petroleum industries, in the manufacture of electronic tubes and electrodes for inert-arc welders, as a refractory material, and in the manufacture of special optical glass.

The greatest potential for thorium, however, is as a nuclear fuel for advanced converter and breeder type reactors. Although thorium (Th_{232}) is not a fissile material like U_{235}, it is a fertile material and can be converted into fissionable uranium - 233 (U_{233}) if it is exposed to irradiation by neutrons in a reactor. The use of this 'Th_{232} - U_{233} fuel cycle' has many potential advantages in both advanced converters and breeder reactors, but the technology is presently at a very early stage of development compared with conventional reactor technology. Most authorities agree that it may be 1980 or 1985 before this future generation of reactors reaches the commercial stage.

OUTLOOK

Since the European Nuclear Energy Agency completed a review of the non-communist world's resources* of thorium in 1965 no new significant resource-data have come to light. Similarly, although research in other non-nuclear uses of thorium is being carried out with promising results, the principal users of thorium continue to be the manufacturers of gas lamp mantles and magnesium alloys. Finally, the recent rapid growth in demand for certain rare-earth elements has resulted in an over-supply of thorium far in excess of demand.

Although a minor increase in demand can reasonably be anticipated for thorium due to current and new industrial uses, a major increase in thorium consumption must await the full development of breeder and near-breeder reactor technology. Development of a commercial breeder reactor is not expected much before 1985 although commercial advanced converter (near-breeder) reactors could be operating somewhat earlier. The economic incentive for the

*Total 'reasonably assured' reserves available in the non-communist world, recoverable at prices up to $10 (US) a pound ThO_2 were reported to be 565,000 tons ThO_2.

development of these reactors is great and the benefits to be accrued through the resulting efficient use of energy resources are many. Consequently, while the requirements for thorium for nuclear purposes may amount to no more than a few hundred tons over the next 15 years, the demand can be expected to rise sharply during the later part of this century.

EXPLORATION FOR URANIUM INTENSIFIES: a Sikorsky S-55 bringing fuel oil to one of Eldorado's exploratory drill sites in the Beaverlodge area of Saskatchewan. Land acquisition and exploratory drilling were also active in several areas of Ontario and Quebec.

WAITING TO GO ON SHIFT: skilled miners at Eldorado's Beaverlodge operation increased output by 19 per cent in 1967. The company was developing the new Hab mine, 7 miles northwest of the Beaverlodge operation, that is scheduled for production in mid-1969.

Vanadium

G.P. WIGLE*

Vanadium is recovered in Canada, from crude oil, in the form of vanadium pentoxide (V_2O_5), by Canadian Petrofina Limited at its refinery near Pointe-aux-Trembles, Quebec. The Petrofina byproduct plant recovers vanadium from fly-ash, collected from the burning of petroleum coke produced and used in the oil refining process. It is the first plant in Canada to recover vanadium commercially. Production capacity is about 1,000 pounds of V_2O_5 a day.

Production and consumption of vanadium in 1967 was reduced from 1966. Vanadium pentoxide price reductions in the United States and Europe indicated an improved supply situation. Abundant supplies of columbium at reduced prices could have contributed to the reduced demand through substitution for vanadium in some applications in the steel industry. New sources of supply and these influences on demand are now indeterminate factors in the vanadium market that had recently appeared rather closely balanced.

MINERALS AND OCCURRENCES

More than 65 vanadium minerals are known but among the more important are the complex sulphide, patronite; the vanadium-bearing mica, roscoelite; a potassium uranium vanadate, carnotite; the lead vanadates, vanadinite, descloizite and mottramite. Patronite with asphaltite found at Mina Ragra in the Peruvian Andes was an important source of vanadium until 1955 when mining of the high grade deposit was completed. Vanadates of lead, zinc and copper found in the oxidized zones of base metal deposits have been sources of vanadium production in several countries. Vanadium-bearing titaniferous magnetites in South Africa and Finland have become important sources, and large similar deposits are known in the USSR and the United States. Vanadium occurs in some clays, shales and phosphate rocks, and is found in association with asphaltum, coal, chromium, copper, iron, lead, titanium, uranium, and petroleum. Vanadium has not been produced commercially from deposits in Canada but many occurrences are known. A typical analysis of ilmenite from the Allard Lake area of Quebec shows 0.27 per cent vanadium pentoxide (V_2O_5).

The Athabasca tar sands in northern Alberta contain an estimated 240 parts per million (0.024 per cent) of vanadium, part of which could be recovered in due course from the coke residue of the distillation process.

TABLE 1

Canadian Imports and Consumption of Vanadium, 1966-67

	1966		1967P	
	Short Tons	$	Short Tons	$
Imports				
Ferrovanadium				
United States	379	1,743,000	241	1,075,000
USSR	–	–	99	248,000
Austria	–	–	27	131,000
Britain	49	199,000	18	79,000
Other Countries	50	286,000	3	23,000
Total	478	2,228,000	388	1,556,000
Consumption				
Ferrovanadium				
Gross weight	314	. .	. .	. .
Vanadium content	216	. .	. .	. .

Source: Dominion Bureau of Statistics.
P Preliminary; – Nil; . . Not available.

*Mineral Resources Division.

WORLD PRODUCTION AND CONSUMPTION

CANADA

Canadian Petrofina Limited started vanadium recovery in 1965. The fractional distillation step in the oil refining process removes the lighter components and leaves a residual fuel that can be used as bunker oil or for asphalt production or the manufacture of petroleum coke. Most of the vanadium in the crude is concentrated in the residual fuel product. The part in the coke can be recovered from the fly-ash formed in burning the powdered coke as a fuel component, with oil or gas, used in producing steam for the distillation process. The fly-ash, from Venezuelan crude, which may contain 15 per cent V_2O_5 is recovered in electrostatic precipitators and then leached in sulphuric acid. The slurry formed is filtered and vanadium pentoxide is separated from the filtrate by oxidation with sodium chlorate and precipitation with ammonia. The V_2O_5 is dried, fused, and cast into flakes containing 99 per cent vanadium pentoxide.

TABLE 2

World Production of Vanadium in Ores and Concentrates 1964-67
(short tons)

	1964	1965	1966	1967[e]
United States	4,362	5,226	5,166	5,994
Republic of South Africa	1,282	1,519	1,711	. .
South West Africa	1,102	1,275	1,353	. .
Finland	1,084	1,062	1,070	. .
Other Countries	3	1	. .	. .
Total	7,833	9,083	9,300	9,335[e]

Source: US Bureau of Mines Minerals Yearbook, 1966 and US Bureau of Mines Commodity Data Summaries, January, 1968.
. . Not available; [e] Estimated.

Great Canadian Oil Sands Limited started oil recovery from the Athabasca tar sands near Fort McMurray in northern Alberta in September 1967. The operation will produce and use some 3,000 tons of petroleum coke a day in producing 45,000 barrels of oil a day. The ash from the coke is reported to contain about 4 per cent vanadium, most of which could be recovered.

OTHER COUNTRIES

The United States Bureau of Mines estimated 1967 non-communist world production of vanadium at 9,335 tons of which the US produced 5,994 tons. Non-communist world production in 1966 was 9,300 tons; US production was 5,166 tons. Industrial consumption in the United States decreased to 5,060 tons in 1967 from 5,468 tons in 1966. The steel industry used 85 per cent, nonferrous alloys 11 per cent, and chemicals and others used 4 per cent. The amounts consumed in the common forms of supply are shown in Table 3.

TABLE 3

Vanadium Consumed in the United States, 1967
V. Consumption
(pounds)

Ferrovanadium	8,315,453
Oxide	260,262
Ammonium metavanadate	223,836
Other	1,319,752
Total	10,119,303

Source: United States, Bureau of Mines, Mineral Industry Surveys.

United States vanadium production was a by-product from five uranium mines, two companies recovering vanadium as a byproduct of elemental phosphorus production from Idaho rock, and as a primary product from the new vanadium mining and milling complex of Union Carbide Corporation at Wilson Springs, Arkansas. The primary producer is equipped to treat 1,600 tons of ore a day and produce 10 million pounds of vanadium oxide a year.

The Republic of South Africa produced 3,054 tons of vanadium pentoxide in 1966 compared with 2,713 tons in 1965. The Vantra Division (formerly Transvaal Vanadium Company) of Highveld Steel and Vanadium Corporation at Witbank, in the Transvaal, produces about 6.5 million pounds of V_2O_5 a year by chemical treatment of vanadium-bearing titaniferous magnetite. Construction work is well advanced on Highveld's integrated iron, steel and vanadium complex, near Witbank, scheduled for production in 1968. The plant is designed to produce 23 million pounds of vanadium pentoxide in a slag containing 25 per cent V_2O_5, a high-vanadium pig iron, and steel. Ore reserves are reported to be at least 200 million tons averaging 55 per cent iron and 1.8 per cent vanadium pentoxide. Another South African vanadium producer is the Federale property of Union Carbide Corporation with a capacity of 3 million pounds of V_2O_5 a year.

Increased output of vanadium was expected from South West Africa where it is a co-product of lead-vanadium concentrates that contain about 18 per cent V_2O_5. Production in 1966 was 13,425 tons of concentrates compared with 12,650 tons in 1965.

Finland's only vanadium producer, Otanmaki Company increased its annual capacity to about 2.6 million pounds.

The exploration of a Jameson Range deposit of low-grade vanadium was placed, by the Western Australian government, in the hands of Westfield Minerals Ltd., Charter Consolidated Ltd. and Freeport Sulphur Company.

TABLE 4

Vanadium Consumed in the United States
by End Use, 1966-67
(short tons of vanadium)

	1966	1967p
Steel		
High-speed	501	478
Hot-work tool	99	92
Other tool	173	163
Stainless	38	37
Other alloy[1]	2,950r	2,714
Carbon	818	792
Grey and malleable castings	40r	28
Nonferrous alloys[2]	594	557
Chemicals	183r	127
Other[3]	85	71
Total	5,481r	5,059

Source: US Bureau of Mines Minerals Yearbook, 1966 and US Bureau of Mines Mineral Industry Surveys, Vanadium in December, 1967.
[1] Includes some vanadium used in high-speed or other tool steels not specified by reporting firms; [2] Principally titanium-base alloys; [3] Principally high-temperature alloys, welding rods, and cutting and wear-resistant materials.
p Preliminary; r Revised.

PRODUCTS AND USES

Vanadium is a steel-grey metallic element with a melting point of 1,900° Centigrade (3,450°F). Technical-grade vanadium pentoxide is the common product of primary vanadium producers. It is available as a fused black oxide, 86 to 99 per cent V_2O_5, and as an air-dried powder containing 83 to 86 per cent V_2O_5. Chemical grades of vanadium pentoxide have typical V_2O_5 contents of 99.5, 99.7, and 99.94 per cent. Ammonium metavanadate (NH_4VO_3) and vanadate of sodium are supplied to the chemical industry.

Vanadium is used principally as ferrovanadium, an additive in the iron and steel industry. Its function is to reduce and control grain size, to impart toughness and strength, and to maintain hardness at elevated temperatures. Different grades of ferrovanadium are available with the vanadium content varying from 35 per cent to 85 per cent, carbon from 0.15 to 2.0 per cent, and silicon from 0.50 to 11 per cent. Union Carbide Corporation produces "Carvan" which contains 83 to 86 per cent vanadium, 10 to 13 per cent carbon and only 1 to 3 per cent iron. Ferrovanadium is produced by a reducing process using such reducing agents as carbon, silicon and aluminum in electric furnace or aluminothermic processes. Vanadium is generally used with other alloying elements in iron and steel rather than alone. Titanium-base vanadium alloys, having high-temperature strength qualities and good weldability, are used in the aircraft industries.

Compounds of vanadium are used in the chemical industry as catalysts in such processes as the production of sulphuric acid, and catalytic cracking of petroleum products. Other applications include the colouring of glass and ceramic glazes, as driers in paints and varnishes, processing coloured film, in welding rod, and in cutting and wear-resistant materials.

PRICES

Metals Week of December 25, 1967, quoted the following vanadium prices in the United States:

Vanadium Pentoxide:	per pound V_2O_5 f.o.b. mine or mill, air dried	$1.30
	G.S.A. technical grade	$1.22
Ferrovanadium:	per pound V, packed f.o.b. shipping point, freight equalized to nearest main producer,	
	52–57%	$3.15–$3.45
	70–75%	$2.90
	82–85%	$3.35
	"Carvan"	$2.38
Vanadium metal:	per pound, f.o.b. shipping point 99%, 100-pound lots	$3.45

TARIFFS

	British Preferential %	Most Favoured Nation %	General %
CANADA			
Vanadium ores and concentrates	free	free	free
Vanadium oxide in powder, lumps, formed into briquettes, for use in manufacture of steel	free	free	5
Vanadium metal, in lump, powder ingot, block, (class or kind ruled to be not produced in Canada)	free	15	25
Vanadium metal, bars, rods, processed forms	15	20	25
Ferrovanadium	free	5	5
UNITED STATES			
Vanadium ore, concentrates	free		
Vanadium metal, unwrought	10% ad val		
Vanadium metal, wrought	18% " "		
Ferrovanadium	12.5% "		
Vanadium waste and scrap*	10% ad val		
Vanadium carbide	12.5% "		
Vanadium pentoxide	32% ad val		
Vanadium compounds, other	32% " "		
Vanadium salts	32% " "		

* Temporarily suspended to June 30, 1969.

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT) that was convened in 1964 to consider reductions in tariffs submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968 and final reductions on January 1, 1972.

Zinc

D.B. FRASER*

Mine production of zinc in Canada rose in 1967 to a record 1,244,519 short tons, 19 per cent more than in 1966 and equivalent to 30 per cent of the non-communist world total. Canada remained the world's largest mine producer, a position it has held since 1964.

The increase in production was due chiefly to output from the Kidd Creek mine near Timmins, Ontario, that began operations late in 1966; its 1967 zinc output was 225,000 tons in concentrates and with the Pine Point mine of Cominco Ltd. it was one of the two largest zinc mines in Canada. Three smaller mines were brought into production during the year, one each in British Columbia, Saskatchewan and New Brunswick, which together added 40,000 tons of zinc annually to the Canadian total. Three mines were closed and recovery of zinc from copper ores was discontinued at one other, thus reducing total output of zinc on an annual basis by 20,000 tons.

Development continued during 1967 at two large zinc-lead mine projects, one being the Pyramid mine at Pine Point in the Northwest Territories and the other the Anvil mine at Ross River in the Yukon Territory. Production at the first is scheduled to begin at the end of 1968, and at the second in 1969. Smaller development projects were under way at several other locations. Mine production is expected to remain at the 1967 level until the latter part of 1969 and then to increase to an estimated 1,350,000 tons annually.

Output of refined zinc in 1967 totalled 396,136 tons. Each of the four zinc plants was operated at less than capacity, which at the end of 1967 was as follows:

	Annual Capacity (short tons)
Canadian Electrolytic Zinc Limited, Valleyfield, Que.	140,000
Cominco Ltd., Trail, B.C.	263,000
East Coast Smelting and Chemical Company Limited, Belledune, N.B.	42,000
Hudson Bay Mining and Smelting Co., Limited, Flin Flon, Manitoba	79,000

Although two new zinc reduction plants have been opened and one of the older plants has been expanded since 1963, the proportion of Canadian mine production smelted in Canada has gone down from about 60 per cent in the early 1960s to 40 per cent in 1967. This declining trend reflects the development of large new zinc mines in Canada during the 1960s, and is likely to continue for several years, though at a reduced rate. Exports of zinc concentrates have risen sharply and in 1967 reached a record total of 735,705 tons (zinc content). Most of these were from the central and eastern provinces. Except for amounts treated at Valleyfield and Belledune, the production of these provinces was exported to smelters in the eastern and central United States, Europe and Japan. Zinc concentrates produced in Manitoba and Saskatchewan were refined at Flin Flon. Most of those produced in British Columbia and the two Territories were treated at Trail but some were exported to Montana and Idaho and to overseas smelters. Refined zinc was exported to 37 countries, 42 per cent going to Britain and 27 per cent to the United States.

*Mineral Resources Branch.

TABLE 1

Canada, Zinc Production, Trade and Consumption, 1966-67

	1966		1967p	
	Short Tons	$	Short Tons	$
Production				
All forms[1]				
Ontario	82,395	24,883,265	272,737	79,039,259
Quebec	293,148	88,530,542	242,941	70,404,291
Northwest Territories	189,167	57,128,344	200,000	57,960,000
New Brunswick	142,395	43,003,390	153,720	44,548,213
British Columbia	152,562	46,073,790	112,766	32,679,698
Manitoba	34,967	10,559,915	35,629	10,325,302
Newfoundland	34,160	10,316,464	34,100	9,882,180
Saskatchewan	28,909	8,730,647	30,205	8,753,286
Yukon	5,725	1,729,027	4,413	1,299,214
Nova Scotia	678	204,692	46	13,203
Total	964,106	291,160,076	1,086,557	314,904,646
Mine output[2]	1,046,964r		1,244,519	
Refined[3]	382,612		396,136	
Exports				
Zinc blocks, pigs and slabs				
Britain	106,250	26,951,000	125,554	30,671,000
United States	115,980	31,870,000	79,820	19,709,000
Japan	492	101,000	13,781	2,785,000
India	8,372	2,106,000	10,222	2,430,000
China (Mainland)	5,875	1,455,000	6,988	1,759,000
Italy	5,425	1,092,000	6,906	1,411,000
Netherlands	2,745	703,000	6,530	1,705,000
Sweden	–	–	5,598	1,400,000
Republic of South Africa	28	7,000	5,296	1,309,000
Belgium and Luxembourg	1,344	269,000	5,104	1,033,000
Philippines	544	136,000	3,924	917,000
Taiwan	342	90,000	3,479	808,000
West Germany	1,855	448,000	3,149	776,000
Other countries	6,901	1,586,000	21,301	4,793,000
Total	256,153	66,814,000	297,652	71,506,000
Zinc contained in ores and concentrates				
United States	311,947	38,187,000	359,806	43,071,000
Belgium and Luxembourg	162,240	21,840,000	190,527	22,696,000
Japan	21,767	2,654,000	72,757	9,688,000
Netherlands	24,459	2,988,000	26,838	4,214,000
Britain	7,377	1,026,000	25,146	4,349,000
France	13,983	2,230,000	18,866	3,556,000
West Germany	19,131	2,420,000	18,328	2,702,000
Poland	19,791	3,194,000	12,903	1,659,000
India	–	–	6,315	552,000
Other countries	10,627	1,402,000	4,219	443,000
Total	591,322	75,941,000	735,705	92,930,000
Zinc fabricated materials, n.e.s.				
United States	1,274	677,000	3,143	1,256,000
Britain	483	264,000	367	137,000
Trinidad and Tobago	38	20,000	39	17,000
Belgium and Luxembourg	3	2,000	12	11,000

TABLE 1 (cont.)

	1966		1967p	
	Short Tons	$	Short Tons	$
Spain	–	–	12	5,000
Other countries	134	57,000	9	5,000
Total	1,932	1,020,000	3,582	1,431,000
Zinc and alloy scrap, dross and ashes (gross weight)				
United States	7,356	1,537,000	4,979	881,000
Belgium and Luxembourg	2,037	204,000	1,940	152,000
Britain	62	8,000	486	85,000
Yugoslavia	165	12,000	283	19,000
West Germany	45	3,000	223	21,000
Other countries	298	40,000	310	39,000
Total	9,963	1,804,000	8,221	1,197,000
Imports				
In ores and concentrates	80	5,000	75	10,000
Dust and granules	1,302	511,000	1,211	430,000
Slabs, blocks, pigs and anodes	126	36,000	1,065	317,000
Bars, rods, plates, strip and sheet	751	467,000	660	445,000
Slugs, discs, shells	350	148,000	137	58,000
Zinc oxide	1,616	466,000	1,703	523,000
Zinc sulphate	2,503	323,000	2,352	305,000
Lithopone	218	31,000	316	44,000
Zinc fabricated materials, n.e.s.	950	1,114,000	738	862,000
Total	7,896	3,101,000	8,257	2,994,000

	1966			1967p		
	Primary	Secondary	Total	Primary	Secondary	Total
Consumption						
Zinc used for, or in, the manufacture of:						
Copper alloys (brass, bronze, etc.)	13,405	31	13,436	11,460	18	11,478
Galvanizing						
electro	1,020	56	1,076	838	60	898
hot-dip	46,304	784	47,088	43,949	575	44,524
Zinc die-cast alloy	26,045	–	26,045	33,279	–	33,279
Other products (including rolled and ribbon zinc, zinc oxide)	20,278	2,558	22,836	18,253	2,055	20,308
Total	107,052	3,429	110,481	107,779	2,708	110,487
Consumers stocks on hand at end of year	8,374	467	8,841	8,975	576	9,551

Source: Dominion Bureau of Statistics.

[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.

p Preliminary; – Nil; n.e.s. Not elsewhere specified; r Revised.

TABLE 2

Canada, Zinc, Production, Exports and Consumption, 1958-67
(short tons)

	Production		Exports		Total	Consumption[3]
	All Forms[1]	Refined[2]	In Ores and Concentrates	Refined		
1958	425,099	252,093	217,823	195,708	413,531	56,097
1959	396,008	255,306	184,742[r]	179,552	364,294[r]	64,788
1960	406,873	260,968	169,894	207,091	376,985	55,803
1961	416,004	268,007	199,322	208,272	407,594	60,878
1962	463,145	280,158	242,457	210,723	453,180	65,320
1963	473,722	284,021	213,044	200,002	413,046	73,653
1964	684,513	337,728	403,102	238,076	641,178	88,494
1965	822,035	358,498	487,445	264,200	751,645	93,796
1966	964,106	382,612	591,322	256,153	847,475	107,052
1967[p]	1,086,557	396,136	735,705	297,652	1,033,357	107,779

Source: Dominion Bureau of Statistics.
[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. [3]Refined primary zinc only.
[p] Preliminary; [r] Revised.

In addition to the roasting facilities at the four Canadian plants, two zinc roasters were operated in eastern Canada for sulphur recovery, one by Sherbrooke Metallurgical Company Limited at Port Maitland, Ontario, and the other by Aluminum Company of Canada, Limited, at Arvida, Quebec.

WORLD PRODUCTION AND CONSUMPTION

Mine production of zinc in the non-communist world continued to increase in 1967, rising by 270,000 short tons over the 1966 total to a record 4,200,000 short tons. The largest increase was in Canada, where production was 200,000 tons more than in 1966. Output in Australia rose by 35,400 tons due to increases at existing mines and to the start of zinc production at the Cobar mine in New South Wales. Output increased also in Peru (34,000 tons more than in 1966) and in Japan (10,000 tons more). It declined in the United States by 32,000 tons.

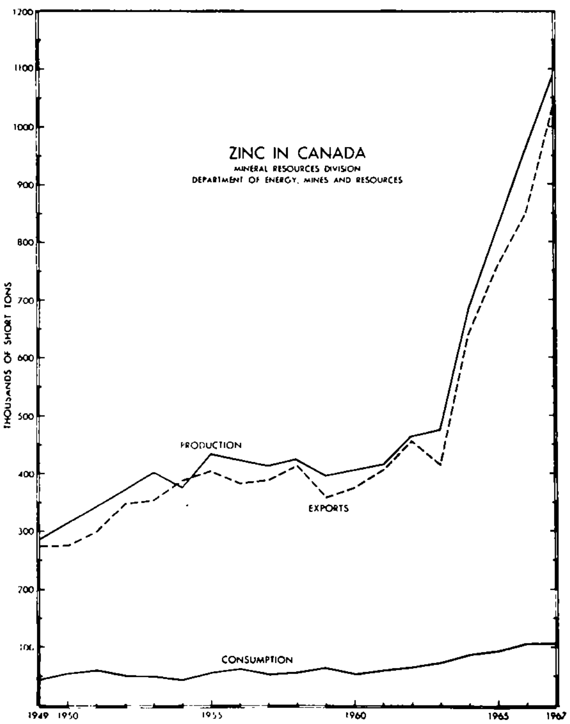
Further increases in mine production are expected in 1968 following the opening of new mines in Ireland (Silvermines), Peru (Huanzala), Iran (Bafq), and the United States (byproduct zinc from new lead mines in Missouri). Expansion at existing mines is planned in 1968 in Japan, Australia, Italy and Spain. In 1969 and 1970 new mines are scheduled to open in Canada (Anvil, Fox Lake), Bolivia (Matilda), Republic of South Africa (Rosh Pinah), and Sweden (Langdal and Nasliden). Expansion in 1969 and 1970 is planned at existing mines in the United States (Balmat), Argentina (Aguilar), Yugoslavia, and South Korea; and expansion begun in 1968 is scheduled to continue through 1970 in Australia, Japan, Italy and Spain.

TABLE 3

World Mine Production of Zinc, 1966-67
(excluding communist-bloc countries)
(short tons)

	1966	1967
Canada	1,047,000	1,249,000
United States	628,900	597,300
Australia	377,200	412,600
Peru	284,200	318,500
Japan	279,300	289,100
Mexico	262,800	258,800
West Germany	132,800	142,600
Dem. Republic of the Congo (Kinshasa)	129,000	. .
Italy	127,000	137,500
Yugoslavia	94,000	. .
Sweden	85,800	84,500
Finland	59,900	66,500
Spain	60,600	65,100
Zambia	35,300	60,000
Argentina	29,100	30,500
Other countries	304,400	. .
Total	3,937,300	4,206,600

Source: International Lead and Zinc Study Group.



Smelter production of zinc in 1967 in the non-communist world was at the same level as in the previous year. Production continued at less than capacity in several countries where producers curtailed output in the last quarter of 1966. In the United States, labour strikes caused the shut-down of several zinc plants, resulting in a loss of more than 100,000 tons of zinc production. Total refined zinc output in 1967, which at capacity levels might have reached a level of 4,000,000 tons, amounted to only about 3,600,000 tons as a result of production curtailments and losses through strikes.

Production from a new Imperial Smelting Furnace (ISF) at Avonmouth, Britain, designed to produce 130,000 tons of zinc annually, began in December 1967. Taking account of the shut-down of an older ISF plant at the time the new furnace began operations, Britain's zinc smelter capacity is expected to rise from 125,000 to 235,000 tons annually. In Australia, The Broken Hill Associated Smelters Pty. Ltd. opened a slag-fuming plant and an electrolytic zinc plant at Port Pirie to treat slag dumps accumulated over the years from lead-smelting operations; the capacity of the electrolytic plant is 45,000 tons a year. A new 22,000-ton zinc plant was opened by Cominco Binani Zinc Limited near Cochin in southwest India, and in Yugoslavia a 45,000-ton electrolytic plant began production at Sabac. Existing capacity was expanded in 1967 in Japan, Italy and France.

Under construction in 1967 and scheduled to open in 1968 was an electrolytic plant at Datteln, West Germany (120,000 tons annually), an electrolytic plant near Udaipur, northwestern India (40,000 tons annually), and an ISF smelter in Poland (55,000 tons annually). Expansion of existing plants is scheduled in Japan, Norway and Mexico.

Zinc consumption in the non-communist world has grown since 1960 at an average rate of 4 1/2 per cent a year, rising from 2,700,000 to 3,600,000 tons in the 7-year period. The annual increase reached a peak of 11 per cent in 1964, and fell off in 1965 to 2.7 and in 1966 to 2.3 per cent. Consumption in 1967 declined by some 90,000 tons, the first drop since 1958, due chiefly to a fall of 190,000 tons in consumption in the United States, where the steel and automobile industries used less zinc than in 1966. Consumption was 13,000 tons lower in Britain, while in Japan and Australia there were substantial increases.

According to estimates made by the International Lead and Zinc Study Group at its annual meeting in October 1967, zinc supply and demand were in balance in 1967, although at lower levels than had been estimated a year earlier, reflecting the economic recession in many countries. The outlook for 1968 was for a continued rise in mine production, and an exceptionally large rise in smelter production and in consumption of zinc. After taking account of imports from communist countries at the current rate of some 110,000 tons a year, the Study Group estimated that in 1968 there would be a statistical surplus of supply over demand of just over 220,000 tons, or about 7 per cent of 1967 refined zinc production. The Group reported, however, that production tended to be over-estimated and that following the preparation of forecasts at the meeting a year earlier, smelter production had been substantially curtailed.

The United States government sold 26,957 tons of zinc from surplus stocks during 1967, compared with 54,530 tons in 1966 and 211,453 tons in 1965. At the end of 1967 there were 107,059 tons available for disposal from amounts previously authorized. The total amount in the government inventory at year-end was 1,198,122 tons, all of which has been determined to be surplus to strategic requirements.

PRINCIPAL DEVELOPMENTS

BRITISH COLUMBIA

Output of zinc in concentrates declined by 10 per cent in 1967 to 135,000 tons. Cominco Ltd. produced 2,118,000 tons of ore from the Sullivan mine and 256,000 tons from the Bluebell mine; ore output in the previous year from these two mines and from the H.B. mine, which was closed late in 1966, totalled 2,771,000 tons. Ore reserves at the three mines at

September 30, 1967, were 70.5 million tons containing a total of 7.7 million tons of lead and zinc.

Zinc concentrates from the Sullivan and Bluebell mines, from Pine Point Mines Limited, and from custom shippers were treated at the Trail metallurgical works, where zinc output was 202,000 tons, compared with 221,900 tons in 1966. Lead and zinc production was derived approximately 30 per cent from the Sullivan mine, 59 per cent from the Pine Point mine, 8 per cent from other company mines and from accumulated slags and residues, and 3 per cent from purchased ores and concentrates.

Western Mines Limited started production at a zinc-copper-lead mine at Buttle Lake, Vancouver Island, where mill construction was completed late in 1966. About 80 per cent of production was from an open pit, 10 per cent was from underground and the remainder from preproduction stockpiles.

Canadian Exploration, Limited operated the Jersey zinc-lead mine south of Salmo and shipped concentrates to US smelters. Zinc concentrates were stockpiled after mid-year due to the strike at the zinc plant of The Anaconda Company at Great Falls, Montana. Reeves MacDonald Mines Limited, also south of Salmo, carried out normal operations and shipped zinc and lead concentrates to Idaho for treatment.

Aetna Investment Corporation Limited operated the Mineral King mine in the Invermere district; the mine was shut down in January 1968 due to exhaustion of ore. Giant Soo Mines Limited suspended operation of its 150-ton mine and mill near Wasa in October 1967.

Columbia River Mines Ltd. continued to explore the Ruth-Vermont property, 25 miles southwest of Golden, that was acquired in 1965. Measured and indicated reserves were reported in August 1967 to be 744,125 tons averaging 4.0 per cent zinc, 3.5 per cent lead and 4.7 ounces of silver, and an additional 316,000 tons of inferred ore. A 500-ton-a-day operation was planned.

YUKON TERRITORY

United Keno Hill Mines Limited operated the Calumet, Elsa, Keno and Comstock Keno silver-lead-zinc mines in the central Yukon. On August 1, ore production was reduced to a rate of 50,000 tons a year and at year-end the Calumet mine was providing all the mill feed. The company planned to sink a 500-foot shaft on the Husky prospect at Elsa in 1968 to carry out underground exploration.

Anvil Mining Corporation Limited, jointly owned by Cyprus Mines Corporation and Dynasty Explorations Limited, began construction of a 5,500-ton mill at its Ross River property in central Yukon, and carried out stripping operations in preparation for the start of production from an open pit in August 1969. A bulk ore test was completed during the year and diamond drilling was continued. Reserves at year-end in three orebodies were a reported 63 million tons averaging 5.7 per cent zinc, 3.4 per cent lead, and 1.2 ounces silver a ton. Sales contracts were negotiated with two Japanese smelting firms for the entire production, estimated to be 240,000 tons of zinc concentrates and 128,400 tons of lead concentrates annually, for a period of eight years. A contract was signed with The White Pass and Yukon Corporation Limited to transport concentrates to Skagway, Alaska for shipment to Japan. The federal government continued construction of a 120-mile road to connect Ross River, near the Anvil property, with Carmacks on the Whitehorse-Dawson highway, and will assist in building a 17-mile mine access road and a bridge to the property. The federal government will also provide power for the mine and townsite from its generating facilities at Whitehorse. Anvil Mining Corporation will study the feasibility of building a lead-zinc smelter in the Yukon, and has arranged its sales contracts to provide for diversion of concentrates to support possible future smelting operations.

Kerr Addison Mines Limited began a re-assessment of its previously explored Vangorda claims, 12 miles east of the Anvil property, with a view to up-dating the economic feasibility study made several years earlier. The company carried out a geochemical survey of the Swim Lakes property, 6 miles southeast of the Vangorda claims, and outlined an anomalous zone that will be trenched in 1968.

NORTHWEST TERRITORIES

Pine Point Mines Limited, a subsidiary of Cominco Ltd., produced zinc and lead concentrates and direct-shipping ore at Pine Point, on the south shore of Great Slave Lake. All direct-shipping ore went to Cominco Ltd. Of the ores and concentrates shipped, 71 per cent were refined in Canada, chiefly by Cominco Ltd., 13 per cent in the United States, 10 per cent in Japan and

TABLE 4

Canadian Mine Output, 1966-67
(short tons)

	1966	1967p
Newfoundland	43,734	48,688
Nova Scotia	176	148
New Brunswick	152,165	183,696
Quebec	329,488	275,669
Ontario	92,351	300,190
Manitoba-Saskatchewan	57,022	61,889
British Columbia	147,257	134,870
Yukon Territory	6,000	6,135
Northwest Territories	218,771	233,234
Total	1,046,964	1,244,519

Source: Dominion Bureau of Statistics.
p Preliminary.

6 per cent in Europe and India. Development of the adjoining Pyramid deposit continued, and construction of a 3,000-ton addition to milling facilities was started, scheduled for completion at the end of 1968. The increase is expected to offset to a considerable degree the loss of metal production that could result from the exhaustion of high-grade ore reserves, which at the end of 1967 amounted to 475,000 tons; total reserves were 40,500,000 tons averaging 6.8 per cent zinc and 2.6 per cent lead.

MANITOBA-SASKATCHEWAN

Hudson Bay Mining and Smelting Co., Limited operated two mines at Flin Flon and two at Snow Lake, and milled copper-zinc and zinc-lead ore at the central Flin Flon concentrator. The Flin Flon mine accounted for 59 per cent of the total tonnage milled, the Chisel Lake mine, near Snow Lake, for 16 per cent, the Stall Lake mine near Snow Lake, for 17 per cent, and the Schist Lake mine, near Flin Flon, for 8 per cent. The zinc concentrates totalling 103,788 tons, produced from these ores along with 19,962 tons of purchased materials and 44,313 tons of oxide fume, were treated in the company's electrolytic zinc plant at Flin Flon where production was 72,061 tons of slab zinc. Four mines in the Flin Flon – Snow Lake area were under development – the Osborne Lake, Anderson Lake, Flexar and Dickstone mines. The company's reserves at the end of 1967 totalled 16,884,600 tons averaging 4.1 per cent zinc, 3.04 per cent copper, 0.2 per cent lead, 0.67 ounce silver and 0.04 ounce gold. At the end of 1966, reserves were 16,765,300 tons.

Share Mines & Oils Ltd. completed construction of a 350-ton zinc-lead mill at Hanson Lake, 35 miles west of Flin Flon, and began operations in June 1967 shipping zinc concentrates to flin Flon for treatment.

Sherritt Gordon Mines, Limited started shaft-sinking at its Fox Lake property, 35 miles south of Lynn Lake, and announced that a 3,000-ton mill would be built at the mine to produce zinc, copper and pyrite concentrates. Production is scheduled to begin in mid-1970. Ore reserves at the end of 1966 were reported to be 12,269,000 tons averaging 2.35 per cent zinc and 1.74 per cent copper. It was also announced that the zinc concentrate would be treated in Canada, and the copper concentrate in Japan.

ONTARIO

Mine output rose from 92,000 tons in 1966 to 300,000 tons in 1967. Seven mines were in operation during the year.

Ecstall Mining Limited, a wholly-owned subsidiary of Texas Gulf Sulphur Company, completed its first full year of operation at the Kidd Creek open pit mine near Timmins. Production was 432,000 tons of zinc concentrates containing 52 per cent zinc; 205,000 tons of copper concentrates containing 25 per cent copper; 43,000 tons of copper-lead concentrates; and 7,800,000 ounces of silver in the concentrates. The 9,000-ton concentrator was operated at slightly above the design capacity of 3 million tons of ore a year although the second and third of the three circuits came on stream in mid-January and mid-February respectively. Metal recoveries during the year averaged 82 per cent for zinc, 91 per cent for copper and 72 per cent for silver, and were somewhat higher in the last two months of the year; further improvement is expected in 1968. Zinc concentrates were exported to smelters in the United States, Europe and Japan. Construction of zinc and copper smelting and refinery facilities in Ontario was studied during the year.

TABLE 5

Principal Zinc Mines in Canada, 1967

Company and Location	Mill Capacity (tons ore/day)	Grade of Ore (Principal Metals) Zinc (%)	Lead (%)	Copper (%)	Silver (oz/ton)	Ore Produced 1967 (1966) (short tons)	Contained Zinc Produced 1967 (1966) (short tons)	Remarks
British Columbia								
Aetna Investment Corporation Limited, Toby Creek	500	4.35	1.60	–	. .	111,332 (114,737)	3,829 (3,809)	Closed January 15, 1968, ore exhausted.
The Anaconda Company (Canada) Ltd., Britannia Beach	3,000	0.39	–	1.07	0.12	627,868 (505,433)	1,178 (1,182)	Exploration and development both surface and underground continued.

TABLE 5 (cont.)

Company and Location	Mill Capacity (tons ore/day)	Grade of Ore (Principal Metals) Zinc (%)	Lead (%)	Copper (%)	Silver (oz/ton)	Ore Produced 1967 (1966) (short tons)	Contained Zinc Produced 1967 (1966) (short tons)	Remarks
British Columbia (cont.)								
Canadian Exploration, Limited, Salmo	1,900	2.86	1.03	–	–	493,029 (417,440)	12,729 (12,875)	
Cominco Ltd. Sullivan, Kimberley	10,000	. .	. .	–	. .	2,118,377 (2,135,660)	69,056 (83,233)	
Bluebell, Riondel	700	. .	. .	–	. .	255,536 (246,390)	13,910 (14,636)	
Giant Soo Mines Limited, Wasa	150	10.3	5.5	–	2.46	31,743 (11,141)	2,917 (1,090)	Closed October 5, 1967.
Mastodon-Highland Bell Mines Limited, Beaverdell	120	1.37	1.47	–	20.99	34,020 (24,138)	465 (486)	Old dumps milled.
Reeves MacDonald Mines Limited, Remac	1,200	3.14	0.89	–	0.06	404,782 (395,921)	11,459 (13,886)	Drove exploration tunnel in new ore area south of Pend Oreille River.
Western Mines Limited, Buttle Lake, V.I.	750	8.2	0.8	1.90	2.0	293,276 (–)	22,433 (–)	Tune-up late 1966 and production started early 1967.
Yukon Territories								
United Keno Hill Mines Limited, (Hector-Calumet, Elsa, Keno, Comstock Keno), Elsa	500	5.89	7.97	–	37.69	106,189 (120,374)	5,436 (5,999)	Mill rate reduced to 137 tons per day, new shaft being sunk on Husky claims, 1968.
Northwest Territories								
Pine Point Mines Limited, Pine Point	5,000	9.7	4.7	–	. .	1,521,279 (1,457,990)	138,650 (144,613)	3000-ton mill for Pyramid orebody scheduled to start production late in 1968. Direct-shipping ore.
		27.9	18.0	–	. .	333,000 (282,309)	92,900 (74,134)	
Manitoba and Saskatchewan								
Hudson Bay Mining and Smelting Co., Limited, Flin Flon (Flin Flon, Stall Lake, Chisel Lake, Schist Lake)	6,000	4.3	0.3	2.64	0.76	1,588,216 (1,689,550)	59,796 (57,109)	Osborne Lake, Anderson Lake, Flexar and Dickstone mines under development.
Share Mines & Oils Ltd., Hanson Lake	350	8.11	4.85	0.46	5.25	41,898 (–)	2,724 (–)	Production started June, 1967.

TABLE 5 (cont.)

Company and Location	Mill Capacity (tons ore/day)	Grade of Ore (Principal Metals) Zinc (%)	Lead (%)	Copper (%)	Silver (oz/ton)	Ore Produced 1967 (1966) (short tons)	Contained Zinc Produced 1967 (1966) (short tons)	Remarks
Ontario								
Canadian Jamieson Mines Limited, Timmins	450	5.23	–	2.70	. .	(. .) (92,685)	(. .) (3,353)	
Ecstall Mining Limited, Timmins	9,000	9.0	0.3	1.9	3.0	3,039,219 (. .)	225,000 (. .)	
Kam-Kotia Mines Limited, Timmins	2,000	1.76	–	1.36	. .	679,677 (464,726)	6,710 (5,143)	Preparing to sink a shaft to develop the Jameland Mines property.
Noranda Mines Limited, Manitouwadge, (Geco)	3,700	3.69	0.13	2.02	2.02	1,461,000 (1,459,586)	40,497 (46,123)	
Willecho Mines Limited, Manitouwadge		3.52	0.19	0.58	1.91	338,437 (325,738)	9,797 (11,000)	Ore milled by Willroy Mines Limited.
Willroy Mines Limited, Manitouwadge	1,700	3.33	0.12	0.66	1.25	165,053 (219,400)	4,532 (5,350)	Three potential ore zones found north of shaft.
Zenmac Metal Mines Limited, Schreiber	165	15.46	–	. .	. .	60,162 (29,839)	8,635 (6,280)	Mill capacity increased.
Quebec								
The Coniagas Mines, Limited, Bachelor Lake	500	4.99	0.39	–	2.71	41,398 (140,093)	1,874 (8,628)	Closed in May, 1967.
Cupra Mines Ltd., Stratford Centre	1,500	3.16	0.42	3.42	1.34	308,347 (158,130)	9,084 (3,550)	
Lake Dufault Mines, Limited, Noranda	1,300	8.51	–	3.96	2.53	492,938 (489,387)	34,386 (37,803)	Sinking shaft in 1968 to develop D-134 area.
Manitou-Barvue Mines Limited, Val d'Or	1,300	2.57	0.14	–	1.34	181,350 (173,130)	4,109 (5,848)	
		–	–	0.70	0.10	294,640 (295,875)	(–) (–)	Copper production 1,935 tons in 1967. Copper production 2,622 tons in 1966.
Mattagami Lake Mines Limited, Matagami	3,850	10.0	–	0.61	0.85	1,414,136 (1,411,100)	128,250 (173,552)	
Mines de Poirier inc., Poirier	2,500	2.72	–	1.25	. .	631,033 (575,907)	11,843 (13,880)	Shaft to be deepened by 900 feet.

TABLE 5 (cont.)

Company and Location	Mill Capacity (tons ore/day)	Grade of Ore (Principal Metals) Zinc (%)	Lead (%)	Copper (%)	Silver (oz/ton)	Ore Produced 1967 (1966) (short tons)	Contained Zinc Produced 1967 (1966) (short tons)	Remarks
Quebec (cont.)								
New Calumet Mines Limited, Calumet Island	800	7.35	2.19	0.16	4.33	90,779 (95,761)	6,221 (6,470)	Mine placed on salvage basis.
New Hosco Mines Limited, Matagami[1]		4.31	–	1.36	. .	331,228 (315,083)	10,758 (946)	Ore milled by Orchan Mines Limited.
Normetal Mining Corporation, Limited, Normetal	1,000	7.13	–	1.50	1.55	348,440 (335,666)	21,789 (22,522)	
Orchan Mines Limited, Matagami	1,900	11.52	–	1.19	0.98	375,135 (368,030)	39,829 (36,529)	
Quemont Mining Corporation, Limited, Noranda	2,300	2.30	–	0.98	0.78	443,774 (578,171)	7,650 (7,805)	
Solbec Copper Mines, Ltd., Stratford Centre		4.54	0.78	1.39	1.69	75,310 (154,795)	3,148 (7,027)	Operations interrupted by a strike from September 1966 to March 7, 1967. Ore treated by Cupra Mines Ltd., which acquired the Solbec mill in 1967.
New Brunswick								
Brunswick Mining and Smelting Corporation Limited, Bathurst								Majority interest in company acquired by Noranda Mines Limited
No. 12 mine	4,500	9.07	3.47	0.29	2.39	1,669,075 (1,650,120)	115,803 (121,270)	
No. 6 mine	2,250	5.96	2.93	0.40	1.79	867,373 (300,676)	44,051 (17,475)	
Heath Steele Mines Limited, Newcastle[2]	1,500	8.87	2.71	0.56	2.64	308,866 (287,515)	23,699 (13,499)	
Nigadoo River Mines Limited, Robertville	1,000	2.06	2.15	0.43	3.22	22,630 (–)	205 (–)	Mill started November 1, 1967.
Nova Scotia								
Dresser Minerals Division of Dresser Industries, Inc. Walton	125	0.4	3.4	0.32	7.4	50,330 (50,213)	148 (577)	

TABLE 5 (concluded)

Company and Location	Mill Capacity (tons ore/day)	Grade of Ore (Principal Metals) Zinc (%)	Lead (%)	Copper (%)	Silver (oz/ton)	Ore Produced 1967 (1966) (short tons)	Contained Zinc Produced 1967 (1966) (short tons)	Remarks
Newfoundland								
American Smelting and Refining Company, Buchans	1,250	13.51	7.52	1.15	4.04	378,000 (355,000)	47,431 (41,267)	
Consolidated Rambler Mines Limited, Baie Verte	1,500	2.54	–	0.95	0.72	94,611 (148,737)	1,897 (2,437)	Zinc recovery circuit closed down October 1967.

[1]Data for fiscal year ended August 31, 1967.
[2]About half the mill capacity was used to treat copper ore from Cominco's Wedge mine.
– Nil; . . Not available.

The Geco mine at Manitouwadge, owned by Noranda Mines Limited, operated at about the same level as in 1966. Ore reserves at the end of 1967 were 840,000 tons higher than a year earlier and totalled 26,719,000 tons averaging 5.07 per cent zinc, 2.10 per cent copper, and 2.20 ounces silver a ton.

QUEBEC

Mine output declined by 16 per cent to 276,000 tons. Production was derived from 12 mines. One of these closed during the year and another reduced its ore output as salvage operations were begun.

Five mining companies associated with Noranda Mines Limited accounted for 75 per cent of the mine output in Quebec. Total production of zinc at the five mines of this group (Mattagami Lake, Orchan, Normetal, Quemont, and New Hosco) was lower than in 1966, mainly because of a reduction in the grade of ore treated at the Mattagami Lake mine, the largest of the group. Noranda Mines Limited reported that ore reserves of the Normental mine would be exhausted by the end of 1972 if no new ore is found and that it was expected the Quemont mine, where exhaustive exploration was conducted, would be finished before the end of 1971.

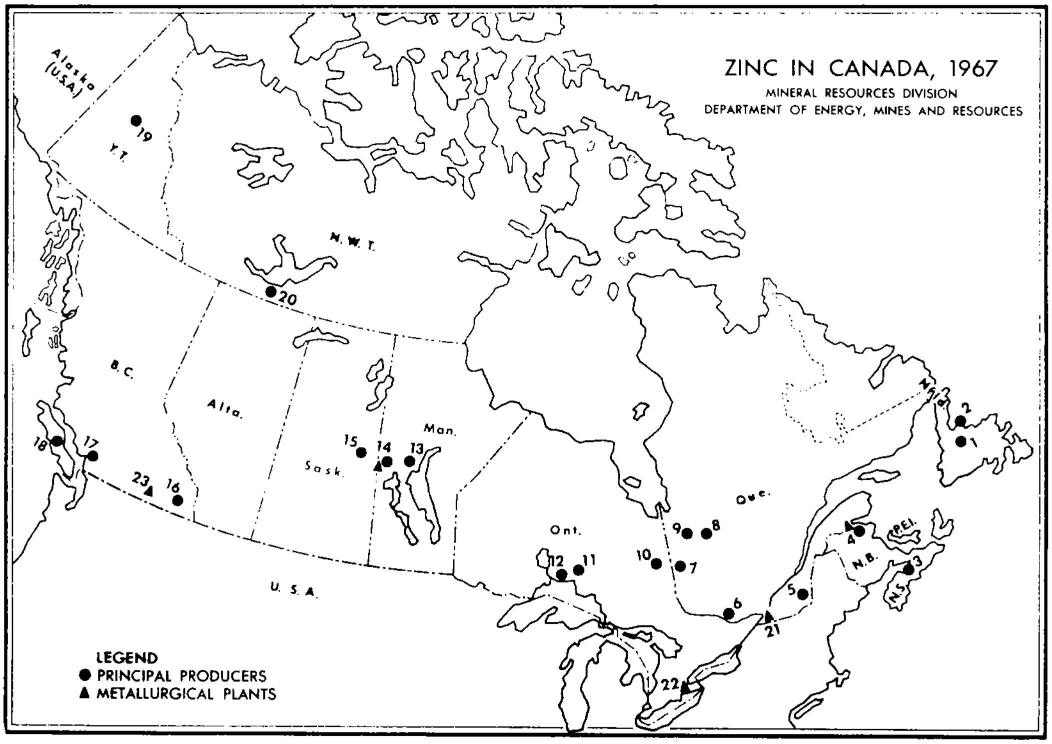
Production of slab zinc by Canadian Electrolytic Zinc Limited, which treats concentrates from the Quebec and Ontario mines of the Noranda group, totalled 119,500 tons.

NEW BRUNSWICK

Mine output increased to 184,000 tons, 21 per cent more than in 1966.

Brunswick Mining and Smelting Corporation Limited operated the No. 12 and No. 6 mines and concentrators, 25 miles southeast of Bathurst. A full year's operation was completed at the No. 6 mine. Ore reserves at the two mines at year-end totalled 67,874,500 tons of zinc-lead ore and 13,478,500 tons of copper ore. Concentrates were sold to European and Japanese smelters except for the requirements of East Coast Smelting and Chemical Company Limited, a wholly-owned subsidiary. At its smelter complex at Belledune, 20 miles northwest of Bathurst, East Coast treated mixed or bulk zinc-lead concentrate from the No. 6 mill, and lead concentrates from the No. 12 mill, in the Imperial Smelting furnace that was completed late in 1966. Difficulties were encountered during a lengthy run-in period so that metal production was much below capacity and revisions to the plant and processes were undertaken. Output was 11,541 tons of zinc, 5,812 tons of lead, 79,831 tons of sulphuric acid and 68 tons of silver-lead bullion. Noranda Mines Limited obtained a majority interest in Brunswick Mining and Smelting Corporation Limited and took over management of all operations in June 1967.

Production by Heath Steele Mines Limited, a subsidiary of American Metal Climax, Inc., rose substantially in 1967 due to a higher grade of ore milled and to an increase in tonnage treated. Ore reserves were increased, and the mine development program initiated in 1965 was continued. The treatment of copper ore from the nearby Wedge mine of Cominco Ltd. is scheduled to end in 1968 to allow for milling the expanded production by Heath Steele Mines Limited.



PRINCIPAL PRODUCERS

(numbers refer to numbers on map)

1. American Smelting and Refining Company (Buchans Unit)
2. Consolidated Rambler Mines Limited
3. Dresser Industries, Inc.
4. Brunswick Mining and Smelting Corporation Limited
   Heath Steele Mines Limited
   Nigadoo River Mines Limited
5. Cupra Mines Ltd.
   Solbec Copper Mines, Ltd.
6. New Calumet Mines Limited
7. Lake Dufault Mines, Limited
   Manitou-Barvue Mines Limited
   Normetal Mining Corporation. Limited
   Quemont Mining Corporation. Limited
8. The Coniagas Mines, Limited
9. Mattagami Lake Mines Limited
   Mines de Poirier inc.
   New Hosco Mines Limited
   Orchan Mines Limited
10. Canadian Jamieson Mines Limited
    Ecstall Mining Limited
    Kam-Kotia Mines, Limited
11. Noranda Mines Limited (Geco)
    Willecho Mines Limited
    Willroy Mines Limited
12. Zenmac Metal Mines Limited
13. Hudson Bay Mining and Smelting Co., Limited – 2 mines:
    Chisel Lake, Stall Lake
14. Hudson Bay Mining and Smelting Co., Limited – 2 mines:
    Flin Flon, Schist Lake
15. Share Mines & Oils Ltd.
16. Aetna Investment Corporation Limited
    Canadian Exploration, Limited
    Cominco Ltd. – 2 mines: Sullivan, Bluebell
    Giant Soo Mines Limited,
    Mastodon-Highland Bell Mines Limited,
    Reeves MacDonald Mines Limited
17. The Anaconda Company (Canada) Ltd.
18. Western Mines Limited
19. United Keno Hill Mines Limited
20. Pine Point Mines Limited

METALLURGICAL PLANTS

4. East Coast Smelting and Chemical Company Limited, Belledune
21. Canadian Electrolytic Zinc Limited, Valleyfield
22. Sherbrooke Metallurgical Company Limited, Port Maitland
14. Hudson Bay Mining and Smelting Co., Limited, Flin Flon
23. Cominco Ltd., Trail

Nigadoo River Mines Limited started operating in November a 1,000-ton lead-zinc-copper mill 25 miles northwest of Bathurst. Previously reported reserves of 1,390,000 tons averaging 2.77 per cent zinc, 2.97 per cent lead, 0.34 per cent copper and 4.36 ounces silver were substantiated by continued underground development.

NEWFOUNDLAND

The Buchans Unit of American Smelting and Refining Company, the main producer, carried out normal operations and shipped zinc, lead and copper concentrates to Europe and the United States for refining.

Leitch Gold Mines Limited reported total reserves at its zinc property in the Great Northern Peninsula to be 5,407,000 tons averaging 7.7 per cent zinc, including 3,700,000 tons in one zone averaging 8.5 per cent zinc.

CONSUMPTION AND USES

Producers' domestic shipments of zinc in 1967 totalled 108,114 tons, 481 tons more than in 1966. Consumption by end-uses is shown in Table 1.

Galvanizing continued to be the largest outlet for zinc in 1967, accounting for 41 per cent of total Canadian consumption. Die castings made from zinc-base alloys were the next largest use, accounting for about 30 per cent; the tonnage consumed in the latter application increased by three times since 1961, due mainly to rising automobile production.

In galvanizing, zinc is applied as an impervious, corrosion-resistant coating to iron and steel products to prevent rust. Galvanized sheet is used in industrial, agricultural and residential construction, and in highway construction for guardrails, culverts and signs. It is used also in automobile underbodies as protection against the attack of road-salt solutions in winter. Galvanized wire is a common fencing material, and galvanized tube is used for railings, fence posts and scaffolding, and as water pipe. Many hundreds of steel articles, from small hardware items to large structural shapes, are commonly galvanized after fabrication to reduce maintenance cost.

Die castings made of zinc-base alloys are used by the automotive industry for such parts as grilles, headlight and taillight assemblies, door and window hardware, carburetors and fuel pumps, all of which amount in total to about 90 pounds of zinc per car. Zinc-base die castings are used as components in household appliances such as washing machines and refrigerators, and in plumbing and hardware supplies. The alloys most commonly used for die castings are made of high-purity zinc (99.99% or higher) to which is added about 4 per cent aluminum, 0.04 per cent magnesium and from 0 to 1 per cent copper.

Brass, a copper-zinc alloy containing as much as 40 per cent zinc, has many applications in the form of sheets and strips, tubes, rods and wire, castings and extruded shapes. Rolled zinc is used in Canada mainly for making dry-cell batteries in which zinc serves both as the negative pole of the cell and as a container. In Europe, rolled zinc is a popular roofing and roof-flashing material. Other uses of rolled zinc are as terrazzo strip and anticorrosion plates for boilers, dock pilings and ships' hulls. Zinc oxide is used in compounding rubber and in making paint, rayon yarn, ceramic materials, inks, matches, and many other commodities. Zinc dust, which is a finely divided form of zinc metal, is used in the processes of printing and dyeing textiles, in zinc-rich paints, in purifying fats, and precipitating gold and silver from cyanide solutions. The more industrially important compounds of zinc are zinc sulphide, which in combination with barium sulphate forms the pigment, lithopone; zinc sulphate, used in rayon fibre manufacture; and zinc chloride, a wood preservative.

TABLE 7

Canada, Producers' Domestic Shipments of Refined Zinc, 1966-67
(short tons)

	1966	1967
1st quarter	29,123	23,927
2nd quarter	29,706	25,319
3rd quarter	25,839	28,565
4th quarter	22,965	30,303
	107,633	108,114

Source: Dominion Bureau of Statistics.

TABLE 8

United States Consumption by End Use, 1966-67
(short tons)

	1966	1967^p
Galvanizing	495,967	434,288
Brass products	185,552	129,684
Zinc-base alloy	606,036	497,209
Rolled zinc	52,612	42,424
Zinc oxide	28,438	29,774
Other uses	41,592	32,850
Estimated undistributed consumption	–	51,600
Total	1,410,197	1,217,829

Source: US Bureau of Mines Mineral Industry Surveys, Zinc Industry in December, 1967.
^p Preliminary; – Nil.

Refined zinc is marketed in grades that vary according to the content of such impurities as lead, iron and cadmium. The principal grades produced are: Special High Grade (99.99%), used chiefly for die casting; High Grade (99.90%), used for making brass, zinc sheet, and miscellaneous products; and Prime Western (98.5%), used for galvanizing. The zinc produced in Canada is Special High Grade and High Grade; Prime Western Grade is produced by adding small amounts of lead to the higher grades, and other commercial grades and special compositions are made to specification to meet consumer requirements.

RESEARCH

In the continuing hot-dip galvanizing research being carried out at the Mines Branch, Department of Energy, Mines and Resources, Ottawa, in co-operation with the Canadian Zinc and Lead Research Committee and the International Lead Zinc Research Organization, work in 1967 was redirected along more fundamental lines. The new investigation initiated is concerned with the kinetics of the galvanizing process.

The principal object is to study the parameters which influence and control the inherent reactivity of ferrous metal surfaces in contact with molten zinc and zinc alloys. These will be examined individually, and in combination as far as possible, under carefully controlled experimental conditions, so as to define the influence of each parameter on the galvanizing reaction mechanism. This study should provide a better understanding of the role of the steel surface in metal coating operations, and in particular should indicate methods by which the surface properties can be modified and controlled to the best advantage. At the present time, work is being concentrated on the design and construction of the experimental apparatus.

PRICES AND TARIFFS

The Canadian and US domestic producers' price each dropped from 14.5 to 13.5 cents a pound, in the respective currencies, during 1967, having been at the higher level since October 1965. The reduction was made in two stages, the first on May 1 when the price dropped to 13.75 cents a pound, and the second on June 21 when the price dropped to 13.5 cents a pound. The overseas producer basis price, which in 1964 replaced the London Metal Exchange quotation as the basis for Canadian sales outside of North America, declined on June 21 from £102 (13.7 cents Can.) to £98 a long ton. The London Metal Exchange quotation was £102.5 a long ton at the beginning of 1967, and fluctuated during the year between a high of £104 on February 16 and a low of £94.75 on September 13. Quotations in sterling were adjusted upwards following the devaluation of the pound on November 17, 1967. The adjusted producer basis price, effective November 20, was £114.33 pounds a long ton.

Canadian and United States tariffs in 1967 were as follows:

	British Preferential	Most Favoured Nation	General
CANADA			
In ores and concentrates	free	free	free
Zinc spelter, zinc and zinc alloys containing not more than 10% by weight of other metal or metals in form of pigs, slabs, blocks, dust or granules, per lb	1/2¢	1/2¢	2¢
Dross and scrap for remelting or processing into zinc dust	free	free	10%
UNITED STATES			
Ores and concentrates		0.67¢ per lb on zinc content	
Unwrought:			
other than alloys of zinc		0.7¢ per lb	
alloys of zinc		19% ad val.	
Waste and scrap		0.75¢ per lb	

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of zinc tariff reductions in some countries with reductions beginning on January 1, 1968, and final reductions on January 1, 1972.

GEOPHYSICAL AID TO THE PROSPECTOR: adjusting electro-magnetic hoops at the start of a survey in northern Manitoba for Hudson Bay Mining and Smelting Company Limited. The company already produces ore from four copper-zinc-lead mines in the Flin Flon area with four other mines under development.

Zirconium and Hafnium

G.P. WIGLE*

Canada imported, from the United States, 1,401 tons of zircon concentrates in 1966 and 1,959 tons valued at $168,400 in 1967. Australia's export statistics show 5,886 tons of zircon shipped to Canada in 1966 and 10,993 tons shipped in 1967. Canada's imports of zirconium metal and alloys in 1967 were 125,898 pounds valued at $3.2 million.

Canada does not produce zirconium or hafnium but has many minor occurrences of zirconium minerals. Canada's use of imported zircon concentrates and zirconium metal and alloys is increasing and, as yet, no domestic mineral sources have been developed.

Eldorado Mining and Refining Limited, a Canadian Crown company, at its Port Hope, Ontario refinery has developed a chemical and solvent extraction process for the recovery of zirconium from zircon sand concentrates. Unlike other processes, the Eldorado process circumvents the production of zirconium sponge and permits the direct production of zirconium and zirconium alloy ingots from hafnium-free zirconium compounds. The company will complete, in 1968, a plant for the production of 300 tons of zirconium ingot or alloy a year.

Zirconium, in its pure state, is a relatively soft, ductile metal that has useful properties which have induced, in recent years, a large increase in its production, and intensive study of the metal and its alloys. Its main commercial use is in the form of its principal mineral, zircon (ZrO_2 SiO_2), in refractories, foundry moulding sand and in abrasives and ceramics. Zircon is also used to produce zirconium metal, alloys and compounds. The metal is highly resistant to corrosion, has high-temperature strength, and a *low* absorption capacity (or high transparency) for thermal neutrons that makes it and its alloys of particular importance as a fuel-cladding and structural material in thermal nuclear reactors using natural uranium fuel.

Hafnium always occurs, in small amounts, with zirconium in minerals and is so similar chemically that it was not positively identified until 1922. It is recovered as a byproduct of the production of hafnium-free reactor-grade zirconium. Its principal importance is, at present, for neutron control rods in nuclear reactors because of its *high* neutron absorption capacity. Zirconium allows relatively free passage of neutrons, hafnium acts as a barrier. The recent history of hafnium production began in 1950 when hafnium-free zirconium was chosen for use in the reactor core of the submarine Nautilus. The next year, the byproduct hafnium was used for the neutron-absorbing control rods in the same reactor.

PRODUCTION AND TRADE

Australia became the world's leading producer of zirconium minerals soon after the start of the mineral-sands industry on its east coast in 1934. Its position has been maintained, except in 1938 when production was very low, and in 1942 when Brazil's production of baddeleyite (ZrO_2) exceeded Australian production of zircon. Australia produced more than 70 per cent of the estimated world total of some 300,000 tons of zircon concentrates in 1965 and has increased its production to 327,420 tons in 1967. Exports were 276,840 tons in 1967.

*Mineral Resources Division Branch.

concentrates. The products recovered, by Associated Minerals Consolidated, are Standard Zircon, Premium Zircon, Zircon flour, Ilmenite, Rutile, and Monazite. The zircon products contain a minimum of 66 per cent ZrO_2.

PRICES*

Published prices for zircon concentrates and zirconium in February 1968 follows:

	US $
Zircon ore, sand, c.i.f. US ports,	
Atlantic ports, bags, 65% ZrO_2, long ton	70.00
Camden, N.J., bulk, 66% ZrO_2, short ton	66.50 – 68.00
Domestic, Starke, Fla., 66% ZrO_2, short ton	56.00 – 57.00
Zirconium	
Sponge, per pound in 1,000 pound lots, f.o.b. shipping point	5.50 to 7.00
Sheet, strip and bar, per pound	12.00 to 16.00
Powder, per pound	12.00 to 13.00
Hafnium	
Sponge, pound	75.00
Rolled bar and plate, pound	120.00

*Sources: *Metals Week*, February 26, 1968; American Metal Market

TARIFFS

	British Preferential	Most Favoured Nation	General
CANADA			
Bars, rods, sheet, strip, wire, forgings, castings and tubes, seamless or welded, of zirconium or zirconium alloys for use in the manufacture of nuclear power reactors, including fuel components	free	free	25%
Sponge and sponge briquettes, ingots, blooms, slabs, billets, and castings in the rough, of zirconium or zirconium alloys for use in Canadian manufactures	free	free	25%
Zirconium oxide	free	5%	7 1/2%
Zirconium silicate	free	free	free
UNITED STATES			
Zirconium ore (including zirconium sand)		free	
Zirconium metal, unwrought, other than alloys; and waste and scrap		12.5%	
Zirconium unwrought alloys		15%	
Zirconium metal, wrought		18%	
Zirconium oxide		10.5%	
Other zirconium compounds		10.5%	
Zirconium salts		10.5%	

The Kennedy Round of the General Agreement on Tariffs and Trade (GATT), that was convened in 1964 to consider reductions in tariffs, submitted its report in 1967. Agreement was reached on a series of tariff reductions in all countries with reductions beginning on January 1, 1968, and final reductions occurring on January 1, 1972.

Statistical Tables

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