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Canadian Minerals Yearbook 1964

MINERAL RESOURCES DIVISION
DEPARTMENT OF MINES AND TECHNICAL SURVEYS, OTTAWA

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Foreword

This Yearbook describes the Canadian mineral industry in 1964 in terms of the more than 65 mineral commodities produced or consumed in significant quantities in Canada. Exploration and development, production, processing, markets, trade, consumption, uses and world trends are discussed in 62 chapters supported by some 100 graphs and maps and 200 statistical tables. The volume is the official annual record of the growth of Canada's mineral industry and is preceded by similar volumes dating back to 1886. Each year, prior to the publication of the yearbook, preprints of the chapters are issued in a loose-leaf service as information becomes available.

Most of the basic statistics on Canadian production, trade and consumption are those collected by the Dominion Bureau of Statistics. Specific data for companies were obtained directly from company officials or from corporate annual reports. Market quotations are mainly from standard marketing reports issued in Montreal, London or New York.

The Department of Mines and Technical Surveys is indebted to all who contributed information, in particular to mine operators, oil and gas producers and others connected with the industry.

W. Keith Buck,
Chief,
Mineral Resources Division.

October 1965.

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General Review

A REVIEW OF THE MINERAL ECONOMY*

This summary of the Canadian mineral industry in 1964 has been prepared to introduce and supplement the mineral industry review series consisting of individual reviews of mineral commodities. The summary consists of descriptive analyses of the year's developments, a brief survey of the industry's progress and problems and an appraisal of developments in mining technology. In addition there is a short section which outlines the development of Canada's mineral economy over the past ten years in relation to the world mining picture. A statistical summary of the Canadian mining industry is made in 56 tables following the individual mineral reviews.

PROGRESS AND PROBLEMS

The value of Canadian mineral production in 1964 reached a new high of almost $3.4 billion. This was an increase of more than $340 million, or 11 per cent, from the total of the previous year, and represents the largest annual percentage increase since 1959. The average annual increase in the value of Canada's mineral production, since the end of the war, has been $145 million, and in only one year, 1958, was there a production decline. Recent production progress may be viewed in perspective against mineral production values of $64 million in 1900, $530 million in 1940, and $502 million in 1946.

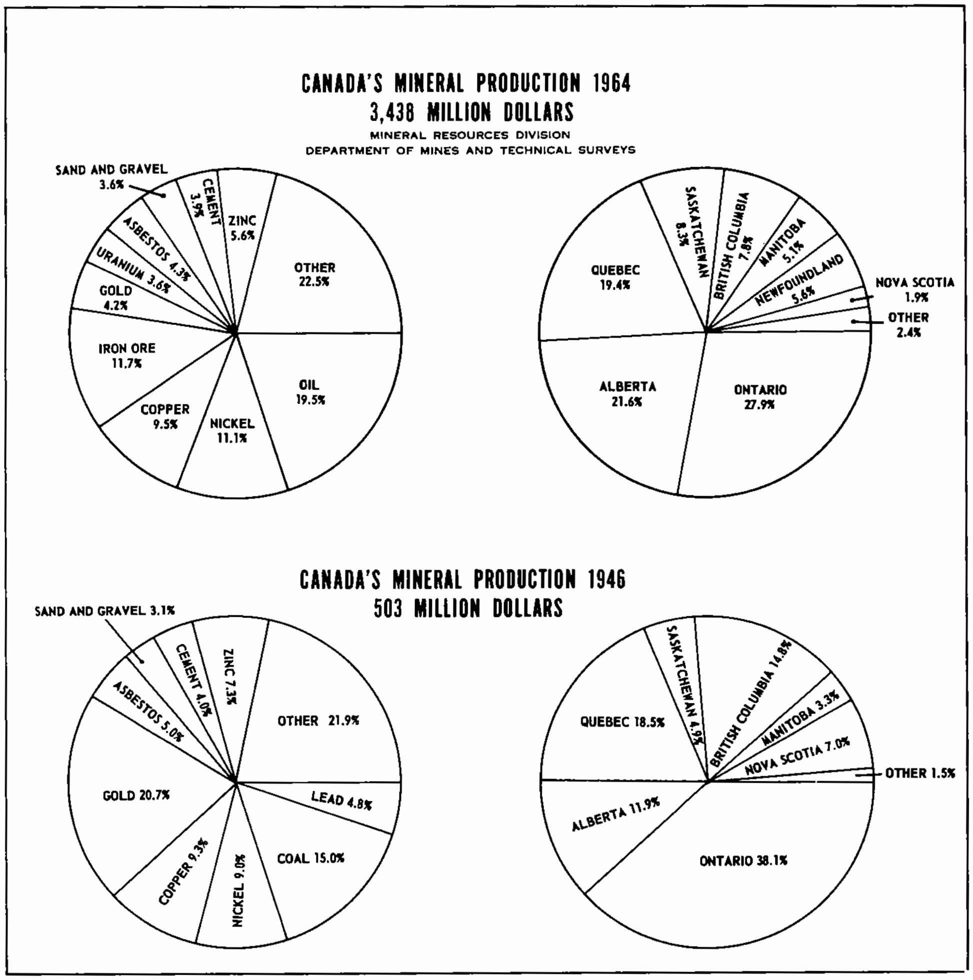
As background to the significant events that took place in the mining industry in 1964 a short review of the post-war era will demonstrate the broad-based strength of the mineral economy.

Since the war, mineral industry growth has taken place in all regions of Canada. In the west the rapid growth of the oil industry, followed in the latter part of the 1950s by large-scale development of natural gas, was paralleled in eastern Canada by the expansion of open pit iron-ore mining in Labrador and Quebec. The uranium industry expanded from an annual U_3O_8 output of about 2,000 tons in 1956 to a maximum of almost 16,000 tons in 1959, contracted to less than 7,000 tons in 1964 but has good prospects for the future. Other mineral resource developments included the discovery and development of copper in British Columbia, in northeastern Ontario, northern Quebec and the Gaspé penin-

*By the Mineral Resources Division.

sula. Production from large lead-zinc deposits in New Brunswick and Quebec, added to the continued large output from British Columbia, has enabled Canada to take over first position among world zinc producers. The discovery of the nickel belt in northern Manitoba and asbestos in northern British Columbia, and the opening up of the Saskatchewan potash resource have also helped to keep the mineral economy expanding at a greater rate than the Canadian economy as a whole. Progress in constructing a full-scale plant for the extraction of oil from the bituminous sands of Alberta and the commencement of lead and zinc shipments from Pine Point in the Northwest Territories are illustrative of the steps being taken by the mineral industry to ensure continuity of growth through the opening up of large new resources.

The changes that have taken place in Canada's mineral economy between 1946 and 1964 can be seen by referring to the accompanying diagram. Gold and



coal, were the dominant minerals in 1946, and accounted for more than 35 per cent of total value but by 1964 this proportion had fallen to about 6 per cent; their place has been taken by oil and iron ore. Some minerals, such as copper, sand and gravel, asbestos and cement hold much the same proportion of the mineral market in 1964 as they held in 1946; others, such as zinc and nickel, hold slightly larger proportions than formerly. Uranium was not among the dominant minerals in 1946 while lead, which represented 4.8 per cent in 1946 had fallen to 1.5 per cent in 1964.

Among the provinces Ontario had the highest value of mineral production, in 1964 as well as in 1946, although its relative share of the total mineral output declined from 38 per cent to less than 28 per cent. Nova Scotia, Saskatchewan and British Columbia all had smaller shares of total Canadian mineral production in 1964, while larger proportions of the total were held by Alberta, where the oil and gas industry is now dominant, and by Manitoba, where the discovery of nickel was the single most important resource development in the past 20 years.

With this strong and diversified industry Canada fills a relatively important place in the world mineral economy as discussed in the last section of this General Review. Because Canada plays a significant part in world mineral trade, and because mineral exports make up about 28 per cent of total Canadian exports, the domestic economy is affected by trends in the international mineral market, trade restrictions and changes in trading policy among the developed nations of the world. The Canadian mineral industry is also affected by the action of foreign firms and governments in mineral resource exploitation – exploration, development and production.

Resources Development and Production

The degree of activity in the mining industry in 1964 may be gauged by references to the new mines that were brought into production and the projects that were started, and also by comparing annual production statistics with those of 1963.

In Newfoundland the picture was one of explosive growth. It was the first full year of production from the Baie Verte asbestos property and there was a 42 per cent increase in the value of iron ore produced. Consolidated Rambler Mines Limited started production from its property near Baie Verte, and became the province's fourth copper producer. At Wabush, Labrador, the new iron ore concentrator will supply the pelletizing plant at Pointe Noire, Quebec. The cost of these two plants was in the order of $300 million. The value of Newfoundland's mineral production increased about 40 per cent to $137¼ million in 1964 compared with 1963.

New Brunswick's mineral production in 1964 was nearly double the output in 1963. The increase was almost entirely from the Brunswick Mining and Smelting Corporation Limited's lead-zinc complex near Bathurst, which started production in 1964 at a rate of 3,000 tons a day. Expansion plans announced during the year for the Bathurst area include the development of a $117-million fertilizer and steel mill complex, and also two new mines to feed a proposed 1,500-ton-a-day concentrator. Construction continued during 1964 on the lead-zinc blast furnace at East Coast Smelting and Chemical Company Limited, 21 miles north of Bathurst, and at Belledune Point on Chaleur Bay where production is expected to start in mid-1966.

In Quebec plans were announced for the construction of a $225-million integrated iron and steel plant to be operated jointly by the province and private industry, under the name of Sidbec. The three zinc-copper mines at Matagami Lake had their first full year of production, the copper-zinc mine of Lake Dufault Mines Limited started production as did Quebec's second nickel mine, operated by Lorraine Mining Company, Limited at Belleterre. The value of mineral production in Quebec rose 23 per cent in 1964 to a total of $670 million.

The most significant event in Ontario was the discovery and development by Texas Gulf Sulphur Limited of a large zinc-copper-silver orebody in the Timmins area. Of importance, too, was the first shipment of pellets from the $30-million Adams mine and concentrator at Kirkland Lake, and completion of the first full year of production of pellets from the Lowphos Ore Limited plant in the Sudbury area. Three new silver mines in the Gowganda area contributed more than 800,000 ounces to the provincial total and Ontario continued to have the highest value of silver production of any province. The total value of mineral production in Ontario increased 4.2 per cent to about $910 million.

Mining laws were liberalized in both Manitoba and Saskatchewan to encourage prospecting. The first solution mining of potash in the world commenced in Saskatchewan in 1964 at the $40-million Belle Plaine operation of Kalium Chemicals Limited. The productive capacity of potash mines in Saskatchewan at the end of the year was 1.3 million tons; by 1968 their capacity is expected to rise to about 4 million tons. The production of elemental sulphur from 'sour' natural gas increased strongly in Alberta and British Columbia. Canada rose to third place among world sulphur producers, after the United States and Mexico. Development work on the Edson gas field, discovered in 1962, shows that this field is very large. Exploratory drilling for oil and gas in western Canada was at the highest level since 1956, and a number of important discoveries were made. The decision by Great Canadian Oil Sands Limited to go ahead with plans to extract petroleum from the bituminous sands north of Edmonton was another major step in opening up the energy resources of western Canada.

Test shipments of very high grade lead-zinc ore were made from the Pine Point deposit in the Northwest Territories. When this deposit reaches full-scale operation, at 5,000 tons a day in 1965 or 1966, it will reinforce Canada's newly won position as the world's major zinc producer.

In British Columbia production started at the 1,000-ton-a-day copper-silver-gold operation of Mt. Washington Copper Co. Ltd. near Courtenay on Vancouver Island, and at the lead-zinc-silver mine of London Pride Silver Mines Limited in the East Kootenay area. Wesfrob Mines Limited began work on a 3-year $25-million development of magnetite-copper deposits on the Queen Charlotte Islands. Development work continued on the large copper deposits of Granduc Mines Limited and The Granby Mining Company Limited, and exploration continued at the Galore Creek copper prospect. Natural gas resource development and pipeline construction continued actively in northeastern British Columbia.

Markets

Since the Canadian mineral industry is predominantly export oriented, its health is a reflection of the strength of the economies of the developed nations and of the competitiveness of the industry in export markets. The economies of the industrial nations of the world were buoyant in 1964, although growth rates were not as high as in previous years. However, Canadian mineral exports rose by 291 million dollars to $2,305 million, the largest annual increase since 1956. Raw and semiprocessed minerals made up more than 28 per cent of Canada's total export trade.

The United States' share of Canadian mineral export trade dropped slightly, although the amount of iron ore shipped there increased. Close corporate ties in the iron and steel industry, and the increased portion of Canadian iron ore production that is being tailored to suit the needs of American steel makers, account for the favourable position of Canadian iron ore in the U.S. market. The major change in the orientation of Canadian mineral exports was the increase in shipments of lead and zinc to the European Economic Community (EEC). This is also due to strong corporate ties; the new lead-zinc complex in New Brunswick made shipments to Belgium under long-term contracts with a participating company. The growth in total Canadian-Japanese mineral trade levelled off although some commodities showed strong gains.

Destinations of Major Canadian Metals and Minerals

(as percentages of export total of each)

		Iron Ore	Aluminum	Copper	Nickel	Lead and Zinc	All Mineral Exports
United States	1950	93	48	48	72	72	64.6
	1955	80	39	49	68	60	61.1
	1960	66	20	37	34	48	52.3
	1961	68	26	25	45	48	53.8
	1962	81	36	31	54	55	62.6
	1963	79	40	29	51	48	60.4
	1964	82	38	30	48	35	58.4

		Iron ore	Aluminum	Copper	Nickel	Lead and Zinc	All Mineral Exports
Britain	1950	5	38	37	18	15	23.0
	1955	9	47	32	19	31	24.7
	1960	18	30	33	26	32	21.3
	1961	14	30	36	30	27	20.6
	1962	7	28	29	26	27	17.1
	1963	10	27	31	28	30	19.0
	1964	10	31	31	33	25	20.3
Other countries of the European Free Trade Area*	1950	0	1	5	9	1	3.1
	1955	0	1	5	12	0	3.6
	1960	0	2	6	21	1	4.8
	1961	0	2	11	15	1	4.7
	1962	0	3	10	15	0	4.3
	1963	0	3	10	15	1	4.2
	1964	0	2	10	11	1	3.5
European Economic Community**	1950	2	2	5	1	11	4.9
	1955	7	6	10	1	8	6.6
	1960	10	20	14	13	8	11.0
	1961	11	12	15	5	13	9.0
	1962	6	10	11	2	9	6.5
	1963	4	10	5	3	10	5.5
	1964	3	10	8	4	27	7.4
Japan	1950	0	0	0	0	0	0.1
	1955	4	0	0	0	0	0.8
	1960	6	3	5	0	5	3.4
	1961	7	6	6	1	4	4.7
	1962	6	2	13	1	1	3.5
	1963	7	3	16	1	3	4.9
	1964	5	4	16	2	5	5.8
All other countries	1950	0	11	5	0	1	4.3
	1955	0	7	4	0	1	3.2
	1960	0	25	5	6	6	7.2
	1961	0	24	7	4	7	7.2
	1962	0	21	6	2	8	6.0
	1963	0	17	9	2	6	6.0
	1964	0	15	5	2	8	5.6

* Norway, Sweden, Denmark, Austria, Switzerland, Portugal.

**France, Germany, Italy, The Netherlands, Belgium, Luxembourg.

In absolute terms the value of Canada's mineral trade with the United States was higher in 1964 by about $130 million, about 10 per cent, compared with the previous year (Tables 18 and 19). The value of shipments of iron ore, nickel, nonferrous metals and fuels all increased significantly. Aluminum exports were virtually unchanged while the value of uranium exported in 1964 was down to about one third the value of the previous year.

All mineral exports to Great Britain increased with the exception of uranium. The value of the gain in trade was $86 million, a rise of 22 per cent compared with 1963. There was little change in the dollar value of trade with the rest of the European Free Trade Area (EFTA).

As previously noted the value of lead and zinc exports to the European Common Market (EEC) area rose sharply in 1964. The value of lead exports increased three fold, and of zinc nearly four fold to a combined total value of about $42 million. Sales of copper, nickel and asbestos also increased, but were offset by small declines in iron ore and aluminum. On balance mineral exports to EEC rose from $111 million to $170 million.

Gradual changes take place both in the relative importance of minerals and in the economies of the countries in which Canadian minerals are marketed. These changes bring about changes in the relative importance of Canada's leading mineral exports. In recent years iron ore and fuels have contributed an increasing proportion to the total value of mineral exports; uranium rose rapidly in the late 1950s and is now declining, although world demand is expected to strengthen by 1970. The percentages of the leading minerals in total mineral exports in 1964 compared with 1962 and 1963 are as follows:

	1962	1963	1964
Copper	10.5	10.3	10.4
Nickel	16.7	16.1	15.8
Lead and Zinc	4.4	4.2	6.7
Iron Ore	11.4	13.5	15.4
Aluminum	14.9	15.3	13.9
Uranium	8.6	6.8	3.2
Asbestos	7.0	6.9	6.8
Fuels	16.3	15.9	16.2
Total	89.8	89.0	88.4

Competition in international mineral markets remains very keen and new conditions had to be met by producers in 1964. Iron ore producers expect increased competition will result following the passing of a law by Minnesota voters that guarantees no disproportionate tax increases for taconite plants in that State. Several companies announced plans for new concentrating plants in Minnesota following passage of the law. Canadian nickel producers benefited from the increasing use of stainless steel by the United States automobile industry and were able to draw down inventories. Workers previously laid off by the two chief producers were re-hired during the year.

Economic, political and labour factors combined to upset the supply-demand balance that the copper market had maintained in 1962 and 1963. This balance had been maintained by production and marketing curtailments initiated by many of the large copper producers in Africa, the United States, Chile and Canada. The high level of industrial activity that carried over from the fourth quarter of 1963 into 1964 was accompanied by a sharp increase in copper consumption. Consumers who had allowed their inventories to dwindle during the period of stability and assured supply were alarmed by the threat of work stoppages at the major United States producers where contract negotiations were scheduled to start at mid-year. Increased purchasing to cover the rise in consumption and to replenish inventories brought about a supply shortage. Idle capacity at the mines throughout the world was reactivated in January but delays in achieving full production, coupled with work stoppages at many of the producing facilities, prevented production from overtaking demand and the shortage persisted to the year-end.

Canadian industry spokesmen appeared before the U.S. Tariff Commission in March 1964 to advocate the removal of import quotas on lead and zinc, but they were not successful. In addition the U.S. Congress authorized the release of 50,000 tons of lead and 75,000 tons of zinc. The U.S. stockpile presents a continual problem to the burgeoning Canadian lead-zinc industry since surplus stocks remain at 1.3 million tons of lead and 1.5 million tons of zinc.

The demand for Canadian potash is expected to increase rapidly within the next decade. The Saskatchewan potash deposits are located relatively close to potential markets in the northern United States and exports are expected to increase rapidly. The first solution mining property started operating in September 1964.

In summary, gains were made in most markets and by most mineral commodities. The gains in the British and Japanese markets of 1963 were continued. The increase in sales to the United States was considerably more than the gain made the previous year. The large gain in the EEC market more than offset the loss of the previous year. Only the EFTA market showed an actual loss and that of only $5 million. Gold and uranium showed losses among the commodities although some commodity markets, such as aluminum, were mixed.

Mineral and Metal Prices

The general trend of mineral and metal prices in 1964 was similar to 1963. Buoyant market conditions and increases in the high level of industrial activity that had prevailed in the last quarter of 1963 carried over in 1964 leading to increased demand for minerals and generally rising prices. However, the fear of permanent loss of markets to substitute materials was a restraining influence on price increases. This did not apply to prices of nonferrous metals on the London Metal Exchange (LME) which rose to prices as high or higher than 1957 levels.

The stability that had been induced in the price of copper in 1962 and 1963 by producer control of production was upset by an increase in demand coupled with various production curtailments, including strikes. Consumer inventories, which had been allowed to diminish, were restocked and production failed to keep pace with demand. The price of copper rose on the LME from the equivalent of 29.25 cents (US) a pound to more than 31 cents (US) early in 1964. The major African producers announced that all copper sold in Europe on long-term contracts would be sold at a producer's price of 29.50 cents (US) not at the LME quotation. Other world producers followed this lead. In Canada the price of copper at this time was 31.50 cents (Can.), and in the United States, 31.00 cents (US). Prices continued to rise, with minor checks, following strikes at copper producing facilities in the United States; the LME price reached a record high of 66 cents (US) on November 4. By the end of the year it had fallen to 46.25 cents (US). The producer's price of copper had risen in two stages to 35 cents (Can.), 34 cents (US), and in Europe to 32.50 cents (US), when the Chilean Government announced all European sales of Chilean copper would be at 35 cents (US). The price of Chilean copper in the United States was raised to 35 cents shortly afterwards.

Lead and zinc continued the price rise that had been in evidence in 1963. The Canadian price of lead climbed from 12.5 cents to 13.0 cents early in the year, rose to 13.5 cents in September, to 14.5 cents in October and 15.5 cents in December. The Canadian price of zinc was 13.0 cents a pound at the beginning of the year, it rose to 13.5 cents in April and 14.5 cents in October.

The list price of aluminum rose from 24.7 cents (Can.) a pound, to 26.0 cents during the year. Price increases also occurred for antimony, bismuth, indium, molybdenum and most of the platinum group of metals. The price of tungsten, which had been very depressed advanced from $11 to $18 and then to $21.50 a short ton unit. The price of mercury rose from $234 a flask in January to $485 a flask in December. Nickel and cadmium were two metals that did not register a price change. Silver remained at the United States Treasury selling price of $1.29 (US) an ounce, the Canadian price was $1.40. The price of gold paid by the Royal Canadian Mint in 1964 averaged $37.75 an ounce, compared with $37.74 an ounce in 1963; during 1964 the price fluctuated between $37.86 and $37.54.

Iron ore prices continued the decline that started in 1960, although there was evidence of a firming trend late in the year. Pellet prices remained firm despite an increase in productive capacity.

Among industrial minerals there were virtually no changes in the prices for various grades of asbestos fibre. The price of sulphur continued the firming trend begun in late 1963 following nearly ten years of oversupply and weak prices. By year's end the price, f.o.b. Gulf points, was $27.00 a long ton up

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from $25.00 a long ton in January 1964. Agricultural prices for potash were higher than in 1963, although there was some fluctuation. Standard grade muriate (60 per cent K_2O minimum) was 37 cents (US) a long ton unit in January, but this price had risen to 40 cents (US) by the end of 1964. Granular grade closed at 44 cents (US).

In general the Canadian mineral industry benefited from the buoyant conditions of the world economy and the attendant rising prices. The rising trend that started in mid-1963 continued throughout the year in the nonferrous sector; the additive minerals generally increased in price, although nickel continued steady, and iron ore prices remained weak.

MINING TECHNOLOGY

Advances in mining techniques that took place in Canada during 1964 are reviewed in this section. In addition to those mentioned, many improvements of an operating nature are continuously being incorporated in any mining plant. They generally do not gain the prominence given entirely new changes in technique but in the aggregate they contribute considerably to cost cutting, safety improvement, and speed of operations.

Production and Mining Methods

The tonnage of ore mined and rock quarried rose from 45.9 million tons in 1950 to 114.3 million tons in 1962 and further increases occurred in 1963 and 1964. The ratio of ore production from open pits to ore from underground mines continues to rise. In metal mining operations in 1963, 57.3 million tons of ore came from open pits and 60.2 million tons came from underground operations.

Tonnage of Ore Mined and Rock Quarried in Canada
Selected Years, 1950 to 1962
(millions of tons)

Ore Source	1950	1960	1961	1962
Metal Mines	45.9	101.6	99.3	114.3
Non-Metal Mines	17.7	42.0	47.0	52.2
Stone Quarries*	34.1	55.8	59.7	62.5
Total (other than coal)	87.7	199.4	206.0	229.0

Source: Dominion Bureau of Statistics, GENERAL REVIEW OF THE MINING INDUSTRY.

*Includes stone quarried for manufacture of cement and lime; does not include sand and gravel.

Ore Production[1] from Metal Mines, 1950–1963

(millions of short tons)

Year	Underground[2] tons[3]	Open Pit[2] tons[3]	Total tons	Ratio Underground to Open Pit
1950	35.4	5.6	41.0	6.3
1960	69.2	24.8	94.0	2.8
1961	64.2	29.3	93.5	2.2
1962	62.4	33.2	95.6	1.9
1963	60.2	57.3	117.5	1.1

[1]Compiled from company reports of tons shipped or milled. Data presented here may not correspond with DBS reports owing to a different method of compilation. Where exact data were lacking, estimates were made. [2]Excludes waste. [3]Tons of 2,000 pounds.

Exploration

Canada continues to lead the world in the number of economic mineral discoveries by means of geophysical techniques. The most spectacular exploration effort of 1964 was the discovery, following an airborne EM survey, of a 55-million ton orebody by Texas Gulf Sulphur near Timmins, Ontario. It was reported that some 60 anomalies disclosed by the survey were drilled at a cost of about $2.5 million.

A number of exploration equipment innovations took place in 1964. A lightweight magnetometer for ground use incorporating a wholly transistorized electronic device for measurement of the earth's magnetic field to an accuracy of one part in 50,000 has been developed by a Canadian company. A smaller model of the same instrument, weighing only 3.5 pounds, has also appeared. Another company has produced a small airborne version of its fluxgate magnetometer to carry out aeromagnetic surveys to an accuracy of ± 50 gammas. An air-driven gyro-stabilized sensing head has been incorporated into the instrument to keep the sensitive element pointing downward despite aircraft manoeuvres. The same company introduced high-power indirect-polarization equipment to work with electrode separation of 10,000 feet. This equipment is expected to serve for investigations to depths of two to three thousand feet.

Mining Methods

Hydraulic mining of coal has proven successful in Coleman Collieries, Alberta. A diamond drill is used to drill a 4¾-inch hole parallel to the dip in the centre of the seam. Water is pumped under high pressure into the drill rods through a special nozzle that replaces the bit after the hole is drilled. The rods

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can withstand a pressure of 10,000 psi without leaking. As the drill rods are slowly rotated at one revolution per 80 seconds, the nozzle is drawn upwards through the seam. The loosened coal drops down into a flume that leads to the screen room and haulage system. The holes are 400 to 600 feet long depending upon the distance along the dip between haulage drifts, and are spaced 27 feet apart along the seam; 10 feet of coal are removed on each side of the hole, leaving, therefore, a 7-foot pillar between successive cuts.

Drilling and Blasting

There has been a continued trend towards the use of silencer-equipped drills in underground mining. Consolidated Mining and Smelting Company of Canada Limited (COMINCO) has developed its own muffler for diamond and percussion drills at the Sullivan mine. In the Geco mine, replacement drills are all silencer-equipped.

The use of wagon drills for drilling up-holes in cut-and-fill stopes was continued at Falconbridge Nickel Mines Limited, Sudbury. Other mining companies have adopted the method with varying success.

At the Lynn Lake mine of Sherritt Gordon Mines Limited, a 12¼-inch diameter hole was drilled to a 3,000-foot depth with a standard oil well drilling rig. The hole was completed in less than two months after which reaming to a final 4-foot diameter was started. This is believed to be the first application of standard oil well drilling equipment to the drilling of large holes in hard igneous rock. The penetration rate was 15 feet an hour. Allowable deviations of the hole were 30 feet from the vertical in the first 2,000 feet and 10 feet from the vertical in the next 1,000 feet. All specifications were easily met.

For surface drilling of 2½- to 4-inch holes, a new crawler drill with a feed tower that swings through 180° was introduced by a Canadian manufacturer. The tower is moved by a cylinder-piston arrangement, completely eliminating manual setting-up. A lighweight gasoline-driven auger drill for drilling 3-inch diameter holes in frozen soil was introduced by another Canadian manufacturer. The drill is designed for drilling holes to take thawing devices; it is equipped with a torque converter that automatically balances the load and speed so that the auger always develops maximum power.

Ammonium nitrate explosives (AN-FO and NCN), as well as a greater variety of loaders, are now used more widely in underground blasting. A series of 'long-delay' non-electric detonators has been developed for use with AN-FO mixtures. The world's largest underground blast took place in 1964 in the Frood-Stobie mine where 464 tons of cartridged explosives were detonated in over a million feet of blastholes to break about 3¾ million tons of ore.

Surface blasting continues to advance by means of wider use of metallized slurries that produce a greater gas volume and greater energy upon detonation. In the Sudbury district a Canadian explosives manufacturer has developed a pump truck to deliver slurried blasting agents directly from the factory to open-pit benches where they are pumped directly into boreholes by means of pumps and vibrators.

Support

The larger mining companies are leading the trend towards greater understanding and use of rock mechanics by establishing rock mechanics departments, as at COMINCO; by the application of a variety of techniques for measurement of stress and closure, as at Falconbridge; and by improved destressing techniques, as at INCO. At Geco, a complete history of stress relief is being built up on maps.

Resins are being used with rock bolts on a wider scale to support difficult ground. Epoxy "Roc Loc" type cemented rock bolts were used to bolt a 5,000 ton ore bin at Eldorado. Polyester rockbolting and guniting were applied to the support of slusher trenches at INCO and it was reported that conventional concrete was replaced under certain conditions.

The use of cement-stabilized fill in cut-and-fill stoping continues to increase. In the undercut and fill stopes at the Frood mine, cemented fill has made possible the replacement of longitudinal laminated stringers and log mats with a wire-mesh mat laid on transverse stringers. A number of mining companies have adopted cemented floors in cut-and-fill stopes as replacements for timber floors. The ratio of cement to tailings used in floors appears to vary from 1:4 to 1:7. Thick slabs with a 1:15 cement to tailings ratio are being tested as an aid to floor pillar recovery.

Loading, Hauling, and Handling

Overhead loaders still predominate in development headings; slushers in stopes; and rail haulage in underground main line haulage. There has, however, been a greater interest in loader-transporters where double scraping was formerly necessary at Mattagami Lake Mines Limited, and in "Transloader" haulage as at Lake Dufault Mines, Limited. Draw point loading trends continue to favour larger loaders.

An automated endless rope haulage system has been installed and is working satisfactorily in the Farley mine of Sherritt Gordon Mines, Limited. What is believed to be the first hoisting rope made up of a 145-ton tensile wire was placed into service in the Creighton mine of INCO. A new polyurethane elastomer has been designed for lining head sheaves as an aid to reducing rope and sheave wear. The treads of the new material are used on Koepe hoists but can be applied to sheaves of all types.

Miscellaneous

Education within the mining industry, and its effect upon future technology, gained considerable attention during the year. Universities, The Canadian Institute of Mining and Metallurgy and The Mining Association of Canada focussed attention on educational and recruitment problems. Curricula in universities where courses related to minerals are taught have undergone revision. Industry and government directed much attention to the encouragement of increased enrollment in university mineral engineering courses because of the acute shortage of mining and metallurgical engineers.

Symposia on Operations Research and rock mechanics continue to be well attended by Canadian mining engineers, indicating a greater awareness of these management and engineering tools.

The Mining Association of Canada formed a Research Advisory Committee to advise and co-ordinate research in the Canadian mineral industry. The Committee has determined that four areas of research require particular attention: ore breaking, consolidation of backfill, operations research, and pipeline hoisting.

CANADA'S POSITION IN WORLD MINING

1954 — 1963

During the period 1954 to 1963 the value of Canada's mineral production more than doubled. This section of the General Review contains an analysis of that period and shows Canada's position in relation to the world mineral economy.

In looking back to the year 1954, certain conditions in the world industry relating to mineral commodities can be cited as characteristic of the day. Steel then, as at almost any time in man's history, was the foundation of all industrial growth but, at the time, the outlook for ferro-alloys was mixed. The production and demand for nickel and molybdenum was going from strength to strength but the outlook for manganese, chrome and vanadium appeared less certain. In the nonferrous sector, there was an acute shortage of copper due to strikes and rising demand. Concern was being expressed about the need for appropriate price mechanisms to ensure that unrestricted production would be equated to demand. Prices for lead and zinc were depressed but the long-term market outlook for both metals was favourable. The gold resource situation had improved with the opening of the Orange Free State mines in South Africa following the tremendous capital investment of the previous six or seven years, and an unexpected bonus in the form of uranium production was being realized. Demand for oil and coal appeared to be insatiable although in North America coal was fast losing ground to oil.

World Production of Principal Minerals, 1963
(only leading countries shown in each instance)

Country	Copper (mine basis) (s.t.)	Lead (mine basis) (s.t.)	Zinc (mine basis) (s.t.)	Nickel (mine basis) (s.t.)	Gold (fine oz)	Silver (fine oz)
Algeria	—	—	—	—	—	—
Arabia (Saudi)	—	—	—	—	—	—
Argentina	—	—	—	—	—	1,546,160
Australia	118,832	436,027	298,657	—	1,023,400	18,900,000
Belgium	—	—	—	—	—	—
Bolivia	—	—	—	—	—	4,854,762
British Guiana	—	—	—	—	—	—
Bulgaria*	—	93,000	81,500	—	—	—
CANADA	452,559	198,988	497,180	217,030	3,986,044	29,927,723
Chile	662,126	—	—	—	—	2,390,120
China	60,000	80,000	90,000	—	—	800,000
Colombia	—	—	—	—	324,514	—
Congo, Republic of the	297,500	—	110,600	—	213,995	1,097,176
Czechoslovakia*	—	—	—	—	—	1,608,000
France	—	—	—	—	—	610,864
Germany (West)	—	—	102,958	—	—	2,100,000
Ghana	—	—	—	—	921,255	—
Guinea, Republic of	—	—	—	—	—	—
Hungary*	—	—	—	—	—	—
India	—	—	—	—	138,280	—
Indonesia	—	—	—	—	—	—
Iran	—	—	—	—	—	—
Iraq	—	—	—	—	—	—
Italy	—	—	101,312	—	—	996,673
Jamaica	—	—	—	—	—	—
Japan	118,021	58,110	218,194	—	261,868	8,786,798
Kuwait	—	—	—	—	—	—
Libya	—	—	—	—	—	—
Mexico	61,576	209,423	264,351	—	237,948	42,760,487
Morocco	—	81,097	—	—	—	772,743
Netherlands	—	—	—	—	—	—
New Caledonia	—	—	—	32,200	—	—
Norway	—	—	—	—	—	—
Peru	195,519	161,317	201,224	—	94,369	36,447,110
Philippines	70,201	—	—	—	376,036	774,917
Poland*	—	—	162,100	—	—	—
Qatar	—	—	—	—	—	—
Rhodesia — Northern	648,238	—	—	—	—	883,681
Southern	—	—	—	—	566,277	—
Roumania*	—	—	—	—	—	—
Spain	—	65,374	98,785	—	—	5,600,000
South Africa, Republic of	59,421	—	—	—	27,431,573	2,736,868
Southwest Africa	—	91,479	—	—	—	634,134
Surinam	—	—	—	—	—	—
Sweden	—	77,000	73,700	—	—	2,874,276
Trinidad	—	—	—	—	—	—
United Kingdom	—	—	—	—	—	—
United States	1,208,197	250,791	526,995	—	1,468,750	35,000,000
U.S.S.R.*	600,000	440,900	463,000	90,000	12,500,000	27,000,000
Venezuela	—	—	—	—	—	—
Yugoslavia	68,446	111,969	56,511	—	—	3,791,923
Other countries	314,484	363,201	444,657	33,870	2,155,691	15,805,585
World	4,935,120	2,718,676	3,791,724	373,100	51,700,000	248,700,000
Canada's position	5	5	2	1	3	4

Sources: Canada: *Dominion Bureau of Statistics* for all minerals listed.
Copper, lead, zinc, nickel, aluminum, bauxite: *American Bureau of Metal Statistics, 1963.*
Coal: *International Coal Trade, September, 1964.*
Iron Ore: *American Iron and Steel Institute, 1963.*
Petroleum: *World Oil, August 15, 1964.*

* Conjectural.

World Production of Principal Minerals, 1963

(only leading countries shown in each instance)

Country	Asbestos (s.t.)	Coal (excluding lignite) (000's of s.t.)	Iron Ore (s.t.)	Petroleum (000's of bbl)	Aluminum Metal (s.t.)	Bauxite (s.t.)
Algeria	—	—	—	183,710	—	—
Arabia (Saudi)	—	—	—	594,591	—	—
Argentina	—	—	—	97,171	—	—
Australia	—	27,664	—	—	—	—
Belgium	—	23,609	—	—	—	—
Bolivia	—	—	—	—	—	—
British Guiana	—	—	—	—	—	1,513,887
Bulgaria*	—	—	—	—	—	—
CANADA	1,275,530	8,702	30.143,649	257,662	719,390	—
Chile	—	—	—	—	—	—
China	110,000	297,624	55,115,000	—	90,000	—
Colombia	—	—	—	60,343	—	—
Congo, Republic of the	—	—	—	—	—	—
Czechoslovakia*	—	31,191	—	—	—	—
France	—	52,640	64,463,000	—	328,888	2,207,907
Germany (West)	—	156,656	14,217,000	52,417	230,138	—
Ghana	—	—	—	—	—	—
Guinea, Republic of	—	—	—	—	—	1,834,237
Hungary*	—	—	—	—	—	1,652,000
India	—	72,672	15,730,000	—	—	—
Indonesia	—	—	—	165,068	—	—
Iran	—	—	—	538,558	—	—
Iraq	—	—	—	422,354	—	—
Italy	63,418	—	—	—	100,782	—
Jamaica	—	—	—	—	—	7,802,411
Japan	—	57,377	—	—	244,791	—
Kuwait	—	—	—	705,471	—	—
Libya	—	—	—	169,235	—	—
Mexico	—	—	—	114,876	—	—
Morocco	—	—	—	—	—	—
Netherlands	—	12,686	—	—	—	—
New Caledonia	—	—	—	—	—	—
Norway	—	—	—	—	241,581	—
Peru	—	—	—	—	—	—
Philippines	—	—	—	—	—	—
Poland*	—	124,726	—	—	—	—
Qatar	—	—	—	69,920	—	—
Rhodesia— Northern	—	—	—	—	—	—
Southern	142,254	—	—	—	—	—
Roumania*	—	—	—	90,597	—	—
Spain	—	14,305	—	—	—	—
South Africa, Republic of	205,744	46,797	—	—	—	—
Southwest Africa	—	—	—	—	—	—
Surinam	—	—	—	—	—	3,866,868
Sweden	—	—	24,769,000	—	—	—
Trinidad	—	—	—	48,678	—	—
United Kingdom	—	219,291	16,573,000	—	—	—
United States	66,606	474,487	80,987,000	2,752,723	2,312,528	1,731,520
U.S.S.R.*	1,200,000	429,900	153,220,000	1,470,950	990,000	4,629,700
Venezuela	—	—	13,360,000	1,185,492	—	—
Yugoslavia	—	—	—	—	—	1,416,578
Other countries	136,448	77,291	117,407,351	496,992	736,218	6,241,279
World	3,200,000	2,127,618	585,985,000	9,476,807	5,994,316	32,896,387
Canada's position	1	18	5	8	3	0

Sources: Canada *Dominion Bureau of Statistics* for all minerals listed.
Copper, lead, zinc, nickel, aluminum, bauxite: *American Bureau of Metal Statistics, 1963.*
Coal: *International Coal Trade, September, 1964.*
Iron Ore: *American Iron and Steel Institute, 1963.*
Petroleum: *World Oil, August 15, 1964.*

* Conjectural.

In 1954, and certainly much before then, the three principal industrial countries of the Free World – the United States, Britain, and Western Germany – were "have-not" countries so far as their mineral requirements were concerned. In fact, the British and German economies had been geared to the condition of being net importers for so long that it was accepted as part of the industrial and economic pattern. But in the United States, this situation was comparatively new, dating back only to the Second World War, and neither Congress nor the United States industry had become reconciled to it. Consequently, matters relative to stockpiling and restrictions to imports were beginning to make an impact on normal supply-demand relations in the world's biggest mineral market. Furthermore, because of its great dependence on international mineral supply, American domination of world mineral markets was greater than ever before, a situation intensified by the American stockpiling programs which had been initiated for strategic purposes but by 1954 had evolved into a program of assistance for domestic mining. In fact, this United States' government participation in mineral markets at a time of rising industrial activity was to have widespread repercussions in the world mineral economy throughout the 1954–63 period.

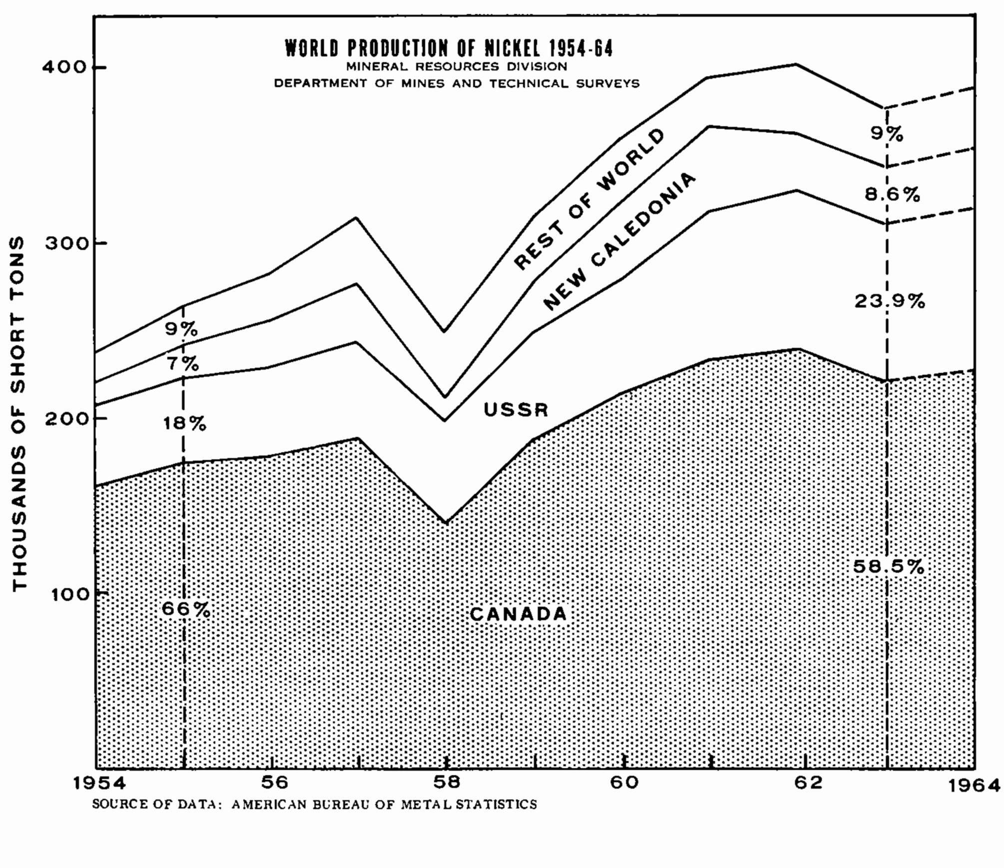
Notwithstanding the build-up in surpluses of some minerals, attention was being given to the long-term outlook for mineral resource development in view of the very fast growing demand for many minerals. Consequently, the mineral resource record of the past ten years is one of world-wide exploration and new property development. The international mineral industry has become greatly enlarged and diversified and in the world race for new production records and wider markets, Canada has done reasonably well in some commodites and lost ground on others. On balance, the country's mineral industry has been able to hold its own as a result of its large-scale mineral developments. On the other hand, any slackening of mineral resource development and marketing effort would soon lead to the country's decline in the world mineral economy in view of the growing number of new mineral projects abroad, particularly in the USSR, Africa, South America and Australia.

In the mid-1950s, after several years of almost uninterrupted growth and prosperity, the long-term growth prospects of the world mineral industry appeared tremendous, notwithstanding many supply and marketing problems, particularly as related to the United States scene. At the same time, it was being realized that the greatest mineral production growth in future would likely occur in the underdeveloped areas of the world. The challenge to the Canadian mineral industry in 1954 was therefore obvious and plainly written for all to see. The record of the past ten years clearly demonstrates the magnitude of this challenge and points to the task ahead if Canada is to maintain and increase its prominent position in the world mineral economy. As the review for 1964 shows, an auspicious start has been made.

In the following 1954–63 assessment, emphasis is placed on foreign mineral developments in stressing the general theme of a rapidly growing world mineral economy. No attempt is made to give a complete accounting of resource developments but rather the purpose has been to select some representative exploration and property development events.

Nickel

Throughout the period 1954–63, Canada retained its position as the world's leading producer of nickel, with no challengers in sight, but its share of world output dropped from 68 to 58 per cent. The Soviet Union's percentage rose from 18 to 24; New Caledonia's percentage remained in the range of 8 to 12; Cuba's declined to 4, and the United States continued in the range of 2 to 4 per cent. Finland was the sixth largest producer in 1963, when it replaced the Republic of South Africa, and accounted for 1 per cent of world output. Production trends of recent years are illustrated in the accompanying figure. During the period 1954–63, world mine production of nickel grew at an average annual rate of 5.6 per cent while Canada's average annual increase was 4.4 per cent.



SOURCE OF DATA: AMERICAN BUREAU OF METAL STATISTICS

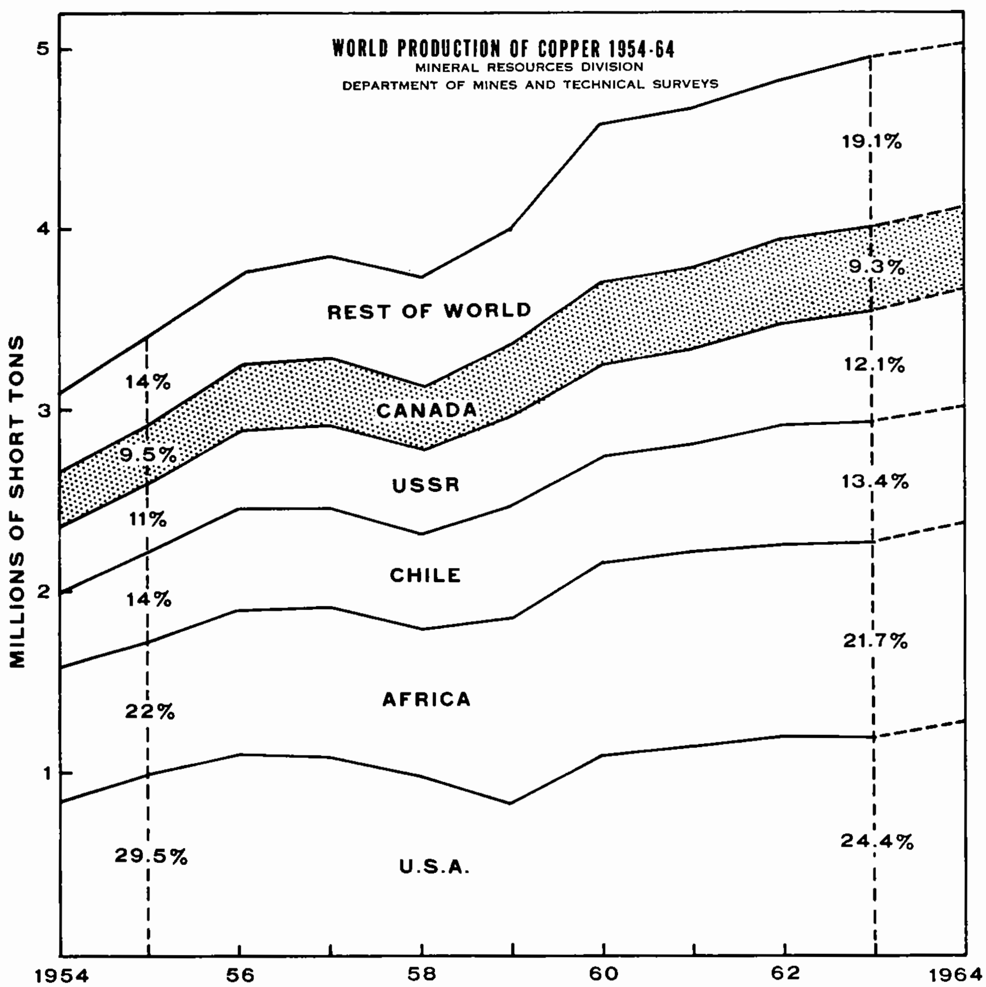
The following events are indicative of the trend of events in the world nickel industry. In 1954, The International Nickel Company of Canada, Limited (INCO) started deliveries of metallic nickel to the United States government stockpile and Falconbridge Nickel Mines, Limited, prepared to make stockpile deliveries by enlarging its production facilities. In Cuba, steps were taken to expand the Nicaro facilities. In the same year, Sherritt Gordon Mines, Limited started mining operations at Lynn Lake, Manitoba. In 1955, with world supply not keeping pace with demand, the Sumitomo Mining Company of Japan made plans to resume operations of its nickel mine in the southern Celebes Islands and Freeport Sulphur Company scheduled completion of its Cuba-Louisiana 50-million-pound operation for 1959. The year 1956 saw the beginning of the Thompson nickel project in northern Manitoba and the U.S. government continued with its Nicaro plant designed to produce 54 million pounds a year. At the same time, the 1960 target of 65 million pounds was set for the processing of New Caledonian nickel ores in France and Japan. Free World annual nickel production capacity was reported at 525 million pounds in 1958 and projects under way were scheduled to increase capacity to 650 million pounds in 1961. INCO's Thompson project was making good progress in 1959 for an annual output capacity of 75 million pounds in 1961 and Société de Nickel completed its expansion to provide an output of 50 million pounds in New Caledonia. Notwithstanding the provision of new production facilities, nickel exploration continued actively in the early 1960s due in part to the loss of Cuban production to the western world. In addition to exploratory work in several areas of Canada, resource appraisals in the British Solomon Islands, the Dominican Republic, Guatemala and Venezuela by Canadian interests, in the Indonesian Celebes by a Japanese firm, and in Yugoslavia, were indicative of the world-wide search for nickel deposits.

Copper

Since 1954, Canada has maintained a firm hold on fifth position among world producers, its output being either 9 or 10 per cent of the world total throughout the period. First place has been continually held by the United States, with Northern Rhodesia (now Zambia) and Chile switching about in second and third places, and the Soviet Union, fourth. Katanga has been consistently in sixth place. Generally, percentage shares of the six world leaders have remained in a narrow range of 1 or 2 per cent, although the U.S. share has declined 5 or 6 per cent as Peru and some of the smaller producers have increased their output. Production trends of recent years are illustrated in the accompanying figure. During the period 1954-63 world mine production grew at an average annual rate of 4.9 per cent while Canada's average annual increase was 6.1 per cent.

At the start of the period, the United States was entering the market to make purchases for its stockpile and, at the same time, European demand was rising quite rapidly. This increase in market demand was accompanied by strikes at mines in the United States and Chile thereby leading to a tight supply situation. Thus there was a strong incentive for new mine development and this led in 1954 to the financing of the Toquepala copper project in southern Peru, to expansion of the copper industry in Northern Rhodesia and to mine development activity in Finland and the Philippines. Mine expansion under way in the United States and Canada during the period 1956-58 made provision for the addition of 250,000 tons a year of new capacity while in Central and South America another 40,000 tons was added to existing capacity and on the African continent, some 140,000 tons was added.

Late in the 1950s a readjustment took place in the copper industry as supply caught up with demand; however, predictions were being made of a United

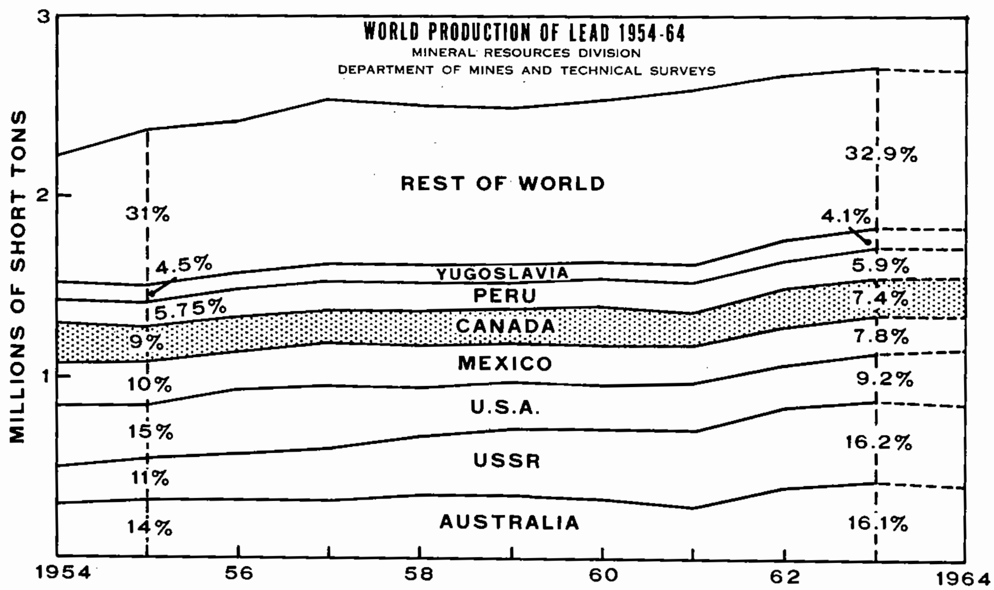


SOURCE OF DATA: AMERICAN BUREAU OF METAL STATISTICS

States producers' price of 36 cents (U.S.) a pound as being required to meet the demands of increasing costs and markets in the 1960s. In 1959, the big Toquepala project of Southern Peru Copper Company came into production at 120,000 tons a year and in the United States American Smelting and Refining Company made plans to develop an open-pit mine near Tucson, Arizona. At the start of the 1960s copper exploration work was active in Mexico, Chile, Peru, Ireland, Cyprus, Greece, Uganda, Egypt, Australia and the Soviet Union; Canadian developments in British Columbia were also attracting world interest. Copper resource development is continuing actively throughout the world and, although no single recent development has been as significant as the Texas Gulf discovery in the Timmins area of Ontario, the number of exploratory projects abroad is illustrative of the challenge Canada faces in world mineral resource development.

Lead

Since 1954 Canada has held fifth place in world lead production except in 1961 when fourth place was reached. The Soviet Union has been the largest producer since 1959; earlier in the period under review, the United States and Australia alternately held first place. In recent years Australia has been the second largest producer followed by the United States and Mexico. Peru has been consistently in sixth place. Canada's share in world production has declined from 10 to 7 per cent since 1954; the United States' share from 15 to 9 per cent, and Mexico from 11 to 8 per cent. The Soviet Union has raised its percentage from 10.5 to 16 per cent and Australia from 13 to 16 per cent. Among the small producers, Yugoslavia, Sweden, Morocco and Bulgaria have increased their



SOURCE OF DATA: AMERICAN BUREAU OF METAL STATISTICS

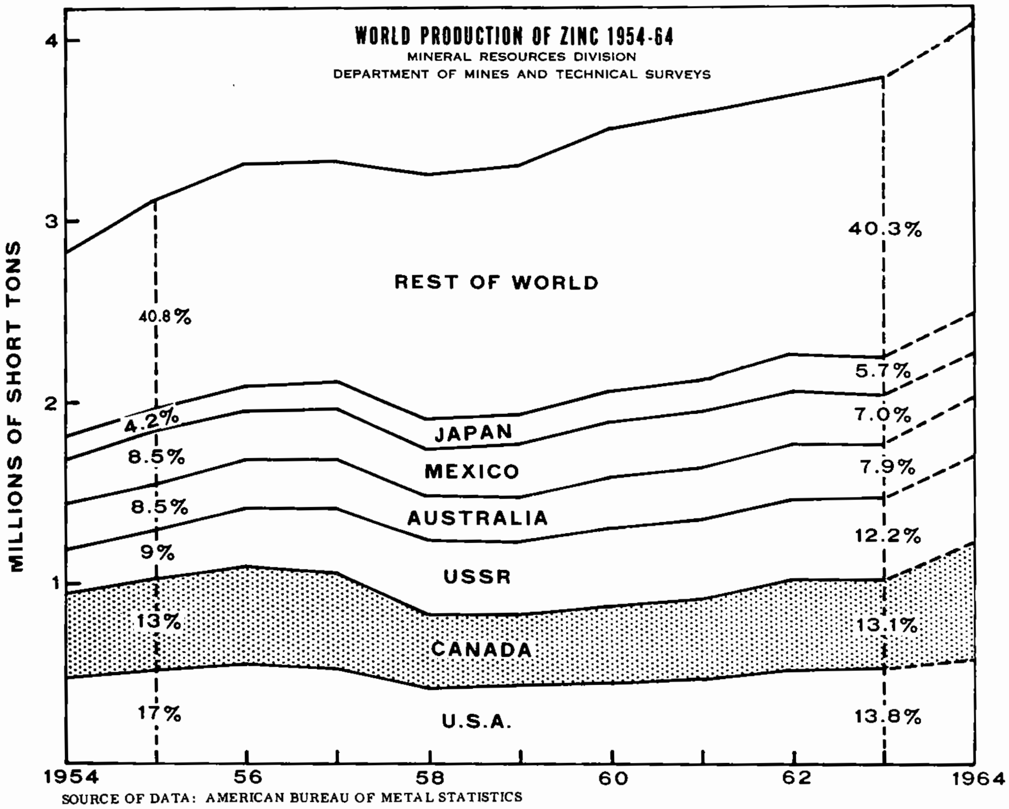
production significantly. Production trends for the period 1954-63 are illustrated in the accompanying figure. During the period, world mine production of lead increased at an average annual rate of 2.9 per cent whereas Canadian production fluctuated but showed no over-all gain.

In 1954, United States output fell to its lowest level since 1934 and the government endeavoured to strengthen the domestic industry and the price situation by the resumption of stockpiling in face of a consumption decline of 9 per cent. Elsewhere, lead resource development and production was active, particularly in Canada, but also in Australia, Spain, Tunisia, Algeria and Morocco. In 1956, the U.S. barter program was putting a floor under the world price but experience was showing that stockpiling, whether from a defence, barter or price-control point of view, was not providing the protection the United States mining industry was demanding against the impact of foreign competition. The same applied to zinc. In 1958, lead and zinc quotas were established in the United States. The low market growth rate in the 1950s – about one tenth the European rate – had affected the entire world supply-demand situation and, consequently, resource development was retarded. Early in the 1960s, property development was under way in Southwest Missouri and Eire and exploration results were being reported from Iraq and Hungary; Canadian developments appeared to be as promising as any.

Zinc

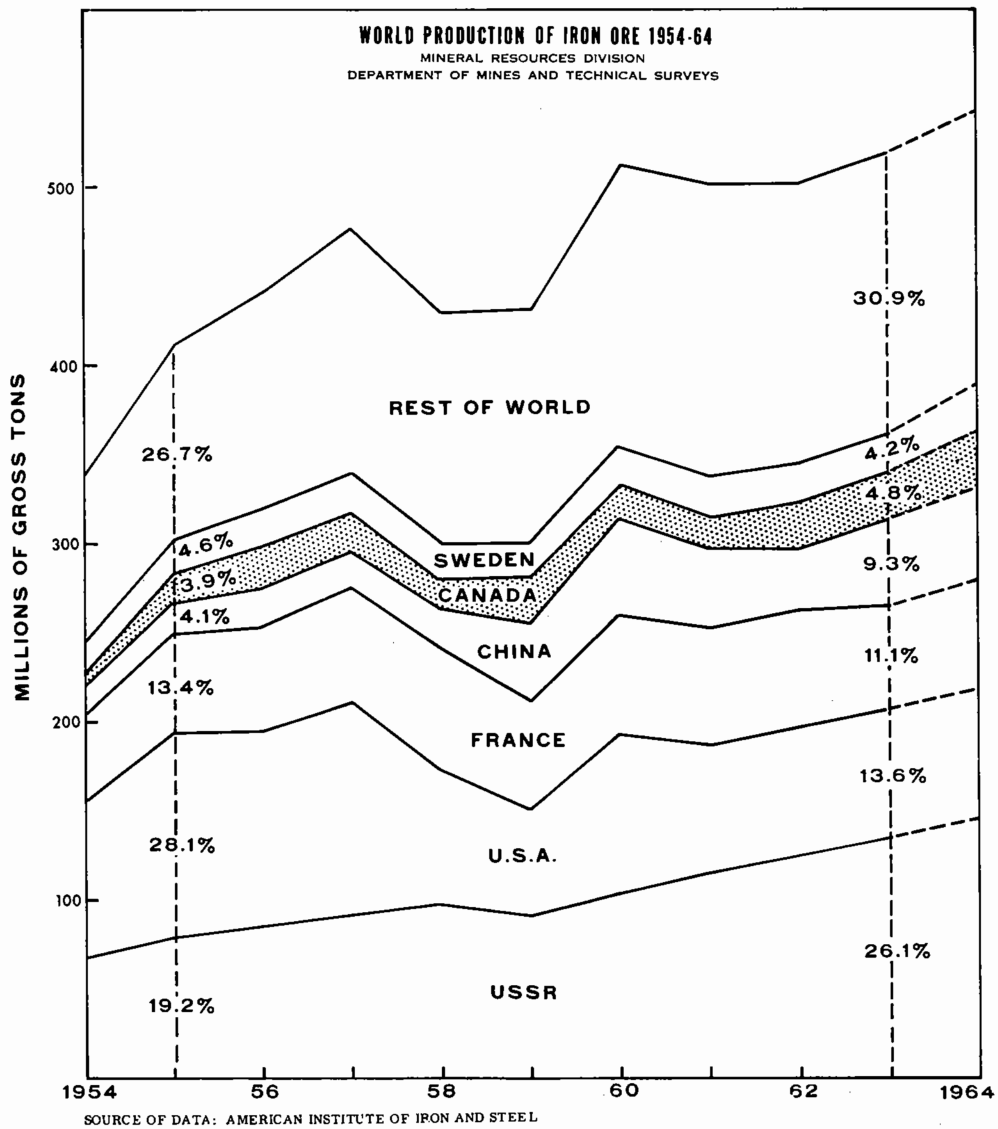
Canadian production of zinc fluctuated from fourth to second place during the years 1954-63, but ended in a strong position in preparation for taking over first place in 1964. The United States and the Soviet Union have been the other leading producers while Australia, Mexico and Japan have generally occupied fourth to sixth places in world output. Canada's share of world output remained at about 13 per cent throughout the period under review while the United States percentage declined from 17 to 14 and the Soviet Union's increased from 9 to 12. Among the smaller producers, Spain, the Congo and Northern Korea showed production increases. Production trends are illustrated in the accompanying figure for the period 1954-63 when the average annual increase in world production was 2.9 per cent and the Canadian average was 2.2 per cent.

The resource development situation for zinc paralleled that of lead. U.S. stockpiling started in 1954 and quotas in 1958, with domestic mine production declining during the latter part of the 1950s as imports increased and the price remained low. In the mid-1950s zinc exploration was active in Turkey, Yugoslavia, Brazil, Poland, Bulgaria and Russia. In the United States, important discoveries were made in Tennessee. Throughout most of the 1950s, the world zinc industry was plagued by over-capacity brought on mainly by the stimulation of production during the Korean emergency and by United States stockpiling following the emergency. However, zinc consumption had grown steadily and overtook production by the end of the 1950s; the long-term outlook remained favourable. In the early 1960s zinc exploration brought favourable results in Eire, the United States and Australia, while sufficient progress was being made in Canada in opening up new properties to ensure Canada's leadership in the mid-1960s.



Iron Ore

Canada held eighth place in world iron ore production in 1954, rose to fourth in 1956-57, declined to seventh in 1961 and since then has been in fifth place. Throughout the period it has accounted for 4 or 5 per cent of world output. The United States was replaced as world leader by the Soviet Union in 1958 and has held second place since then followed by France and China. Many new producers have entered the world picture in recent years but these five countries plus Sweden, West Germany, Britain and Venezuela have continued to account for about four fifths of world output. However, the newer South American, Asian and African producers are beginning to reduce the dominance of the eight or nine leaders. The accompanying figure illustrates recent growth trends; during the period 1954-63 world iron ore production grew at an average annual rate of 6 per cent while Canada's rate of increase was 16.5 per cent.



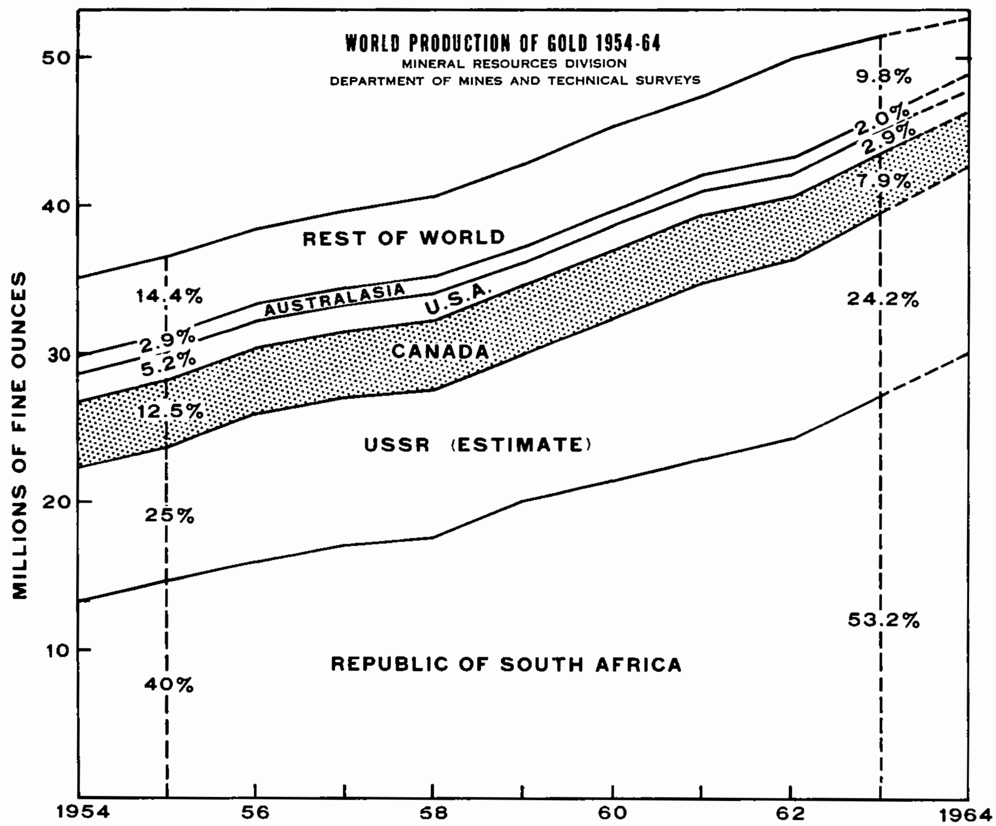
SOURCE OF DATA: AMERICAN INSTITUTE OF IRON AND STEEL

Although U.S. iron ore production in 1954 was the lowest since 1946 because of surplus stocks and a decline in markets, plans for new productive capacity went ahead on the Lake Superior ranges, with interest focussed on the new taconite and other low-grade ore developments in Minnesota and Michigan. This was the year of first iron ore shipments from Quebec-Labrador and from U.S. Steel Corporation's Cerro Bolivar mine in Venezuela. The El Romeral mine in Chile neared completion and production in Peru more than doubled from 1953. Exploration for iron ore was reported successful in many countries, including the Philippines, Argentina and several in Africa. In 1955, both Canada and Venezuela increased their production sharply. In 1956 foreign ores filled one quarter of United States' requirements, with Canada supplying nearly one half and Venezuela supplying a third of U.S. imports. The search for high-grade iron ores continued unabated throughout the world; at the same time intensive research into the utilization of taconites and other beneficiating ores through concentration and pelletizing gained momentum. The possibility of a world oversupply seemed likely. South American production was coming from mines in Brazil, Chile, Peru and Venezuela. One mine in Liberia was shipping ore and several other deposits were under investigation. A large new iron ore discovery in West Germany was announced and reserves of many billions of tons were confirmed in Brazil. In the late 1950s, new iron ore developments and expansion programs were under way in many countries in North and South America, Asia and in Russia. Widespread exploration continued, especially in Russia, India and West Africa.

Early in the 1960s, world attention was directed to major high grade iron ore discoveries in Northern and Western Australia following relaxation of an export embargo by that country. Suspected large reserves of iron in Russia's Kursk Magnetic Anomaly were confirmed. While announcements were being made concerning the Snake River and Baffin Island discoveries in Canada, reports of new mining developments came from the United States, Canada, Chile, Liberia, Malaysia, Mauritania, Peru, Swaziland, Sweden and others. Previous ore discoveries in many countries were proven to contain tremendous reserves. The growing importance of beneficiation was demonstrated by the construction of concentrating plants in Canada, the United States, Peru, Chile, Sweden and others. The record since the mid-1950s is thus one of widespread discovery with many new properties being prepared for production, and increasing competition in world markets as a result of expanding international trade in iron ore. Advancing technology has played an important part in these developments, particularly in the utilization of low-grade ores. Beneficiation promises to become far more important in the future, not only for low-grade ores but also for high-grade, earthy ores. Canada has played a leading role in iron ore processing and will continue to be one of the world leaders in development of new techniques.

Gold

Throughout the period reviewed, Canada was the world's third largest gold producer but its share in world output declined from 12 to 8 per cent while South Africa's rose from 38 to 53 and Russia's remained in the range of 24 to 26 per cent. The United States, Australia, and Ghana in aggregate produced less

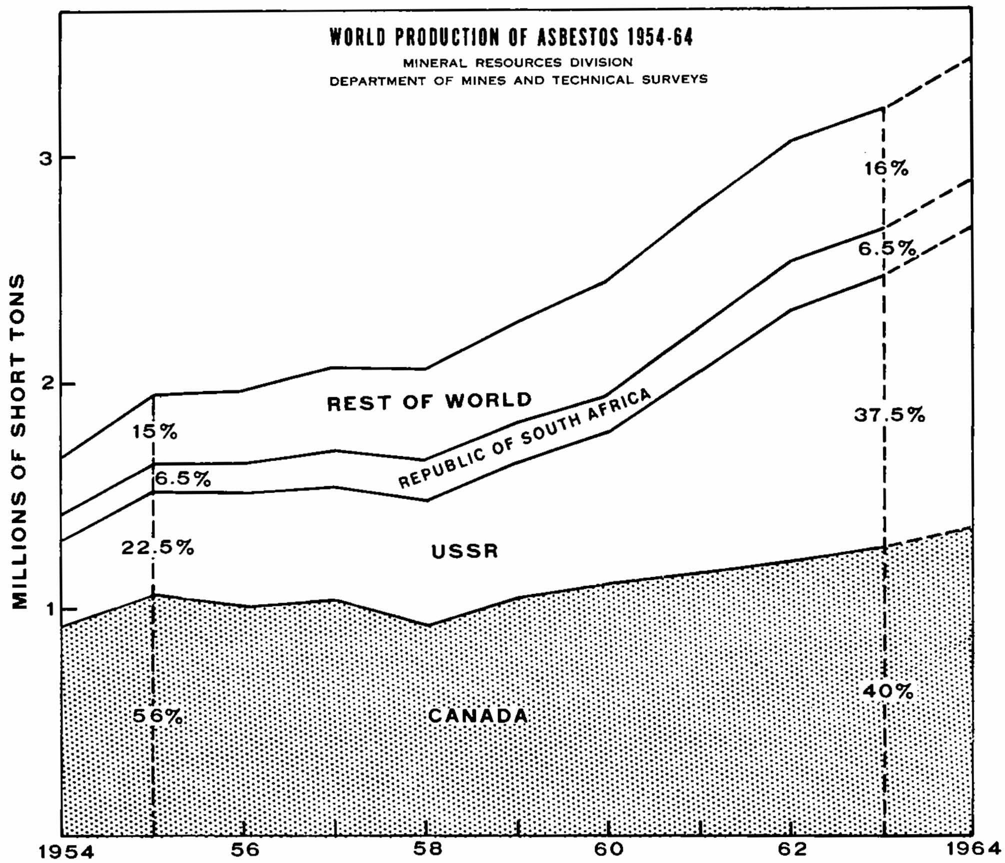


SOURCE OF DATA: AMERICAN BUREAU OF METAL STATISTICS

than 10 per cent. The accompanying figure illustrates production trends since 1954. Canadian production reached a peak of 4.63 million ounces in 1960 and then declined to 4.0 million ounces in 1963. There is little of significance to report in the world resource picture other than the completion of the deep mines in the Orange Free State and the opening up of the large new gold-producing district of South Africa. Gold output doubled in South Africa in the period 1954-63 and increased by one third in the Soviet Union. There were production declines in most other countries but a world gain of 50 per cent. Unlike other minerals, world gold production is becoming less diversified; there is little incentive for exploration and property development under conditions of a fixed price and rising costs.

Asbestos

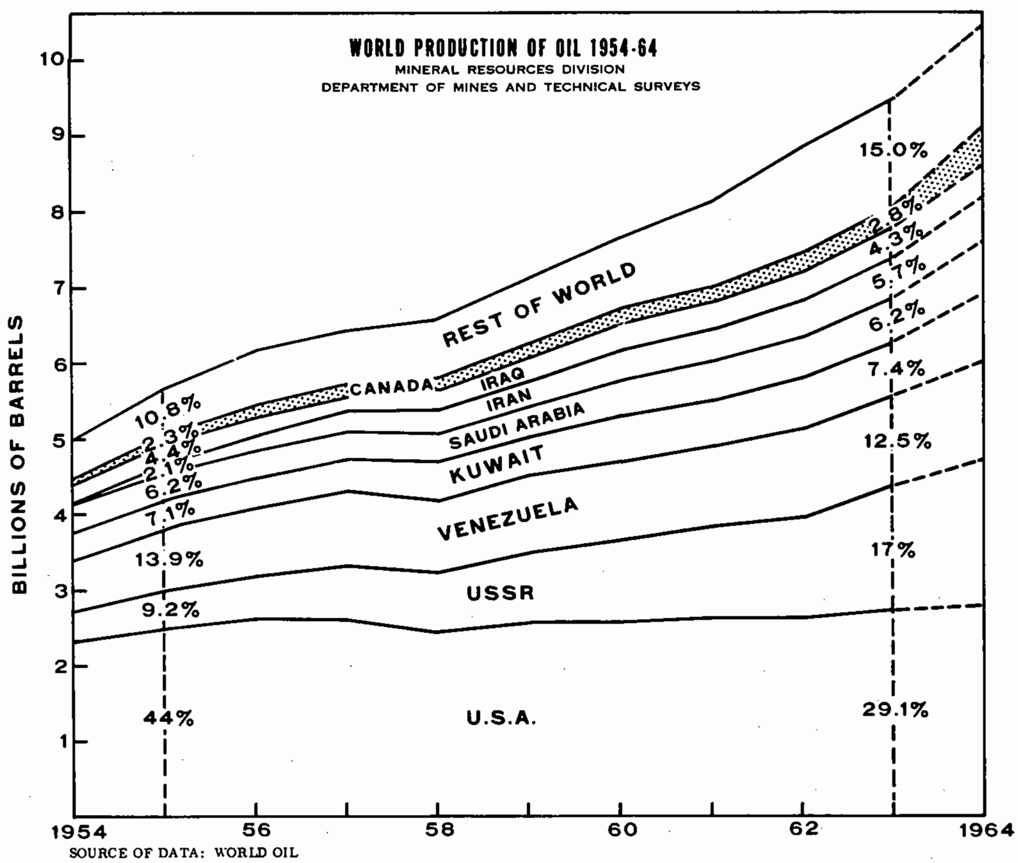
Canada has been the world's leading producer of asbestos but, in recent years, has been seriously challenged by the Soviet Union. Canadian production as a percentage of the world total declined from 55 to 40 in the period 1954-63



SOURCE OF DATA: STATISTICAL SUMMARY OF THE MINERAL INDUSTRY, LONDON

whereas Russia's increased from 22 to 37.5. South Africa, Southern Rhodesia, China and the United States are the other principal producers but in 1963 aggregated only 15 per cent of the world total. World production increased at an average annual rate of 6.5 per cent in 1954-63 while Canada's annual increase was only 3.5 per cent. The accompanying figure illustrates production trends for the period. In the mid-1950s Canada's asbestos industry underwent a major expansion and modernization program while Southern Rhodesia completed new mining and milling operations. Russian fibre began to enter European markets, indicative of significant resource development in the Soviet Union. In the late 1950s and early 1960s property development started in Greece, South Africa, California, the Solomon Islands, North Borneo and Thailand. Although these and other resource activities in the world asbestos industry are indicative of some diversification, Canada and the Soviet Union, with the largest developed resources of chrysotile asbestos, are likely to continue to account for close to four fifths of world output. The record of the past ten years shows that Canada faces a major competitor in world markets.

Canada has held eighth place in world crude oil production in recent years. Although Canadian resource development has been rapid, the opening up of huge oil fields in the Middle East and the Soviet Union has overshadowed oil developments elsewhere. In the ten-year period ending in 1963, world oil production almost doubled although output of the United States, the world's leading producer, only increased 15 per cent. Production of Middle East countries increased by two and a half times and Russia's output tripled. As a result, the pattern of world oil production has changed notably, even since 1954, with the U.S. share declining from over 45 to less than 30 per cent while the Middle East increased its share from 20 to 30 per cent and the Soviet Union doubled its percentage to 17 per cent. Although Canada's output, less than 3 per cent of the world total, is not significant on a world scale, an important Canadian role in North American supply is evolving. World production trends of the period 1954-63 are shown in the accompanying figure.



SOURCE OF DATA: WORLD OIL

Canada is the world's third largest producer of natural gas, after the United States and the Soviet Union. The growth rate of Canadian natural gas production has been similar to that of the Soviet Union; the two countries have shown by far the greatest production progress in recent years. The United States still accounts for about two thirds of world output, while the Soviet Union and Canada produce, respectively, about one fifth and one fifteenth of the total. Sulphur resource development in Canada has come about largely as a result of the country's natural gas development. The most significant world development in recent years has been the opening up of large natural gas reserves in Holland and the preparation for exploration in the North Sea.

Other Minerals

World resource development has also proceeded rapidly in a number of other mineral sectors in which Canada has significant production. In silver, Canada's percentage of world output declined from 15 to 12 per cent in the period 1954-63 and the country held either second, third or fourth positions in world production during that period. Mexico was the consistent leader and the United States, Peru, the Soviet Union and Australia were the other prominent producers. There was little change in the relative output of other leading countries with the exception of the United States whose production declined from 18 to 14 per cent of the world total. Sizable production increases for the following small producers were indicative of considerable world resource activity: Yugoslavia, Sweden, Spain, Japan and the Republic of South Africa.

Uranium resource development was, of course, unique in its rapid build-up in the mid-1950s and subsequent rapid decline in the early 1960s. Canada increased its share of world output from 17 to 27 per cent in the period 1954-63 and since 1959 has been the second largest producer. The United States has maintained first place and other prominent producers have been the Republic of South Africa, the Congo (Leopoldville), France, Australia and Portugal. With proven reserves of one third of the Free World total, and ultimate reserves of at least one million tons of U_3O_8 and 700 thousand tons of thorium oxide, Canada is in a strong position to assume world leadership in uranium production when market trends turn upward in the 1970s.

Canada has done well in molybdenum resource development, and although only accounting for slightly more than one per cent of current world production, it has in recent years developed important resources. The United States has been by far the most important producer but its share of world output declined from 83 to 71 per cent in the period 1954-63. The Soviet Union has held second place for several years followed by Chile and China, with Canada now in fifth place. The extent of recent resource development in Canada will ensure an improving position for Canadian molybdenum notwithstanding extensive resource developments elsewhere in the world.

Canada has, of course, made outstanding progress in the development of some of its industrial mineral resources, particularly potash and sulphur. Although potash production only got under way in the early 1960s in Canada, the country has now established itself as the possessor of the world's largest reserves of this mineral. The plans to produce four million tons a year by 1970 from this high grade resource will ensure a leading role for Canada in world potash production even though new production is planned in Russia, Israel, the Congo and several other countries. Similarly, resource development of sulphur in Canada has outpaced sulphur resource development elsewhere in the world. Canada now has production capacity equivalent to ten per cent of world demand and ranks second to the United States in elemental sulphur production. Construction materials, an important sector of the Canadian mineral industry, do not enter world trade, and resource information on other countries is limited. However, construction materials resource development has proceeded rapidly in Canada and at a rate comparable with developments as known elsewhere.

Comment

Seen in retrospect, the period 1954-63 is one of increasingly widespread development of the world's mineral resources. Several significant trends can be noted in addition to the over-all exploration and production increases. The Soviet Union has been developing large resources of most minerals at a rapid rate and has continually improved its position as a world producer. The government role in all countries has been increasing, with direct government participation in a number of countries of Asia and the Far East in particular. China has been revealed as a country of great mineral potential. Recently, Australia has been advancing rapidly in its mineral resource development and marketing activities. The marked growth in Japanese mineral demand has done much to promote mineral exploration throughout the world. The largest market of the world, the United States. is becoming increasingly dependent on foreign mineral supply. In the fast changing mineral supply situation, as shaped by these and other trends, the Canadian mineral industry can look forward to continuing growth. However, the record of the past ten years indicates increasing competition over the near term at least. In the long run, the country's favourable mineral resource potential will be an important factor in meeting the huge world mineral demands of the future.

Abrasives

J.S. ROSS*

Canada is a major producer of crude artificial abrasives but its output of natural and refined abrasive grains is insignificant. It is the world's largest producer of crude silicon carbide and crude fused alumina, the two most commonly used artificial abrasives. However, Canada's requirements for most types of abrasive grains are met by imports, as is a large proportion of its consumption of secondary abrasive products.

Almost all minerals, mineral assemblages and many man-made materials may be used as abrasives. However, only those with the most suitable physical properties for each general type of use are normally in demand. Abrasives have numerous industrial applications and include materials which are employed for their cutting, grinding, polishing, gripping or wear-resistant properties. In general, they may be classified by origin (natural or artificial) and by degree of abrasiveness. The high-grade type includes diamond, corundum and the principal artificial products—silicon carbide and fused alumina. Quartz and feldspar are examples of the low-grade type. Mild abrasives include lime and diatomite. They commonly have a small particle size and are used for polishing and scouring.

The natural abrasives produced in Canada are mainly minority coproducts from plants established to supply commodities for nonabrasive purposes. The domestic output of natural abrasives is estimated to be valued at about $100,000 a year. It includes silica and beach sand, iron oxide, feldspar, granite and grindstone. Aside from these commodities, but not designated in abrasive production, are large tonnages of ores used as grinding media in autogenous and pebble grinding. These media perform the role of abrasives during grinding but eventually become pulverized and utilized as an ore, rather than as an abrasive. Imports of natural abrasives are large and in 1964 amounted to $7.2 million of the $17.5 million total for all abrasives imports. Almost all ($6.7 million) consisted of industrial diamond and diamond dust, practically all of which came from the United States. However, a substantial proportion of these diamonds is re-

*Mineral Processing Division, Mines Branch

TABLE 1

Abrasives – Production, Trade and Consumption

	1963		1964	
	Short Tons	$	Short Tons	$
Production				
Artificial abrasives				
Crude silicon carbide[1]	78,370	11,040,485	..	..
Crude fused alumina[1]	148,116	15,599,715	..	..
Abrasive wheels and segments	..	8,683,527	..	..
Other products[2]	..	9,743,720	..	..
Total		45,067,447		
Imports				
Natural and artificial abrasives				
Diamonds, industrial		5,809,537	..	6,198,213
Diamond dust		..	..	473,105
Pumice, lava and volcanic dust, crude or ground		195,349	10,876	159,720
Abrasives, natural, not elsewhere specified		309,709	4,430	369,030
Abrasives, artificial, crude and grains, not elsewhere specified		2,968,607	10,150	3,320,162
Abrasive wheels		2,263,512	..	2,465,410
Abrasive stones and blocks		468,785	..	537,145
Abrasive paper and cloth		1,500,989	..	1,922,482
Metal shot		..	..	1,211,829
Abrasive basic products, not elsewhere specified		599,375	..	817,458
Total				17,474,554
Exports				
Natural and artificial abrasives				
Abrasives, natural, not elsewhere specified	124	4,029	193	12,335
Fused alumina, crude and grains	152,461	16,318,688	155,686	17,366,131
Silicon carbide, crude and grains	72,905	9,855,821	81,059	10,625,294
Abrasive paper and cloth		351,271		394,127
Abrasive wheels and stones		145,277		315,672
Abrasive basic products not elsewhere specified	260	955,244	..	1,083,129
Total		27,630,330		29,796,688

Aggregates, Lightweight

H.S. WILSON*

The Canadian construction industry set its third consecutive record during 1964. The value of all construction increased 12.1 per cent over the previous year, reaching $8.7 billion. This increase was the greatest since 1956 when it was 21.6 per cent over the preceding year.

The lightweight aggregate industry did not share proportionately in the increase in construction. The value of all the lightweight aggregates increased 2.7 per cent to $6.4 million. The expanded clay and shale aggregate production increased 10.2 per cent in volume and 8 per cent in value over the 1963 figures. Two plants that were in production in 1963 did not operate in 1964: at Lafleche, Quebec, and Edmonton, Alberta. Production of expanded slag was 1.2 per cent higher in volume and 1.5 per cent higher in value than in the previous year.

Exfoliated vermiculite was the only lightweight aggregate that had a decrease in production: down 5.3 per cent and 2.6 per cent in volume and value, respectively. This was the second consecutive year in which production declined. The plant at Richmond, British Columbia, did not produce vermiculite during 1964.

Expanded perlite production rose 2.8 per cent in volume and 3.5 per cent in value over the 1963 figures. The plant at Lennoxville, Quebec, did not operate in 1964. The value of pumice used as lightweight aggregate increased 2.3 per cent from the 1963 value.

SOURCES OF RAW MATERIALS AND PRODUCERS

Shales and common clays are the most widespread of the raw materials used for lightweight aggregate manufacture. Most plants obtain their raw material from nearby deposits but one is supplied from a deposit 15 miles away.

*Mineral Processing Division, Mines Branch

Nine plants were in operation in 1964, two less than in 1963, as follows: Quebec – Laprairie; Ontario – Cooksville; Manitoba – St. Boniface (two); Saskatchewan – Regina (two); Alberta – Calgary and Edmonton and British Columbia – Saturna Island. Three plants, at Lafleche, Quebec; Ottawa, Ontario, and Edmonton, Alberta, were not in production during 1964.

Expanded blast furnace slag is a processed byproduct of the iron and steel industry. It was produced at Hamilton, Ontario, and at Sydney, Nova Scotia.

TABLE 1

Construction in Canada, 1963–64

Type of Construction	Percentage Change 1963–64	Percentage of Total Value 1963	Percentage of Total Value 1964p
Engineering.............	+16.1	39.2	40.7
Residential.............	+15.4	29.2	30.1
Commercial.............	+ 7.6	9.6	9.2
Institutional............	-11.7	11.1	8.7
Industrial................	+23.9	6.9	7.7
Other building...........	+ 1.3	4.0	3.6

Source: Dominion Bureau of Statistics.
p Preliminary.

TABLE 2

Production of Lightweight Aggregates, 1963–64

	1963		1964p	
	Cubic Yards	$	Cubic Yards	$
From domestic raw materials				
Expanded clay and shale............	437,824	2,369,410	482,488	2,558,474
Expanded slag	283,405	678,609	286,840	688,834
From imported raw materials				
Exfoliated vermiculite..............	324,412	2,468,323	307,126	2,404,041
Expanded perlite....................	89,594	722,682	92,057	748,157
Pumice		31,000		38,000
Total........		6,270,024		6,437,506

Source: Information supplied directly by the producers.
p Preliminary.

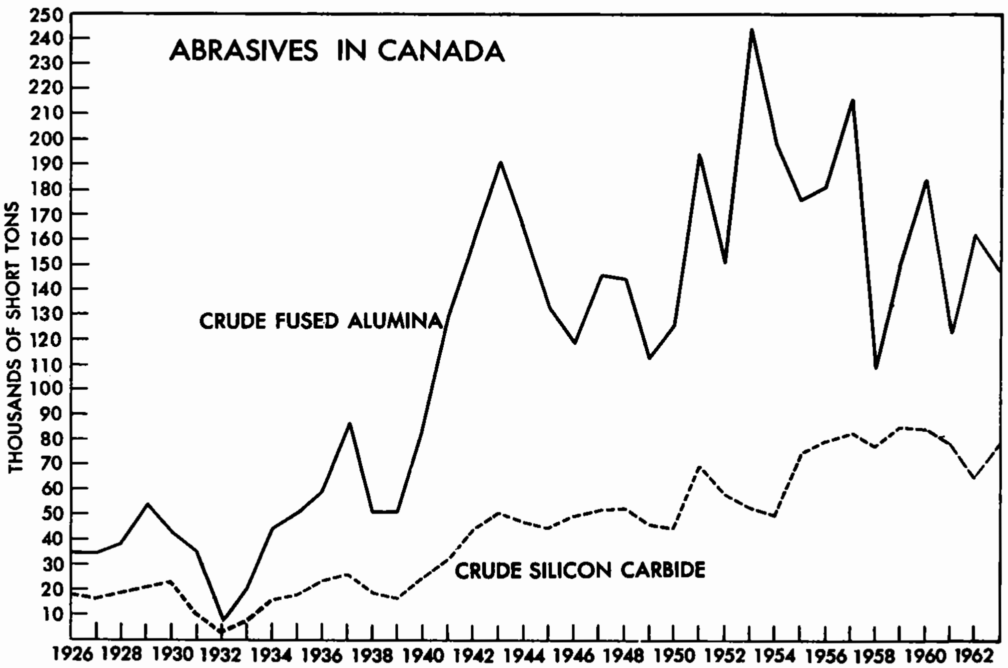
Table 1 (cont.)

	1963		1964	
	Short Tons	$	Short Tons	$
Re-exports				
Abrasives, natural		..		2,237,065
Diamonds, industrial and dust		3,591,228		..
Abrasive basic products		..		67,770
Consumption, incomplete[3]				
Abrasives, natural and artificial, in the production of artificial-abrasive products				
Natural-abrasive grains				
Garnet	238	68,000		
Emery	53	12,000		
Quartz or flint	125	8,000		
Other	7	1,000		
Total	423	89,000		
Artificial-abrasive grains for wheels, paper, etc.				
Fused alumina	2,843	928,000		
Silicon carbide	2,588	712,000		
Total	5,431	1,640,000		

Source: Dominion Bureau of Statistics.
[1]Includes material for use in refractories and for other nonabrasive purposes. [2]Includes abrasive cloth, paper and tile, sharpening stones and tiles, artificial pulpstone, boron carbide, fused magnesia and firesand. [3]Does not include the consumption of such natural abrasives as diamonds, pumice and calcareous tufa, nor the consumption of natural and artificial grains for final use as loose grains.
.. Not available.

exported, virtually all to the United States. In 1964, re-exports were valued at $2.2 million and consisted basically of diamonds. These statistics do not include small quantities of materials such as diatomite and iron oxides brought into this country for abrasive use, nor do they include quartz imported for sand blasting. Exports of natural abrasives are insignificant.

Canada produces a substantial quantity of crude artificial abrasives. In 1963 this amounted to 148,116 tons of crude fused alumina valued at $15.6 million and 78,370 tons of crude silicon carbide valued at $11.0 million, both below the peak years of the 1950s. It is estimated that Canada's 1964 output will be similar. The 1963 production represented 92 and 72 per cent, respectively, of the North American output of crude fused alumina and silicon carbide. About one quarter of the former and one tenth of the latter are used for nonabrasive purposes. Plant shipments are dependent on the export demand and virtually all the crude product is shipped to the United States. The export demand and consequently production of fused alumina fluctuates appreciably from year to year, whereas that for silicon carbide is more stable. Metallic abrasives such as shot are also produced but no production statistics are available.



Canada also produces manufactured abrasive products other than crude artificial abrasives. In 1963 they consisted of abrasive wheels and segments valued at $8.7 million and other materials valued at $9.7 million including abrasive cloth and paper, pulpstone and abrasive tile, as well as a small quantity of nonabrasive materials. In summary, the total production value of Canada's artificial abrasives industry was $45.1 million in 1963, up slightly from 1962.

Imports of artificial abrasives amounted to $10.3 million in 1964. They represented more than half the total value of abrasives imports and 91 per cent came from the United States. They mainly consisted of refined grains, wheels, stones and other shapes, cloth, paper and metal shot. Refined grains accounted for the largest value and practically all came from crude silicon carbide and fused alumina that had been produced in Canada and shipped to the United States for processing. Exports amounted to $29.8 million in 1964 and consisted mainly of all the crude silicon carbide and fused alumina produced in that year, most of which went to the United States. The remaining exports were paper, cloth, wheels, stones and other abrasives.

PRODUCERS

The small output of natural abrasives is produced mainly as minor coproducts. It includes quartzite, sandstone, beach sand, feldspar, granite and iron oxide.

Quartzite for sandblasting is produced by Dominion Industrial Mineral Corporation at St. Donat de Montcalm, Quebec; by Nova Scotia Sand and Gravel Limited near Shubenacadie, Nova Scotia; and on occasion by Selkirk Silica Co. Ltd., Selkirk, Manitoba. Small shipments of feldspar for use in soaps and cleansers are made at Buckingham, Quebec, by International Minerals & Chemical Corporation (Canada) Limited. Finely ground silica is sold for the same purpose by Canadian Silica Corporation Limited, St. Canut, Quebec. Bog iron oxide is processed for use as crocus and jeweller's rouge by The Sherwin-Williams Company of Canada, Limited, at Red Mill, Quebec. Grindstones are manufactured from sandstone at Sackville, New Brunswick, by H.C. Reid.

Although not considered products of the abrasives industry, ores used in pebble and autogenous grinding temporarily perform as natural abrasives. Like most others, they result from materials required mainly for other purposes. However, 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.

Canada's production value of crude artificial abrasives by far outweighs that of the natural variety. Practically all this country's shipments of artificial abrasives consist of crude fused alumina and crude silicon carbide. They are produced by six companies at four plants in Quebec and at four plants in Ontario.

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	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

These plants and their products are listed in Table 2 and have experienced no major changes in recent years. Their products go mainly to the United States but small quantities are exported to the United Kingdom and a few other countries. Consequently, the output from these plants is dependent on the degree of metal fabrication mainly in these other countries.

Significant amounts of abrasive wheels, segments, stones, paper and cloth are also produced in Canada. Most of these are produced in southern Ontario, although Quebec and British Columbia supply small amounts.

CONSUMPTION AND USES

Consumption statistics for natural and artificial abrasive grains are incomplete. However, diamonds represent by far the largest part of the consumption value and in 1964 the apparent value was more than $4 million. For 1963, Table 1 gives the consumption value and amount of most natural and artificial abrasives used in the production of abrasive products. This does not include the quantity consumed for final use as loose grains.

Abrasives are employed universally and in numerous applications. Although each abrasive product has many possible applications, its versatility normally is limited by cost and performance. As a result, the numerous grades of each type provide a preferred abrasive for every use.

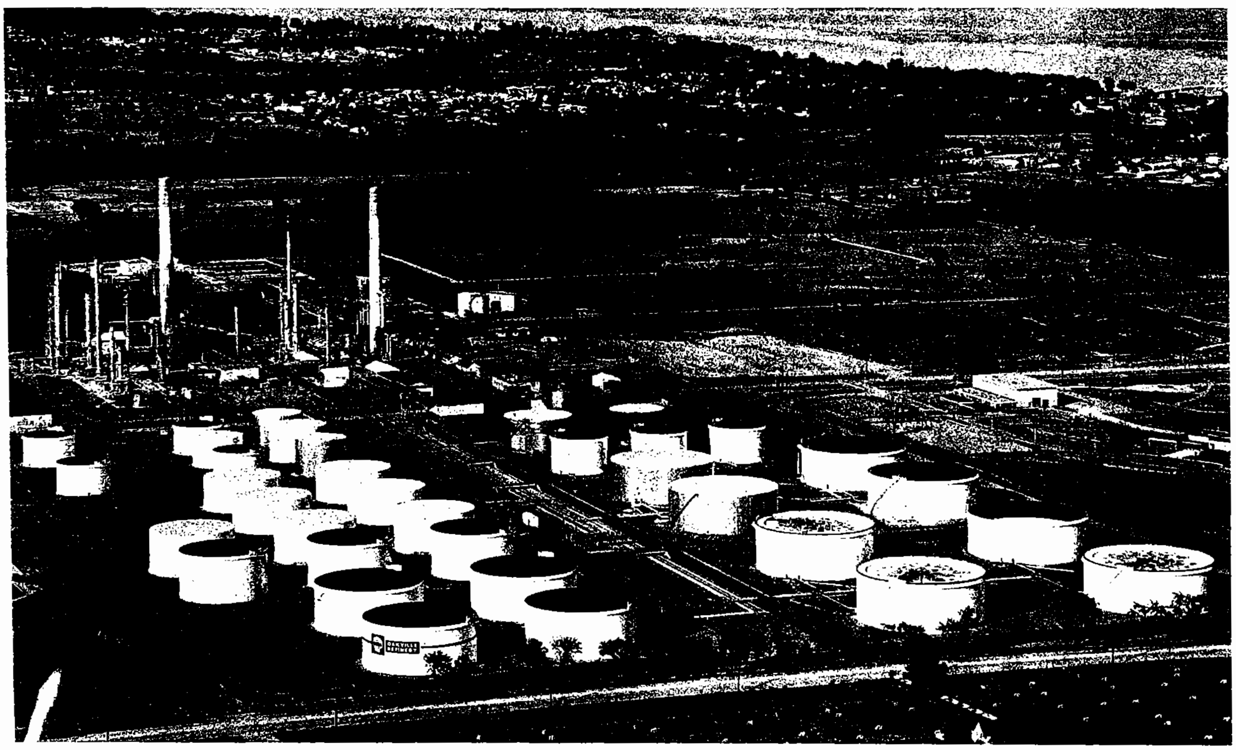
All minerals and rocks can be used as natural abrasives but only a few are in demand. The application of ores in pebble and autogenous grinding has already been mentioned. Natural and synthetic diamonds are employed in grinding, cutting and boring metallic and nonmetallic materials and in polishing glass. 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.

Fused alumina and silicon carbide are by far the most popular artificial abrasives. Because they are both high-grade types, they compete in many applications. In the form of loose grains, they have similar 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.

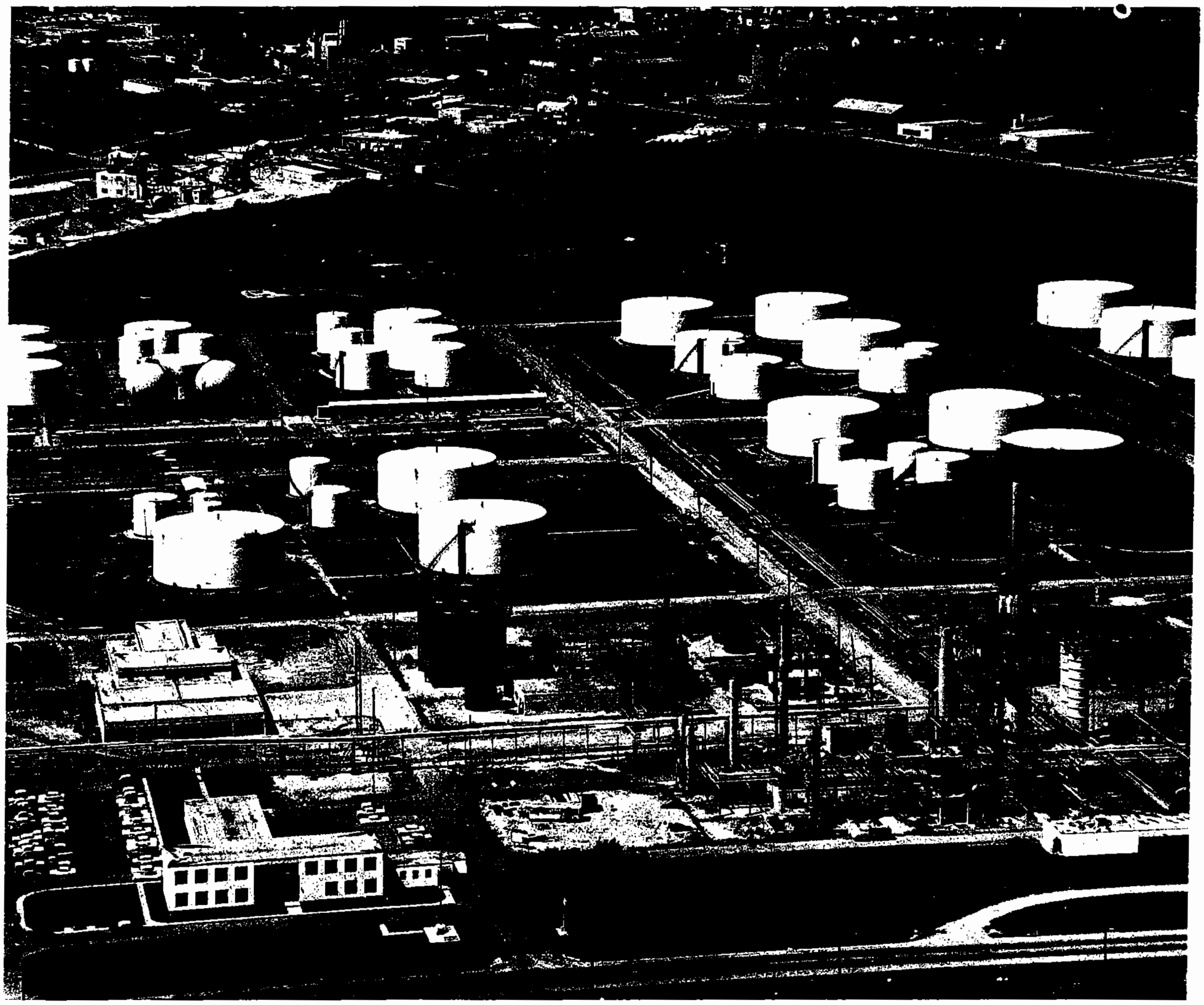
PRICES

Canada does not produce refined grains for the production of manufactured abrasive products. Consequently, in 1963 the following average prices per short ton were for imported abrasives used at abrasive products plants:

Fused alumina	$326
Silicon carbide	275
Garnet	286
Emery	226
Quartz	64



Shell Oil Co. refinery at Oakville, Ontario.



Shell Canada Limited's refinery at St. Boniface, Manitoba has a crude oil refining capacity of 19,200 barrels a day. It makes a full line of petroleum products from premium gasolines through aviation turbine fuel to heavy fuel oil and asphalt.

TABLE 3

Lightweight Aggregate Plants in Canada

Company	Location
Producing Plants	
Expanded Clay	
Atlas Light Aggregate Ltd.	St. Boniface, Man.
Cindercrete Products Limited	Regina, Sask.
Echo-Lite Aggregate Ltd.	St. Boniface, Man.
Edmonton Concrete Block Co. Ltd.	Edmonton, Alta.
Consolidated Block and Pipe Ltd.*	Regina, Sask.
Expanded Shale	
Aggrite (1962) Inc.	Laprairie, Que.
British Columbia Lightweight Aggregates Ltd.	Saturna Island, B.C.
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.
Mid-West Expanded Ores Co. Ltd.	St. Boniface, Man.
Vermiculite Insulating Limited	Lachine, Que.
Western Gypsum Products Limited	Vancouver, B.C.
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.
Perlite Products Ltd.	Winnipeg, Man.
Vantec Industries Ltd.	Richmond, B.C.
Western Gypsum Products Limited	Vancouver, B.C.
Pumice	
Miron Company Ltd.	Montreal, Que.
Ocean Cement Limited	Vancouver, B.C.

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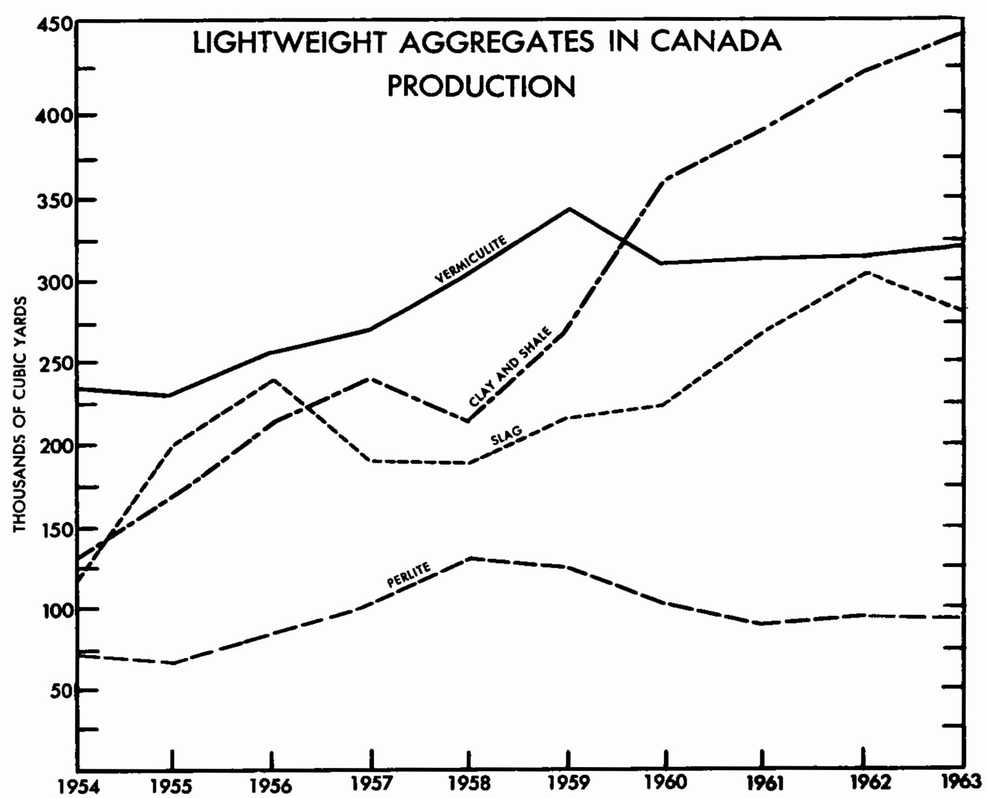
Table 3 (cont.)

Company	Location
Nonproducing Plants	
Expanded Clay	
Consolidated Concrete Limited	Edmonton, Alta.
Featherock Inc.	St. François du Lac, Que.
Expanded Shale	
Cell-Rock Inc.	Lafleche, Que.
Hayley-Lite Limited	Ottawa, Ont.
Perlite	
Miron Company Ltd.	Montreal, Que.
Sherbrooke Perlite Inc.	Lennoxville, Que.

* Formerly Light Aggregate (Sask.) Limited. ** Formerly Grant Industries Limited.



Vermiculite is a type of hydrous mica that exfoliates when heated, to form a cellular material possessing good insulating properties. All the raw vermiculite exfoliated in Canada is imported from the United States and The Transvaal, South Africa. Five companies produced exfoliated vermiculite at 10 locations; British Columbia – Vancouver (two); Alberta – Calgary; Saskatchewan – Regina; Manitoba – Winnipeg and St. Boniface; Ontario – Toronto and St. Thomas and Quebec – Lachine and Montreal.

Perlite is a volcanic rock that 'pops' when heated, to form a cellular product of low density. Deposits occur in central and southern British Columbia but they have not been developed commercially. Raw material is imported from the western United States for processing. Eight plants were in operation during the year: Quebec – Ville St. Pierre and Charlesbourg West; Ontario – Caledonia and Hagersville; Manitoba – Winnipeg; Alberta – Calgary; British Columbia – Vancouver and Richmond.

Pumice, a highly vesicular material of volcanic origin, is used in its natural state as a lightweight aggregate. All the pumice used is imported from the United States. Because the known Canadian deposits are either too small or too far from transportation facilities, none is produced in Canada.

CONSUMPTION

EXPANDED CLAY AND SHALE

Concrete blocks and precast concrete shapes accounted for 83 and 5 per cent, respectively, of the 1964 production. Consumption changed from 81 and 8 per cent in 1963. Cast-in-place structural concrete used 11 per cent in 1964 compared with 8 per cent during the previous year. Minor uses – refractory products, bridge embankments, loose insulation, etc., accounted for 1 per cent of production, 2 per cent lower than in 1963.

EXPANDED SLAG

In 1964, as in 1963, 98 per cent of the expanded slag produced was used as aggregates in concrete blocks. Precast concrete shapes and cast-in-place structural concrete each consumed 1 per cent.

EXFOLIATED VERMICULITE

Loose insulation consumed 78 per cent of production in 1964 compared with 80 per cent in 1963. Plaster accounted for 12 per cent, unchanged from the preceding year. Six per cent, up 1 per cent from 1963, was used in insulating concrete. Four per cent, 1 per cent less than 1963, was used for such purposes as underground pipe insulation, fertilizer conditioner and in agriculture.

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EXPANDED PERLITE

Plaster aggregate accounted for 81 per cent of the 1964 production, 7 per cent less than in 1963. Nine per cent was used in insulating concrete, 6 per cent more than in 1963. Ten per cent was used in horticulture, insulation, acoustics, etc., an increase of 1 per cent.

PUMICE

As in previous years all pumice was used as aggregate in concrete blocks.

PRICES

Expanded clay and shale aggregates sold at $4.50 to $6 a cubic yard. Expanded slag sold at $2.35 to $3.85 a cubic yard. Exfoliated vermiculite sold at 25 to 30 cents a cubic foot and expanded perlite at 25 to 35 cents a cubic foot. Vermiculite and perlite are marketed in bags of 3 and 4 cubic feet. All prices are f.o.b. plant.

Aluminum

W.H. JACKSON*

Canada is second, after the United States, in Free World aluminum production. As all bauxite and much of the alumina used by aluminum smelters must be imported, mainly from the Caribbean area, aluminum metal production is classed in Canadian statistical data with manufactures and not with mineral industry statistics.

Primary aluminum output in 1964 was 843,002 tons, an increase of 17.2 per cent from 1963. Smelter shipments of primary forms to the domestic market totalled 150,950 tons. Exports of primary forms declined slightly from 635,187 tons to 627,992 tons.

The United States and Britain are the two major outlets for Canadian exports of primary forms. The United States is the largest world producer with output of 2,552,970 tons in 1964 according to data compiled by the U.S. Bureau of Mines. Its exports were 208,622 tons. Imports of crude metal and alloys were 392,419 tons of which Canada supplied 257,852 tons, or 65.7 per cent. Britain has a very small production – 35,516 tons in 1964. According to the British Bureau of Non-Ferrous Metal Statistics, Canada supplied 53.4 per cent of British imports, or 195,127 tons out of a total of 365,544 tons.

Preliminary data indicate that consumption of primary was 161,937 tons compared to 153,296 tons in 1963, and was accompanied by a rise in consumer stocks. Total consumption at the first processing stage as reported by consumers was 170,969 tons, an increase of 5.6 per cent. Exports of semi-fabricated products rose to 18,054 tons from 12,787 tons. Total exports of aluminum and its products, excluding scrap, valued at $318 million, represented 3.9 per cent of total domestic exports in 1964.

*Mineral Resources Division

TABLE 1

Aluminum – Production and Trade

	1963		1964p	
	Short Tons	$	Short Tons	$
Production				
Ingot	719,390		843,002	
Imports[1]				
Bauxite ore[2]				
British Guiana			974,774	7,164,000
Surinam			712,941	6,407,000
Guinea			58,562	244,000
United States			5,744	171,000
Total			1,752,021	13,986,000
Alumina[2]				
Jamaica			486,301	29,968,000
United States			193,122	14,371,000
British Guiana			167,902	9,876,000
Guinea			23,567	1,463,000
Other countries			82	19,000
Total			870,974	55,697,000
Total, bauxite ore and alumina				
British Guiana	801,521	13,900,336	1,142,676	17,040,000
Surinam	665,160	5,987,892	712,941	6,407,000
Jamaica	537,544	33,431,331	486,301	29,968,000
United States	147,049	11,004,508	198,866	14,542,000
Guinea	39,602	2,500,986	82,129	1,707,000
Other countries	36	5,463	82	19,000
Total	2,190,912	66,830,516	2,622,995	69,683,000
Aluminum and aluminum alloy scrap	1,492	318,527	20,112	857,000
Aluminum paste and powder	164	190,771	280	239,000
Aluminum pigs, ingots, shot, slabs, billets, blooms and extruded wire bars	1,954	1,364,959	3,996	2,613,000
Aluminum castings and forgings	..	..	1,094	2,763,000
Aluminum bars and rods, not elsewhere specified	888	948,511	545	720,000
Aluminum plates	28,740	21,621,217	1,967	2,399,000
Aluminum sheets and strips	..	..	32,960	24,047,000
Aluminum foil or leaf	..	1,431,929	646	897,000
Converted aluminum foil	..	..	..	827,000
Structural shapes, aluminum	1,046	1,684,446	988	1,838,000

Table 1 – (cont.)

	1963		1964p	
	Short Tons	$	Short Tons	$
Aluminum pipe and tubing..........	410	709,858	349	606,000
Aluminum wire and cable excluding insulated......................	491	473,724	356	303,000
Aluminum and aluminum alloy fabricated materials, not elsewhere specified[3]............	..	..		3,178,000
Exports				
Pigs, ingots, shot, slabs, billets, blooms and extruded wire bars				
United States	274,496	117,676,471	254,673	115,584,395
Britain........................	168,459	81,804,007	189,021	96,637,849
West Germany...................	30,390	14,093,761	42,332	20,433,701
Japan..........................	17,532	8,252,820	24,086	11,531,008
Republic of South Africa.........	13,947	6,304,300	18,184	8,389,181
Brazil.........................	18,682	8,178,223	9,580	4,394,229
Ireland........................	4,197	2,012,339	8,489	4,217,676
Hong Kong.....................	6,848	3,159,927	8,247	4,002,178
Spain.........................	11,652	5,255,624	7,911	3,409,385
Sweden........................	15,658	7,243,569	7,617	3,475,623
New Zealand...................	3,769	1,769,237	7,575	3,743,603
Argentina.....................	3,882	1,773,359	5,699	2,853,144
Italy..........................	13,478	5,856,025	4,353	1,919,729
Belgium and Luxembourg	3,096	1,611,101	3,758	1,918,775
Other countries.................	49,101	22,190,268	36,467	17,735,329
Total	635,187	287,181,031	627,992	300,245,805
Bars, rods, plates, sheet, circles, castings and forgings				
India..........................	2,608	1,241,029	6,825	3,645,878
United States	2,243	1,575,773	3,527	2,400,221
Spain.........................	1,741	860,953	1,787	848,835
Britain........................	295	186,825	1,658	922,339
New Zealand...................	824	477,101	1,141	620,642
Hong Kong.....................	...	371	515	283,060
Portugal......................	335	155,128	483	230,252
Republic of South Africa.........	550	224,278	395	307,120
France........................	512	372,348	326	299,088
Italy..........................	519	262,080	310	172,033
Other countries.................	3,160	1,796,879	1,087	1,023,176
Total	12,787	7,152,765	18,054	10,752,644
Foil				
Britain........................	307	319,154	270	285,703
United States..................	29	22,862	52	34,956
New Zealand..................	82	103,851	31	33,873

Table 1 (cont.)

	1963		1964p	
	Short Tons	$	Short Tons	$
Peru..........................	–	–	10	14,478
Mexico........................	–	–	4	5,832
Venezuela.....................	3	3,961	4	4,359
Other countries	44	13,756	8	12,868
Total.......................	465	463,584	379	392,069
Fabricated materials, not elsewhere specified				
Italy..........................	123	57,335	1,663	754,881
Nigeria	28	18,933	1,577	757,219
New Zealand	2,753	1,190,040	986	398,509
Colombia......................	286	134,909	954	453,848
United States..................	728	667,750	820	878,793
Venezuela.....................	919	426,032	675	438,071
Pakistan......................	771	563,063	608	348,385
Mexico........................	3,853	1,617,991	472	234,837
Thailand......................	233	156,914	456	381,186
Other countries	4,609	3,099,796	2,194	1,900,581
Total.......................	14,303	7,932,763	10,405	6,546,310
In ores and concentrates (alumina)				
United States..................	2,595	352,863	4,726	497,515
Colombia......................	–	–	276	11,788
Britain........................	22	1,136	28	9,041
Other countries	27	3,572	11	1,594
Total.......................	2,644	357,571	5,041	519,938
Scrap				
United States..................	14,313	2,216,331	16,735	2,550,104
Italy..........................	19,462	6,881,394	7,715	2,765,677
Japan.........................	6,368	2,297,275	5,270	1,997,284
West Germany..................	577	104,479	1,735	302,077
Britain........................	13	4,018	794	277,754
Other countries	2,813	1,140,249	558	265,971
Total.......................	43,546	12,643,746	32,807	8,158,867

Source: Dominion Bureau of Statistics.

[1] Due to changes in import classification, effective 1964, imports for 1964 as reported are not completely comparable with previous years. [2]Comparable classes not available prior to 1964. [3]The 1963 total of aluminum manufactures, which amounted to $15.3 million, included categories of products not included in 1964 in "aluminum and aluminum alloy fabricated materials ne.s."

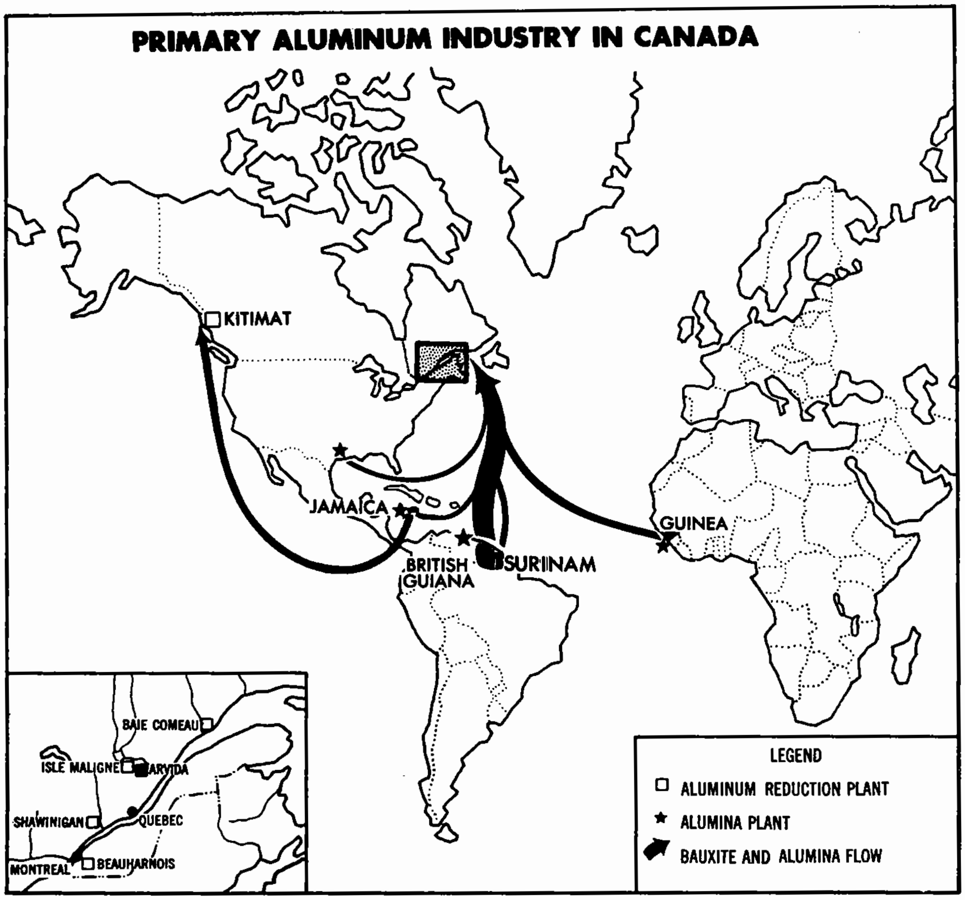
Symbols: p Preliminary; .. Not available; ... Less than 1 short ton; – Nil.

TABLE 2

Primary Aluminum – Production, Trade and Consumption
1955–64
(short tons)

	Production	Imports	Exports	Consumption*
1955	612,543	99	510,631	91,522
1956	620,321	1,405	508,994	91,869
1957	556,715	2,122	478,670	77,984
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
1964p	843,002	3,996	627,992	170,969

*Producers' domestic shipments to 1959, consumer reports from 1960 includes secondary.
p Preliminary.



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DOMESTIC INDUSTRY AND DEVELOPMENTS

Smelting capacity at the end of 1964 increased 25,000 tons to 913,000 tons from a year earlier. Details, by company and plant, are listed in Table 4.

Aluminum Company of Canada, Limited (ALCAN) produced 740,400 tons of aluminum in 1964 at five smelters compared with 625,600 tons in 1963. In February, a 20,000-ton addition to the Kitimat smelter was in production. Another 20,000 tons will be completed in 1965. The installation of another 150,000-horsepower generator at Kitimat by 1966 will raise generating capacity to 1,200,000 horsepower, sufficient to support a smelter of 310,000 short tons annually. In June, a modernized line was in operation at Arvida. ALCAN capacity

TABLE 3

Canadian Consumption of Aluminum at First Processing Stage

(short tons)

	1961	1962	1963	1964p
Castings				
Sand	1,183	1,472	1,212	1,399
Permanent-mould	2,348	2,583	3,040	3,055
Die	3,520	4,571	6,806	9,302
Other	593	747	801	121
Total	7,644	9,373	11,859	13,877
Wrought products				
Extrusions, including tubing	30,524	41,229	40,900	41,664
Sheet, plate, coil and other (including rod, forgings and slugs)	94,944	97,792	105,160	109,248
Total	125,468	139,021	146,060	150,912
Destructive Uses				
Non aluminum-base alloys, powder and paste	967	1,604	1,559	2,662
Deoxidizers	1,496	1,895	2,355	2,827
Other Uses	..	..	..	691
Total	2,463	3,499	3,914	6,180
Total consumed	135,575	151,893	161,833	170,969
Secondary aluminum produced	9,644	11,422	14,995	21,326
Receipts and inventories at plants	Metal Entering Plant		On Hand Dec. 31	
	1963	1964p	1963	1964p
Primary aluminum ingot and alloys	151,912	172,714	53,587	64,364
Secondary aluminum	6,913	6,597	795	641
Scrap originating outside plant	20,662	24,575	2,150	2,240

Source: Dominion Bureau of Statistics as reported by consumers, adjusted.
Symbols: p Preliminary; .. Not available.

TABLE 4

Annual Capacities of Canadian Aluminum Plants
December 31, 1964

Company and Plant Locations	Annual Capacity
	Short Tons
Aluminum Company of Canada, Limited (ALCAN)	
Arvida, Quebec	373,000
Beauharnois, Quebec	38,000
Shawinigan, Quebec	70,000
Alma, Quebec	115,000
Kitimat, B.C.	212,000
Canadian British Aluminium Company Limited (CBA)	
Baie Comeau, Quebec	105,000
Total	913,000

at year-end was 808,000 tons and the operating rate 94 per cent of capacity. Metal inventory at cost was $55,249,803 compared with $39,688,617 at the end of 1963. In January 1965 the rate of production was lowered to 89 per cent by the shutdown of two pot-lines at Arvida, representing 35,000 tons of older and marginal equipment. In March, a 19,000-ton line at Beauharnois was shut down. These lines will be renovated.

Aluminium Limited group companies of which ALCAN is subsidiary produced 244,000 tons outside of Canada; internal use of primary by the group and its non-consolidated subsidiaries, totalled 444,280 tons. Ingot sales to other customers were 418,300 tons compared with 435,500 tons in 1963. Total stocks held in inventory were about 396,000 tons at the end of 1964 compared with 315,000 in 1963.

Canadian British Aluminium Company Limited (CBA) produced an estimated 102,000 tons in 1964. With minor modifications the existing facilities, which were originally rated at 90,000 tons annually, would be capable of producing at a rate of 115,000 tons. Nesco Aluminum Ltd., a Reynolds group company, completed a $2-million rod mill at La Malbaie, Quebec, with an annual capacity of 25,000 tons.

The Canadian smelting industry is dependent on world export markets for its existence, more so than the aluminum industry in any other country. Competition and the need to have a greater proportion of output firmly committed has resulted in long-term contracts or in expansion in subsidiary plants processing primary ingot into the semi-fabricated forms required by secondary industry. The need of continuing markets for a large proportion of output is of particular concern to the growth of the Canadian industry. As shown in the statistical tables, the Canadian secondary manufacturing industry is not a significant factor in export markets. CBA ingot production is sold to The British Aluminium Company, Limited, to affiliates of the Reynolds Metals Company in Canada and

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to independents. ALCAN ingot competes in all world markets except where tariffs or embargos inhibit trade. The main expansion of ALCAN group companies during the year was the incorporation of Alcan Aluminum Corporation which acquired control of Alroll, Inc. whose plant at Oswego, New York, has a capacity for producing reroll sheet aluminum stock of 110,000 tons a year. The aluminum sheet fabricating plants of Cerro Aluminum Company and Bridgeport Brass Company, representing in total a capacity of about 90,000 tons, were purchased. In Germany, a large 200,000-ton rolling mill will be constructed in 1965 in partnership with Vereinigte Aluminum Werke A.G.

Table 5 is a listing of the main companies in Canada that process aluminum and indicates the general types of products they manufacture. Domestic shipments of ingot amounted to 150,950 tons. Table 3 gives a comparison for the

TABLE 5

Main Consumers of Aluminum

Consumers	Products						
	General alloying, deoxidizers	Extrusions	Castings	Sheet	Cable	Foil	Rod
The Algoma Steel Corporation, Limited	x						
Almag Aluminum and Magnesium Limited		x					
Alumaloy Castings Limited			x				
Aluminum Company of Canada, Limited		x		x	x	x	x
Aluminum Goods Limited				x			
Rio Algom Mines Limited Atlas Steels Division	x						
Barber Die Casting Co. Limited			x				
Bay Bronze (1962) Ltd.	x		x				
Canada Foils, Limited				x		x	
Canada Wire and Cable Company, Limited					x		
The Canada Metal Company, Limited	x		x				
Canadian General Electric Company Limited	x		x				
Canadian Name Plate Co. Limited		x					
Canadian Steel Improvement Limited			x				
Chrysler Canada Ltd.			x				
Custom-Aire Aluminum Limited		x					
Daymond Company Limited		x					
Dominion Die Casting Limited			x				
Dominion Foundries and Steel, Limited	x						
Dominion Magnesium Limited	x	x					
Dunbar Aluminum Foundry, Limited			x				
Electrolux (Canada) Limited			x				

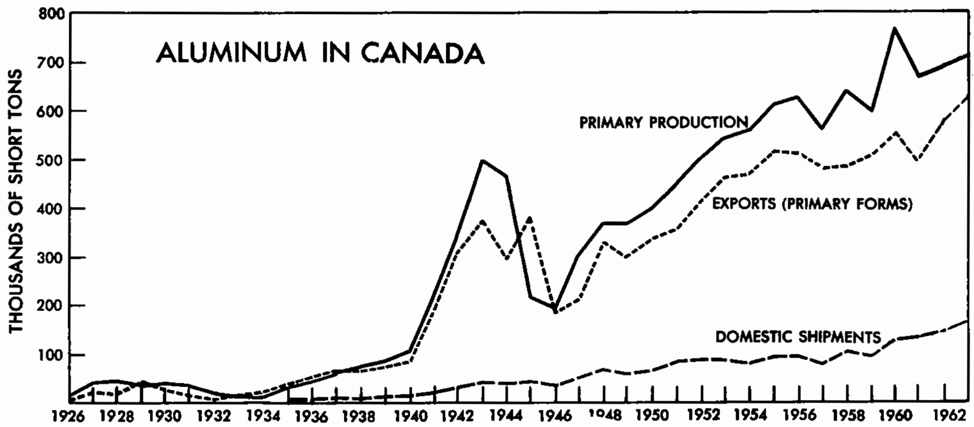
Table 5 (cont.)

Consumers	Products						
	General alloying, deoxidizers	Extrusions	Castings	Sheet	Cable	Foil	Rod
Eureka Foundry and Manufacturing Co., Ltd.			x				
H.K. Porter Company (Canada) Ltd. Federal Wire & Cable Division					x		
Federated Metals Canada Limited	x		x				
General Impact Extrusions (Manufacturing) Ltd.		x					
General Wire & Cable Company Ltd.					x		
The Hoover Co., Limited			x				
Industrial Wire & Cable Co., Limited					x		
Kaiser Aluminum & Chemical Canada Limited		x					
Kawneer Company Canada Limited		x					
Lakeshore Die Casting Limited			x				
McKinnon Industries, Limited			x				
Metals & Alloys Company Limited	x						
Monarch Fabricating Co. Limited			x				
Nesco Aluminum Ltd.							x
Noranda Copper and Brass Limited				x			
Northern Electric Company, Limited					x		
Outboard Marine Corporation of Canada, Ltd.			x				
Pirelli Cables Limited					x		
Phillips Cables Limited					x		
Precision Castings Limited			x				
Price-Acme of Canada Limited		x					
Reynolds Aluminum Company of Canada Ltd.				x		x	
Reynolds Extrusion Co. Ltd.		x					
The Steel Company of Canada, Limited	x						
Sterling Factories of Canada Ltd.		x					
Supreme Aluminum Industries Limited				x			
Thompson Products, Limited			x				
Western Wire Products (1963) Ltd.					x		

years 1961 to 1964 of metal used at the first processing stage in Canada which includes primary, secondary, and scrap from all sources. Except for some reroll stock, imports of semi-fabricated products are not included in the data. There were slight increases in most categories totalling 5.6 per cent, reflecting increased demand for automotive castings, rod and sheet. To reflect busbar use, the total should be increased by an estimated 4,200 tons. With reference to Canadian imports in Table 1, it should be noted that for 1964 about three fifths of the material classed as scrap was waste or drosses.

Throughout the world there were plant expansions but the industry as a whole is phasing new smelter construction to meet anticipated demand for primary metal for an increase of about 8 per cent annually.

Although there has been a rapid growth in demand, profits have been low for the last six years. Free World production was 4.68 million tons in 1963 and about 5.22 million in 1964. Many companies need to expand bauxite and/or alumina facilities to meet projected smelter requirements. A brief outline of the main developments follows.



In Europe, the United States and Japan, smelters operated at virtual capacity. Aluminum producers in the EEC are protected by tariffs that are to become uniform at 9 per cent ad valorem in 1968. As alumina producers or aluminum smelters in member countries will have an advantage, the tariff has stimulated mining and smelting in associate countries such as Greece where a 62,500-metric-ton smelter will start in 1966 and Surinam where alumina capacity at Paranam will be 200,000 metric tons in mid-1965, rising to 600,000 tons in 1966. About 100,000 tons will be required for the Brokopondo smelter of Suriname Aluminum Company which controls the integrated complex and the remainder will be exported.

Power from the Volta dam in Ghana will be available towards the end of 1965 and the 100,000-ton smelter of Volta Aluminum Company at Tema will be in operation in 1967. Currently, the Edea smelter in Cameroon is the only smelter in Africa although Guinea is an important producer of bauxite and alumina.

Australia continues to increase its exports of bauxite and alumina. The 600,000-long-ton alumina plant at Gladstone will be completed in 1967 and capacity of the Kwinana plant in Western Australia will be enlarged from 210,000 to 410,000 tons. The Australian smelters at Geelong and Bell Bay produced 77,000 tons in 1964, some 17,000 tons in excess of current domestic needs.

North American Coal Company closed its $1¼-million experimental alumina plant at Powhatan, Ohio. Its process of utilizing waste clays associated with coal mining operations to produce alumina was found to be technically but not economically feasible. The Anaconda Company in 1964 was studying the economic feasibility of producing alumina from clays in the State of Georgia.

Economic deposits of bauxite are usually found in parts of the world where laterization has taken place. This is a weathering process in which silica has been dissolved from rocks or clays leaving a residue high in alumina (Al_2O_3). To be of economic interest as an ore of aluminum, the bauxite must have a 35- to 50-per-cent alumina content and have not more than 4 per cent silica in the ore if it is to be used directly without beneficiation. Most mines are open pit. In converting bauxite to alumina, the first refining step uses caustic soda which is a main cost item. Caustic is available from chemical complexes in industrial areas. The larger, higher grade bauxite deposits are in non-industrialized and usually remote areas. The relative cost of transporting bauxite or caustic is a major factor in the choice of location of alumina plants. Smelters must be located near low cost sources of power. The delivered cost of alumina and petroleum coke is also an important consideration as is the cost of moving metal to markets.

Representative values of materials at the various processing stages are indicated by the following data. Metal grade bauxite has a value of about $5.00 a ton f.o.b. When transported and unloaded at Atlantic ports such material would have an approximate value of $13.00 a ton. Alumina sells for $59 to $74 f.o.b. and varies with the price of metal which at the end of November was worth $520 a ton. It takes about 4½ tons of bauxite or 2 tons of alumina to make one ton of metal. Other material cost items per ton of metal are 16,000 kilowatt hours of electricity at prices from 1.5 to 3 mills and 0.6 ton of petroleum coke which sells f.o.b. oil refinery for about $9.50 a ton.

The locations of Canadian smelters in relation to sources of bauxite and alumina are shown on the accompanying map. The alumina plant at Arvida produced an estimated 850,000 tons in 1964. It is supplied with ore from the N.V. Billiton Company in Surinam and from the Demerara Bauxite Company, Limited, an ALCAN subsidiary in British Guiana. The latter exported 596,850 tons of dried bauxite, 518,540 tons of calcined bauxite and 326,500 tons of alumina in 1964. Jamaican ores are of a different type. They are very fine grained, high in iron, and are treated as mined, without beneficiation, at alumina plants of Alcan Jamaica Limited at Kirkvine and Ewarton. Alumina production was 832,000 tons in 1964; capacity was 870,000 tons. A plant addition at Ewarton will increase capacity by 40,000 tons. Canadian alumina imports represent 51 per cent of alumina production in British Guiana and 58 per cent of Jamaican production.

USES

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

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 Canadian price was 24.7 cents a lb at the start of the year, advancing to 25.5 cents in March and to 26.0 cents early in mid-November. There were no further changes at year-end. Canadian prices are listed below for comparison with changes in the United States and the 'export' price. Quotations are based on 50-lb ingots of minimum 99.5 per cent purity, delivered in Canada or f.o.b. buyers plant in the United States, or delivered to main ports in Europe. The latter is called the export price for metal of North American origin. The June price increase in the United States was accompanied by announcements that a one-cent allowance for non-return of scrap would be rescinded. The Canadian market is responsive to American prices, as are world prices.

Effective Date of Price Change	Canada*	United States**	Export**
October 2, 1963	24.7	23.0	23.0
March 6, 1964	25.5	23.5	24.0
June 15, 1964	–	24.0	–
November 18,1964	26.0	24.5	–
November 27, 1964	–	–	24.5

* Canadian funds ** U.S. funds – Nil.

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
Bars, rods, plates, sheets, strips, circles, squares, disks and rectangles	free	3¢ a lb	7½¢ a lb
Angles, channels, beams, tees, and other rolled, drawn or extruded sections and shapes	free	22½%	30%
Wire and cable, twisted or stranded or not, and whether reinforced with steel or not...	free	22½%	30%
Pipes and tubes	free	22½%	30%

	British Preferential	Most Favoured Nation	General
CANADA (cont'd)			
Leaf not otherwise provided for or foil, less than 0.005 inch in thickness, plain or embossed, with or without backing........	free	30%	30%
Aluminum powder.........................	free	27½%	30%
Aluminum leaf less than 0.005 millimetre in thickness	free	free	free
Aluminum scrap..........................	free	free	free
Manufactures of aluminum not otherwise provided for	15%	22½%	30%
Kitchen or household hollow ware of aluminum, not otherwise provided for......	20%	22½%	30%

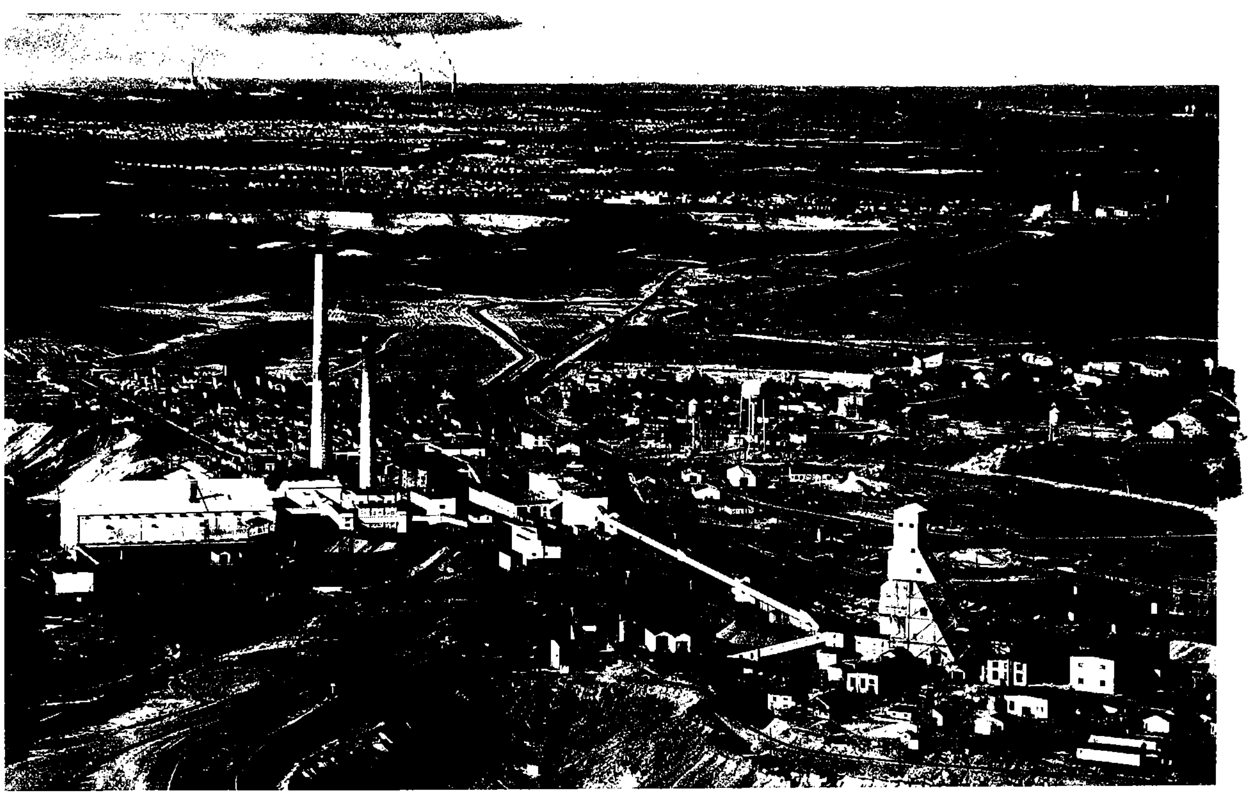
UNITED STATES

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)
Wrought rods of aluminum	2.5¢ a lb
Angles, shapes, and sections, all the foregoing which are wrought, of aluminum	19% ad val
Aluminum wire	
Not coated or plated with metal	12.5% ad val
Coated or plated with metal	0.1¢ a lb +12.5% ad val
Bars, plates, sheets, and strip, all the foregoing are wrought, of aluminum, whether or not cut, pressed, or stamped to nonrectangular shapes	
Not clad	2.5¢ a lb
Clad	
Wholly of aluminum...........................	2.5¢ a lb
Other......................................	24% ad val
Aluminum powders and flakes	
Flakes	5.1¢ a lb
Powders	19% ad val

UNITED STATES (cont'd)

Pipe and tubes and blanks therefor, pipe and tube fittings, all the foregoing of aluminum	
Hollow cast extrusion ingots	1.25¢ a lb
Other	19% ad val
Aluminum foils Not backed or cut to shape	
Etched capacity foil	17% ad val

The Sudbury Basin, Ontario, looking southwest. The Falconbridge headframe is shown in the lower right-hand side of picture and the mill and smelter in the middle left. INCO's Copper Cliff reduction works can be seen at upper left.



Antimony

D.B. FRASER*

Canada's production of primary antimony is derived as a byproduct of lead ores mined in western Canada and is recovered in the form of antimonial lead, not as antimony metal or regulus. Output in 1964, expressed as the antimony content of antimonial lead alloys, was 1.7 million pounds compared with 1.6 million pounds in 1963.

Canadian requirements of antimony metal and antimony oxide are imported. Statistics on metal imports were discontinued in 1964 but based on earlier figures, the main suppliers are Communist China and Yugoslavia, which mine and refine antimony ores and western European countries which import antimony ores and export refined metal. Oxide imports in 1964 came mainly from the United Kingdom, the United States and Communist China.

The Consolidated Mining and Smelting Company of Canada Limited (COMINCO), which operates Canada's only 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 requirements of the user. Generally, most antimonial lead sold contains about 25 per cent antimony.

Most of the antimonial lead produced at Trail is from the lead concentrate obtained from ore of the company's Sullivan mine at Kimberley, British Columbia. Other sources of antimonial lead are the lead-silver ores and concentrates shipped to Trail from the company's two other mines in British Columbia and by other mining companies with mines in British Columbia and elsewhere. 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 a marketable product.

*Mineral Resources Division

Canadian occurrences of the principal antimony mineral, stibnite (Sb_2S_3), have been reported in widely separated locations. On occasion, over many years, several of the occurrences have been explored and partially developed but results were generally discouraging. The better known occurrences are: the Mortons Harbour mine, New World Island, Notre Dame Bay, Newfoundland; the West

TABLE 1

Antimony – Production, Trade and Consumption

	1963		1964p	
	Pounds	$	Pounds	$
Production				
Antimony content of antimonial lead alloys	1,601,253	624,489	1,718,634	866,200
Imports*				
Regulus				
China (Communist)	866,090	136,273	..	..
Yugoslavia	66,247	18,819	..	..
Netherlands	57,795	14,683	..	..
France	45,635	13,554	..	..
United States	468	296	..	..
Total	1,036,235	183,625		
Antimony oxide				
United Kingdom	511,840	151,572	401,500	183,000
United States	82,200	21,202	122,200	65,000
China (Communist)	44,092	7,495	110,200	35,000
West Germany	–	–	45,000	30,000
Belgium-Luxembourg	11,200	3,223	28,600	18,000
Total	649,332	183,492	707,500	331,000
Consumption				
Antimony regulus in production of				
Antimonial lead alloys	648,126		277,190	
Babbitt	91,187		72,020	
Solder	14,691		16,374	
Type metal	180,273		141,484	
Other commodities**	41,350		51,023	
Total	975,627		558,091	

Source: Dominion Bureau of Statistics.
*Classification changes commenced in 1964 resulted in antimony regulus being no longer a single identifiable class. **Includes foil, bronze, lead-base alloys, drop shot and other minor commodities.
Symbols: .. Not available; p Preliminary; – Nil.

TABLE 2

Antimony – Production, Imports and Consumption, 1955-64
(pounds)

	Production* (all forms)	Imports (regulus)	Consumption** (regulus)
1955.........	2,021,726	1,359,163	1,692,000
1956.........	2,140,432	1,803,630	1,478,000
1957.........	1,360,731	1,794,846	1,401,000
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
1964p........	1,718,634	..	558,000

Source: Dominion Bureau of Statistics.
*1955 to 1957 inclusive, antimony content of antimonial lead alloys, flue dust and dore slag; from 1958 antimony content of antimonial lead alloy. **Consumption of antimony regulus as reported by consumers. Does not include antimony in antimonial lead produced by COMINCO.
Symbols: p Preliminary; .. Not available.

Gore deposits, Hants County, Nova Scotia; the Lake George property, Prince William parish, York County, New Brunswick; the South Ham deposit, Wolfe County, Quebec; and the Stuart Lake mine, near Fort St. James, British Columbia. Other occurrences are on record as follows: British Columbia – near the confluence of the Tulsequah and Taku rivers in the northwestern part of the province, near Bralorne in the Bridge River district and near Slocan City and Sandon in the Slocan district; Yukon Territory – south of Whitehorse in the Wheaton River area and near Highet Creek in the Mayo district.

Yukon Antimony Corporation Ltd. began a re-examination in 1964 of the Wheaton River deposits in the Yukon Territory at Carbon Hill and Chieftain Hill, about 40 miles south of Whitehorse. Road work, stripping, trenching and metallurgical testing were carried out. Preliminary sampling of a shear zone at the Becker-Cochran deposit, on the east side of Carbon Hill, gave average results of 5.1 per cent antimony and 0.7 per cent arsenic.

World production of antimony in 1963, as compiled by the United States Bureau of Mines, totalled 61,100 tons. The world's largest known deposits are in Hunan Province in south-central China where stibnite occurs in small, discontinuous quartz veins. The second largest source is the gold-antimony ore of the Republic of South Africa, which is mined by Consolidated Murchison (Transvaal) Goldfields & Development Co. Ltd. Bolivia, Mexico and Yugoslavia are

TABLE 3

World Mine Production of Antimony
(short tons)

	1962	1963
China (Communist)............	18,500e	16,500e
Republic of South Africa (exports)..................	11,697	12,410
Bolivia (exports)............	7,323	8,337
U.S.S.R.	6,600e	6,700e
Mexico......................	5,254	5,320
Yugoslavia	2,966	2,933
Turkey......................	1,962	1,981
Czechoslovakia	1,800	1,800
Canada	966	801
Other countries	2,932	4,318
Total..................	60,000	61,100

Source: United States Bureau of Mines MINERALS YEARBOOK, 1963, and for Canada, Dominion Bureau of Statistics.
e Estimate.

also important sources of antimony ore. Antimony is also obtained in alloy form by remelting scrap lead, a major source, and from the smelting of lead ores.

Exports from China to the European market were sharply reduced in 1963, causing shortages and price increases in both Europe and the United States. The reduction of supplies from China continued throughout 1964. In October, the United States government authorized the disposal of 5,000 tons of antimony from the 53,000 tons in government inventories. Of this total, 27,500 tons were determined as surplus to strategic requirements. Of the authorized disposal, 2,500 tons were released by the end of 1964.

Preparations to increase the mining of antimony ore were reported in the Republic of South Africa and in Bolivia, both leading exporters to European and U.S. smelters.

USES

The principal use of antimony is as an ingredient in lead alloys, in which antimony hardens and strengthens lead. Antimonial lead alloys have many uses but the largest is in the manufacture of lead storage batteries, in which battery plates, terminal posts and other parts are made of antimonial lead containing up to 12 per cent antimony. Battery lead alloys commonly contain 3 to 5 per cent antimony. Antimonial lead alloys are used also for sheathing electric cables and in pipe and sheet. Other lead-base alloys containing antimony and tin are employed as type metal, antifriction bearing metal and solder.

Substantial amounts of antimony are used in the form of antimony oxide, which is usually produced directly from high-grade ore (60 per cent or more antimony content). Antimony oxide is used mainly as a flameproofing additive to paints, plastics and fabrics. It is also valuable in enamel coverings to which it adds hardness and acid resistance. The pentasulphide of antimony is used as a vulcanizing agent by the rubber industry and as a red pigment. Other pigments have applications in the manufacture of glass and ceramics.

High-purity antimony is used in increasing amounts by manufacturers of intermetallic compounds 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.

The recovery of secondary antimony in the United States was 19,400 tons in 1962 and 20,800 tons in 1963. These tonnages, added to the amounts of primary antimony shown in Table 4 give a total use in the United States of about 35,000 tons annually.

TABLE 4

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

Product	1962	1963
Metal products		
Ammunition	*	*
Antimonial lead**	6,090	6,462
Bearing metal and bearings	682	992
Cable covering	114	101
Castings	64	49
Collapsible tubes and foil	112	72
Sheet and pipe	127	81
Solder	172	188
Type metal**	429	652
Other	271	199
Total**	8,061	8,796
Nonmetal products		
Ammunition primers	14	15
Fireworks	23	36

Table 4 (cont.)

Product	1962	1963
Flameproofing chemicals and compounds	1,215	1,601
Ceramics and glass	1,146	1,465
Matches	9	5
Pigments	1,161	1,009
Plastics	1,269	1,352
Rubber products	460	597
Other	2,094	1,656
Total	7,391	7,736
Grand total	15,452	16,532

Source: U.S. Bureau of Mines MINERALS YEARBOOK, 1963. *Included with "other" to avoid disclosing individual company confidential data. **Includes antimony content of imported antimonial lead consumed.

PRICES AND TARIFFS

United States prices quoted by E & MJ METAL AND MINERAL MARKETS, bulk, 99.5 per cent, f.o.b. Laredo, Texas, were as follows in 1964:

January 1	32.5¢ per lb
January 29	35.5
April 23	39.0
June 23	44.0

The United States price of imported metal quoted by E & MJ METAL AND MINERAL MARKETS, in 5-ton lots, 99.5 per cent, f.o.b. New York, 2 cents-a-pound duty paid, was 34-34½ cents a pound at the beginning of 1964. The quotation rose to 57-59 cents a pound in April and declined during the last quarter of the year to 53-54 cents a pound.

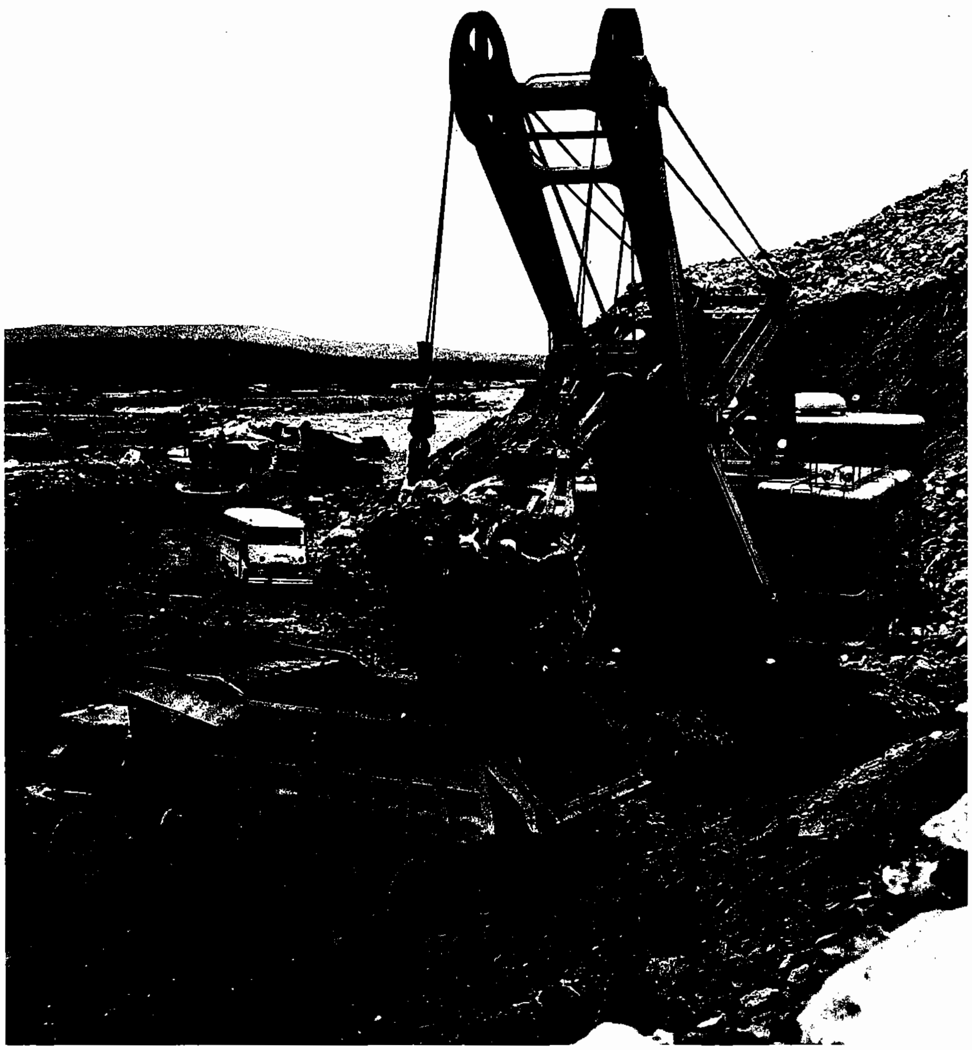
Canadian and United States tariffs in 1964 were as follows:

	British Preferential	Most Favoured Nation	General
CANADA			
Antimony, or regulus of, not ground, pulverized or otherwise manufactured	free	free	free
Antimony oxide	free	12½%	15%
Antimony salts	free	free	free

UNITED STATES

	(per lb)
Antimony ore	free
Antimony metal, unwrought	2¢
Antimony alloys	
Containing by weight 83% or more of antimony	2¢
Other	18%
Antimony metal, wrought	18%
Antimony, needle or liquated	0.25¢
Antimony oxide	0.6¢
Antimony sulphide	0.5¢ plus 12.5% ad val
Other antimony compounds	0.8¢ plus 20% ad val

Quebec Cartier Mining Co., Gagnon. Shovels load broken iron ore into trucks for haulage to the concentrator.



Arsenic Trioxide

J. S. ROSS*

Although there was no appreciable change in the arsenic trioxide industry in 1964, there have been noteworthy developments since 1960, when the last mineral review of this series was written on this subject. The former producer, Deloro Smelting & Refining Company, Limited, closed its Deloro, Ontario, smelter and refinery in January 1961. The refinery had been in existence since the 1880s and had been operated since 1907 primarily to smelt and refine cobalt-silver concentrates from the Cobalt area of Ontario. However, the plant was closed because the quantities of cobalt received in these concentrates fell below the level required for economic plant operation.

Production of arsenic trioxide was resumed in Ontario in the first part of 1962, shortly after the opening of a silver smelter and refinery near Cobalt by Cobalt Refinery Limited. This plant has a rated capacity of 400 tons a year of refined byproduct arsenic trioxide and recovers silver, and copper, cobalt and nickel oxides as well.

Refined arsenic trioxide is also known as white arsenic or arsenious oxide. It is a white, highly toxic powder refined from grey crude arsenic trioxide, which must be recovered during the smelting of ores containing arsenic in order to prevent severe air pollution. Consequently, it is basically a smelter byproduct. Much of the crude product is disposed of in that state or after conversion to harmless calcium arsenate. The remainder is refined and used as the basic source of arsenic.

Prior to 1961, shipments of refined arsenic trioxide depended mainly on an export market that fluctuated considerably from year to year. Since then, Canada's output has been much smaller because the product has been recovered from silver concentrates rather than from concentrates high in cobalt and associated arsenides. Since this output is well below domestic requirements, it has found a small, steady domestic market and has been dependent on the export trade only to a slight extent.

*Mineral Processing Division, Mines Branch

TABLE 1

Arsenic Trioxide – Production, Trade and Consumption

	1963		1964	
	Short Tons	$	Short Tons	$
Production (shipments)				
Refined arsenic trioxide				
Ontario	98	7,498	150p	12,000p
Exports				
United States	2	264	35*	4,486*
Imports				
Arsenic acid				
United States	305	22,140	..	..
France	28	2,025	..	..
Soda arseniate binarseniate				
United States	18	26,694	..	..
United Kingdom	48	7,832	..	..
Lead arsenate				
United States	25	9,527	..	..
France	7	2,302	..	..
Botanical arsenical formulations not elsewhere specified**				
United States	..	409,343	613	420,667
Peru	..	–	60	24,615
Belgium-Luxembourg	..	8,435	28	3,788
Netherlands	..	1,748	1	1,150
Other	..	111,985	–	–
Total	..	531,511	702	450,220
Consumption (incomplete)				
Arsenic trioxide				
Glass and glass products	70		..	
Pesticides	215		..	
White metal alloys	..		..	
Miscellaneous chemicals	..		..	

Source: Dominion Bureau of Statistics.

*U.S. imports of merchandise for consumption, REPORT FT 125. **Statistics for 1964 are not comparable with those of previous years.

Symbols: p Preliminary; – Nil; .. Not available.

TABLE 2

Refined Arsenic Trioxide – Production, Exports and Consumption

(short tons)

	Production[1]	Exports[2]	Consumption[4]
1954	590	711	205
1955	786	470	217
1956	895	584	217
1957	1,849	1,615	230
1958	1,162	852	199
1959	789	565	175
1960	862	527	206
1961	210	144	241
1962	80	–	260
1963	94	2	285
1964	150p	35[3]	..

Source: Dominion Bureau of Statistics.
[1]Producers' shipments. [2]Excludes content of gold ores and concentrates exported. [3]United States imports from Canada, reported in U.S. imports of merchandise for consumption, REPORT FT125. [4]Available data on consumption of arsenic trioxide.
Symbols: p Preliminary; – Nil; .. Not available.

In 1964, shipments of the refined commodity amounted to 150 tons valued at $12,000, up from 98 tons for the previous year. This increase was assisted by an agreement between the Royal Canadian Mint and Cobalt Refinery Limited, which became effective on April 1, 1963, and stipulates the delivery of from 2 to 6 million ounces of silver a year to the Mint for a 5-year period. By early 1964 all silver producers from the Cobalt area were shipping concentrates to Cobalt Refinery Limited rather than to the northwestern United States.

Canadian export statistics are not available for 1964 but United States statistics indicate that 35 tons of arsenic trioxide valued at $4,486 (U.S.) were shipped to the United States, probably representing total exports. Canada imports arsenic trioxide as well as arsenic acid and arsenate of lead and lime, mainly from the United States. The amounts are relatively small but statistics are not available for 1964. Canada is a net importer of arsenic trioxide.

Canada is a minor contributor to the world output of refined arsenic trioxide, which amounted to 53,200 tons in 1963. Sweden, Mexico and France were the largest producers in that descending order and accounted for two thirds of the output.

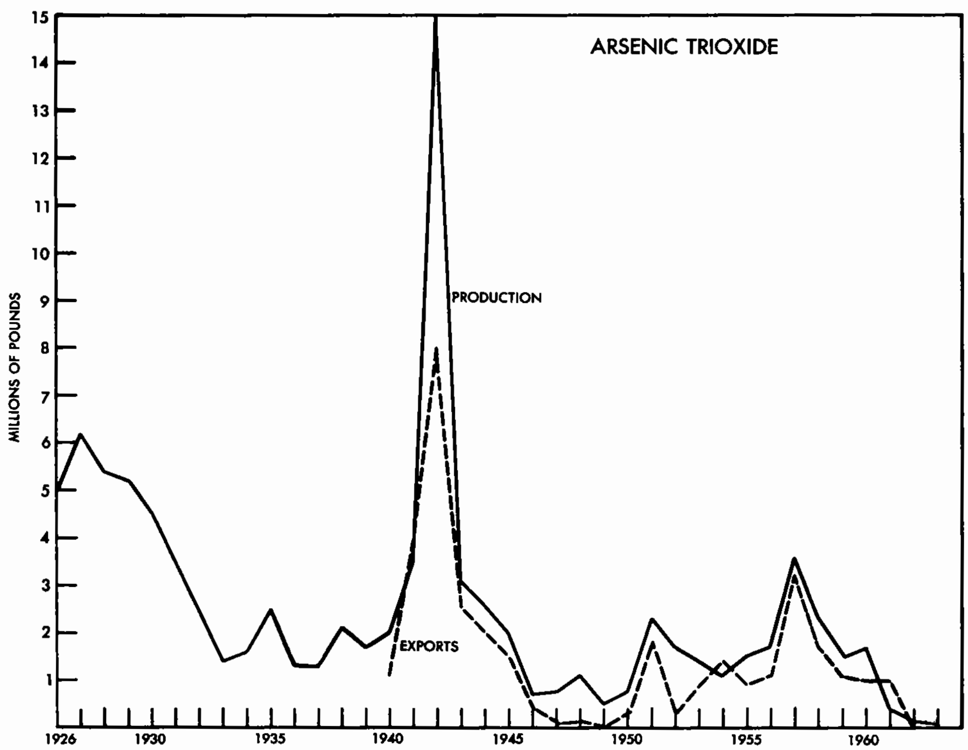


TABLE 3

Free-World Production of White Arsenic

(short tons)

	1962	1963
Sweden	12,100e	12,100e
Mexico	12,000	11,700e
France	10,300	11,000e
Japan	1,100e	1,100e
Portugal	634	770e
Southern Rhodesia	1,207	605
Peru	572	550e
Spain	234	190e
Brazil	164	165e
Canada	80	94
W. Germany	75	65e
United States	..	..
Belgium (exports)	..	..
Total	53,900e	53,200e

Source: U.S. Bureau of Mines, 1963.
Symbols: e Estimate; .. Not available for publication.
Estimates included in world total.

PRODUCERS

Cobalt Refinery Limited is the only Canadian producer of refined arsenic trioxide which is recovered from smelter gas during the custom smelting of arsenical silver concentrates from the Cobalt area. By early 1964 this smelter was treating all silver concentrates produced from that area. The refined arsenic trioxide is sold mainly to customers in eastern Canada.

At Trail, British Columbia, The Consolidated Mining and Smelting Company of Canada Limited produces high-purity arsenic for use in semiconductors from purchased arsenic metal.

OTHER DOMESTIC SOURCES

No other company produces the compound in its refined form. However, to reduce toxic air pollution, crude arsenic trioxide is removed from gases during the roasting of arsenical gold ores at the Yellowknife, Northwest Territories, plants of Giant Yellowknife Mines Limited and The Consolidated Mining and Smelting Company of Canada Limited; and, in Ontario's Red Lake area at Campbell Red Lake Mines Limited, Cochenour Willans Gold Mines, Limited and Dickenson Mines Limited. The crude arsenic dust is carefully disposed of in dumps or in special underground workings.

Arsenic-bearing gold concentrates are exported to the United States by Bralorne Pioneer Mines Limited, Bralorne, British Columbia. Arsenic is a constituent in many other metalliferous deposits in Canada.

CONSUMPTION AND USE

Arsenic trioxide is the raw material used in the production of other arsenic compounds, arsenic metal and arsenic alloys.

These compounds are used throughout the world chiefly for their poisonous effects. Calcium and lead arsenates are commonly used in pesticides. However, particularly in the last decade, organic and other inorganic poisons have become more popular. Nevertheless there is a current trend towards an increased application of organic arsenic-bearing compounds for use in weed and pesticide control. In 1963 Canada consumed 215 tons of arsenic trioxide and an unknown amount of other arsenic compounds in the preparation of pesticides.

That same year, 70 tons were used to assist in the decolourization and fining of glass products. Arsenic trioxide is also used in the production of arsenic compounds, alloys and metal. Metallic arsenic is used in small quantities in some copper- and lead-based alloys. High-purity arsenic metal is employed as a semiconductor.

In recent years, sodium arsenite has been used widely to defoliate potato plants prior to harvesting and to control weeds. Also, it has served on a limited scale to kill and debark trees for the pulp and paper industry. Arsenic compounds are also used in wood preserving, hide tanning and in the manufacture of paint pigments.

PRICES

United States prices for arsenic as quoted in OIL, PAINT AND DRUG REPORTER of December 28, 1964, were as follows, f.o.b. works:

	¢ per lb
Arsenic, crude (95%)	
Bulk, car lots	2.9
Bbl, car lots	4.5
Arsenic, white, refined, powdered	
Bbl, car lots	5.4
Bulk, car lots	3.8
Arsenic trioxide, powdered, drums of 300 lb	4.8

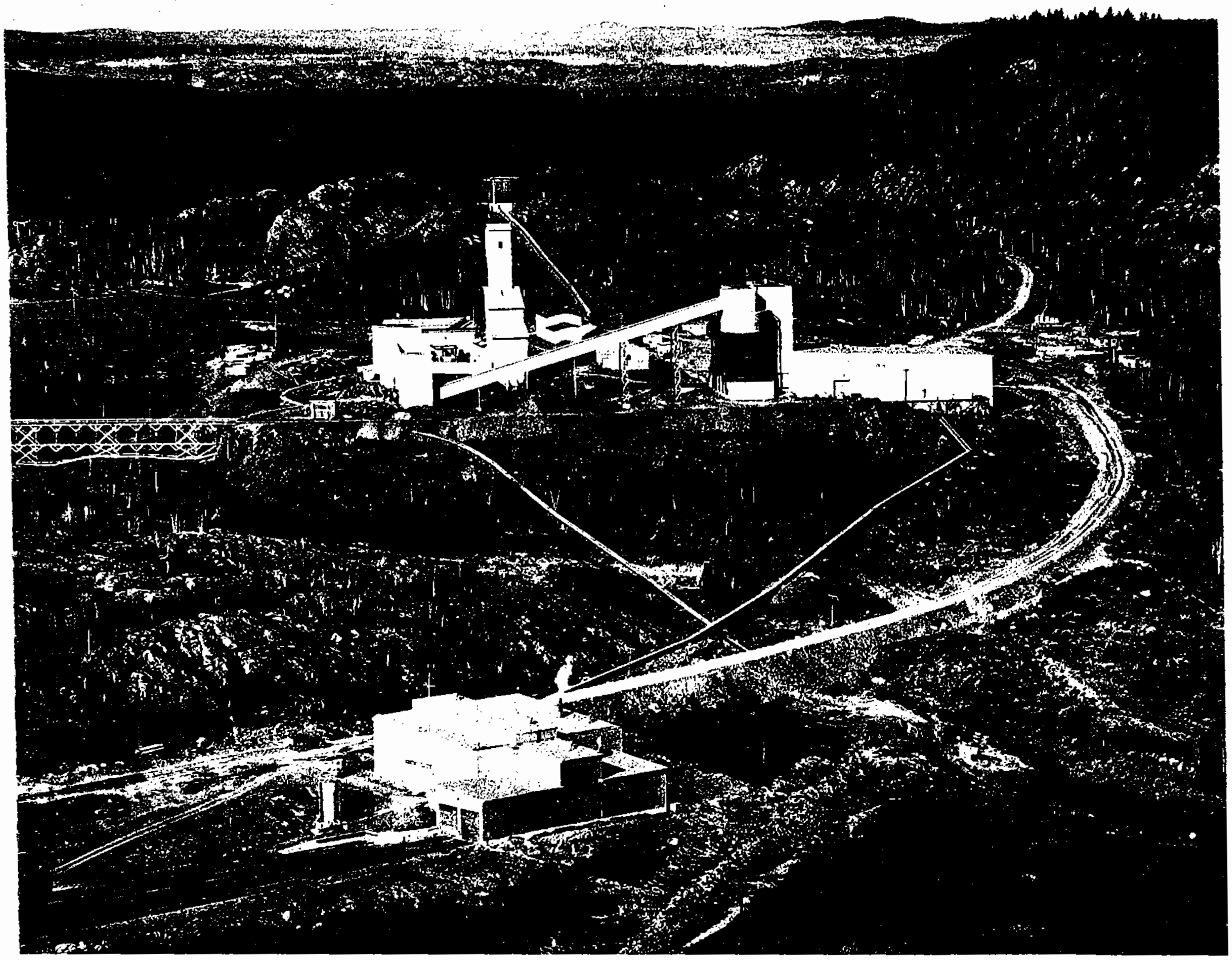
Prices in the United States as quoted in E & M J METAL AND MINERAL MARKETS of December 21, 1964, were as follows:

Arsenious trioxide, per lb, f.o.b.

Refined, white (99%)	
N.Y. docks, bbl, carloads	4.5¢
Laredo, bbl	5.4
Laredo, bulk	3.8
Crude	
Tacoma, bbl	4.5
Laredo, bulk	2.9
Tacoma, bulk	2.9

In 1963 the average value received for Canadian shipments was 7.7 cents a ton at the producing plant.

Both crude and refined arsenic trioxide enter the United States and Canada duty free.



Lake Dufault Mines, Ltd., a new copper-zinc producer in the Noranda district of Quebec.

98115—6

Mattagami townsite 1964

Asbestos

H.M. WOODROOFFE*

During 1964 shipments of asbestos by Canadian producers established a new record for the fifth successive year and amounted to almost 1.4 million tons valued at more than $148 million. The increase of eight per cent was almost wholly attributed to increased production in Quebec and Newfoundland. Production in Ontario decreased significantly. The principal grades of fibre were in good demand during the year.

While Canada is by far the Free World's leading asbestos-producing nation, its position in world production has been challenged by the U.S.S.R. The latter country is now mining asbestos at a level equal to or slightly above Canadian production. In spite of increasing world production, the Canadian industry has maintained a steady growth pattern, having doubled production in the past 15 years. It now accounts for 40 per cent of world output of this widely used commodity.

Because the consumption of asbestos in Canada is relatively small, almost all production is exported to world-wide markets. During 1964, 50 per cent of the asbestos exports were consigned to the United States. The consuming industry in Canada imports its requirements of amosite asbestos from the Republic of South Africa and of crocidolite from South Africa and Australia.

Although chrysotile asbestos is not uncommon in northern Ontario, Quebec, Newfoundland, British Columbia and Yukon Territory, most occurrences are not of economic grade. Consequently, production is restricted to a few areas in the four provinces. Quebec, where production has been continuous since 1878, contributes 90 per cent of Canada's output of fibre.

What are believed to be the world's largest deposits of asbestos occur in the Eastern Townships of Quebec in a narrow band extending from east of the Chaudière River, southwest almost to Sherbrooke, approximately 80 miles east

*Mineral Processing Division, Mines Branch

of Montreal. All the producing deposits in the province are in this region. The presence of the mineral at depth, as established by drilling, indicates that reserves are sufficient for many years.

TABLE 1

Asbestos – Production and Trade

	1963		1964p	
	Short Tons	$	Short Tons	$
Production (shipments)				
By type				
Crude................	217	177,045	218	–
Milled fibres..........	579,085	100,218,289	647,365	–
Shorts	696,228	36,560,846	729,496	–
Total.............	1,275,530	136,956,180[1]	1,377,079	148,370,312[1]
By province				
Quebec	1,158,210	116,582,134	1,245,442	125,897,947
British Columbia	63,215	11,681,337	65,856	11,920,000
Newfoundland.........	20,390	3,320,064	50,281	8,296,365
Ontario	33,715	5,372,645	15,500	2,256,000
Total.............	1,275,530	136,956,180[1]	1,377,079	148,370,312[1]
Exports				
Crude				
West Germany.........	108	79,764	96	78,145
Japan................	44	34,735	78	57,415
United States	35	45,356	39	46,653
Other countries	8	5,242	1	1,410
Total.............	195	165,097	214	183,623
Milled				
Group 3 grades				
United States..........	14,016	6,026,300	14,618	6,314,263
West Germany	4,115	1,631,036	5,152	1,989,658
Britain	1,997	789,772	3,710	1,177,778
France	2,044	794,793	3,149	1,166,375
Japan	1,168	487,710	2,127	845,878
Italy	820	309,959	849	324,686
Belgium and Luxembourg	355	141,687	700	291,356
Spain	694	252,770	362	137,763
Mexico	105	39,250	300	118,400
Brazil................	63	25,360	120	46,331
India	639	209,120	120	63,814

Table 1 (cont.)

	1963		1964p	
	Short Tons	$	Short Tons	$
Australia	20	6,831	99	34,887
Austria	73	24,139	89	34,522
Netherlands	65	23,978	51	19,931
Other countries	2,010	863,739	2,961	1,295,666
Total	28,184	11,626,444	34,407	13,861,308
Group 4 and 5 grades				
United States	163,135	27,692,903	190,284	32,485,324
Britain	40,831	7,264,591	46,430	7,963,788
West Germany	47,616	7,899,213	44,483	7,392,193
France	26,932	4,699,070	40,133	6,718,089
Japan	31,160	4,178,819	38,330	5,130,350
Australia	20,247	3,520,511	28,134	4,462,697
Belgium and Luxembourg	24,922	4,418,229	27,120	4,723,878
Spain	17,504	3,031,023	20,137	3,488,074
Mexico	14,582	2,621,371	17,316	3,133,316
India	20,891	3,948,713	14,904	2,856,254
Italy	12,735	2,270,543	14,873	2,660,646
Netherlands	13,462	2,334,905	14,025	2,309,685
Austria	9,518	1,669,331	11,375	2,016,461
Brazil	15,917	2,769,356	9,752	1,692,541
Other countries	67,783	11,762,751	78,812	13,630,258
Total	527,235	90,081,149	596,108	100,663,554
Total, milled fibres, Groups 3,4 and 5				
United States	177,151	33,719,203	204,902	38,799,587
Britain	42,828	8,054,363	50,140	9,141,566
West Germany	51,731	9,530,249	49,635	9,381,851
France	28,976	5,493,863	43,282	7,884,464
Japan	32,328	4,666,529	40,457	5,976,228
Australia	20,267	3,527,342	28,233	4,497,584
Belgium and Luxembourg	25,277	4,559,916	27,820	5,015,234
Spain	18,198	3,283,793	20,499	3,625,837
Mexico	14,687	2,660,621	17,616	3,251,716
Italy	13,555	2,580,502	15,722	2,985,332
India	21,530	4,157,833	15,024	2,920,068
Netherlands	13,527	2,358,883	14,076	2,329,616
Austria	9,591	1,693,470	11,464	2,050,983
Brazil	15,980	2,794,716	9,872	1,738,872
Other countries	69,793	12,626,310	81,773	14,925,924
Total	555,419	101,707,593	630,515	114,524,862

Table 1 (cont.)

	1963		1964p	
	Short Tons	$	Short Tons	$
Short fibre grades				
United States	445,261	23,923,387	445,580	24,149,856
Japan	43,267	3,632,057	55,537	4,594,791
Britain	35,019	1,836,266	47,877	2,640,735
West Germany	31,333	1,788,778	38,651	2,105,715
France	15,331	1,098,912	27,908	1,667,306
Belgium and Luxembourg	15,581	1,188,098	19,512	1,398,374
Netherlands...........	14,325	668,476	13,950	832,097
Australia	8,318	513,695	8,678	579,990
Sweden...............	4,760	319,681	5,821	383,046
Austria...............	4,085	280,192	4,810	380,455
Argentina.............	2,881	175,266	4,637	277,939
Italy	3,784	202,044	4,515	220,853
Other countries........	26,866	1,947,902	25,271	1,766,311
Total	650,811	37,574,754	702,747	40,997,468
Grand total, exports of asbestos fibre...	1,206,425	137,447,444	1,333,476	155,705,953
Manufactured products, brake linings and clutch facings				
Cuba.................		–		37,632
Ecuador..............		32,219		28,970
United States		27,510		25,371
Lebanon..............		50,555		23,258
Greece		19,775		22,584
Syria.................		9,176		22,535
Iraq..................		11,192		20,938
Australia		5,729		19,391
El Salvador		18,548		18,573
Iran..................		25,421		13,659
Jamaica		4,392		12,666
Kuwait		14,342		12,463
Other countries........		143,054		115,481
Total		361,913		373,521
Asbestos and asbestos cement building materials				
United States		618,901		1,084,696
Pakistan		–		49,376
Britain		–		41,508

Table 1 (cont.)

	1963		1964p	
	Short Tons	$	Short Tons	$
Australia		65,916		37,154
Venezuela		27,096		27,566
Other countries........		39,318		28,028
Total		751,231		1,268,328
Other asbestos and asbestos cement products				
Unites States		261,909		153,344
Switzerland		16,531		56,201
Jamaica		13,461		22,560
Britain		15,627		21,209
Finland		11,743		14,731
Australia		3,945		12,782
Japan		—		12,146
Chile		—		9,279
Italy		285		8,350
Mexico		30,943		7,039
Other countries........		20,393		12,081
Total		374,837		329,722
Grand total, exports of manufactured products............		1,487,981		1,971,571
Imports[2]				
Packings, facings, linings				
Asbestos packing.......		483,070		597,450
Asbestos brake linings for motor vehicles.....		1,069,950		1,204,470
Asbestos clutch facings for motor vehicles		217,471		265,393
Asbestos brake linings and clutch facings, n.e.s.		334,037		407,247
Total		2,104,528		2,474,560
Miscellaneous manufactures				
Asbestos cloth dryer felts and sheets woven or felted		..		591,905
Asbestos-cement shingles and siding		..		219,818
Asbestos-cement board				

Table 1 (Concl.)

	1963		1964p	
	Short Tons	$	Short Tons	$
and sheets...........		..		747,724
Asbestos and asbestos-cement building materials, n.e.s.......		..		686,379
Asbestos and asbestos-cement basic products, n.e.s...............		..		1,374,482
Total		3,182,460[3]		3,620,308
Total asbestos manufactures.........		5,286,988		6,094,868
Asbestos unmanufactured	..	..	9,218	1,647,866

[1]Does not include values of containers. [2]Due to changes in statistical classification started in 1964, certain of the classes of asbestos imports are not comparable with those of prior years. [3]"Asbestos manufactures, not otherwise provided" as reported in the 1963 import statistics. This class is approximately comparable to the total of the individual classes of miscellaneous asbestos manufactures for 1964 as shown above.

Symbols: — Nil; p Preliminary; .. Not available.

TECHNOLOGY

A number of minerals have a fibrous or pseudo-fibrous habit but lack the physical or chemical characteristics that are required in a fibrous mineral for industrial use. In commerce the term "asbestos" is applied to five silicate minerals; the most widely used is chrysotile, a hydrous magnesium silicate. The others are crocidolite, a sodium-iron silicate; amosite, a silicate of both iron and magnesium partly hydrated; and tremolite and anthophyllite, which are silicates of calcium, magnesium and iron.

Chrysotile provides 90 per cent of the world's asbestos fibre and is the only variety mined in Canada. The two principal modes of its occurrence are as "cross fibre" and "slip fibre". In the former, individual fibres lie parallel across the vein so that the vein width is an approximate indication of fibre length. Many of the partings often found in the veins are caused by the inclusion of magnetite or other minerals. Some fibres are as long as 5 inches, but most of the fibre recovered commercially is half an inch or less in length.

In some occurrences, the fibres of chrysotile lie along fissures in the rock lengthwise and in an overlapping manner. This mode of occurrence, which is so

TABLE 2

Asbestos – Production and Exports, 1955–64

(short tons)

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964p
Production*										
Crude..........	724	717	622	605	432	330	163	205	217	218
Milled	395,096	392,983	404,016	342,562	404,019	483,183	548,230	547,447	579,085	647,365
Shorts.........	667,982	620,549	641,448	582,164	645,978	634,943	625,302	668,162	696,228	729,496
Total........	1,063,802	1,014,249	1,046,086	925,331	1,050,429	1,118,456	1,173,695	1,215,814	1,275,530	1,377,079
Exports										
Crude	586	560	638	483	416	241	176	182	195	214
Milled.........	365,980	377,044	393,311	318,280	401,583	458,053	527,324	532,020	555,419	630,515
Shorts	635,261	586,317	636,611	547,867	611,923	610,199	589,380	632,468	650,811	702,747
Total........	1,001,827	963,921	1,030,560	866,630	1,013,922	1,068,493	1,116,880	1,164,670	1,206,425	1,333,476

Source: Dominion Bureau of Statistics.
* Producers' shipments.
p – Preliminary.

characteristic of the deposits along the Pennington Dike east of Thetford, is known as slip fibre. It is particularly evident in heavily sheared serpentine or peridotite bodies.

Many industrial uses of chrysotile are mainly the result of the mineral's physical characteristics rather than of its chemical nature. These properties vary to some degree with the occurrence. Quebec produces a fine, silky fibre which is ideally suited for spinning and can be worked into textile products; the Ontario product has a harsh texture. This harshness is much desired in the asbestos-cement industry because it gives a fast-filtering quality to an asbestos-cement slurry. The commercial fibre recovered in northern British Columbia is low in magnetite. This is an advantage to the electrical industry where the fibre is used to provide heat-resistant and nonconductive woven insulation.

Crocidolite, commonly called "blue fibre", is an asbestos of the amphibole group and has properties of commercial value. It is used in the manufacture of asbestos-cement pressure pipe and packing. It is not mined in Canada, although occurrences have been reported from the iron-ore region near the Labrador-Quebec boundary. Large commercial deposits occur in South Africa; it is also produced in Australia and in the U.S.S.R.

Amosite, a heat-resistant type of anthophyllite, is used principally in the manufacture of thermal insulation. No Canadian occurrence is known. The world amosite market is supplied from deposits in South Africa.

Other asbestos minerals – fibrous tremolite, actinolite and anthophyllite – occur in Canada but none is produced. The fibres of these minerals are usually weak and unsuitable for most asbestos uses. There are, however, certain uses for which their natural chemical and physical properties are suited. During World War II, a small amount of tremolite was produced in eastern Ontario.

Chrysotile is mined in Canada by both open-pit and underground methods. It is prepared by a dry-milling process in which the ore is crushed, impact-milled, fiberized and separated into different grades of commercial fibre and a waste product or tailing. Although the recovered fibre is graded for the market essentially by length, other factors such as bulk volume, contained dust and degree of openness, are also important.

PRODUCTION AND DEVELOPMENT

NEWFOUNDLAND

Chrysotile occurs in several places in Newfoundland. Advocate Mines Limited produces fibre from a new operation at Baie Verte on the Burlington Peninsula. The 5,000-ton-per-day mill is producing a type of fibre particularly suited to the manufacture of asbestos-cement products. The mine, operated by Canadian Johns-Manville Company, Limited, was jointly financed by an international group.

QUEBEC

Asbestos is mined in the part of the province south and east of the St. Lawrence River in the counties of Richmond, Arthabaska, Megantic and Beauce. This area has often been referred to as the Eastern Townships. During 1964 13 mines were in operation in or near Thetford Mines, Black Lake, Asbestos and Tring.

One of the world's largest asbestos mines, the Jeffrey, is operated by Canadian Johns-Manville Company, Limited, at Asbestos, Richmond County, 80 miles east of Montreal. For many years it was operated as an open-pit mine but since World War II extensive underground workings have been developed and much of the ore has been recovered by the block-caving mining method. Taking advantage of technical improvements, the company embarked upon an extensive conversion program, resulting in the Jeffrey reverting to an open-pit operation.

In 1964 Asbestos Corporation Limited acquired the assets of Johnson's Company Ltd. and Johnson's Asbestos Company, operating an underground mine at Thetford Mines and an open-pit at Black Lake. Johnson's Company had a continuous record of production for over 80 years. The consolidation with Asbestos Corporation, the second largest in the industry, will enable certain production economies to be achieved in the two producing areas. Asbestos Corporation has three mills in operation. Two of these, the British Canadian at Black Lake and the Normandie in Ireland Township, treat ore recovered from adjacent open-pit mines. At Thetford the operations of the Beaver open-pit and the King underground mine have been integrated with a common mill.

The underground mine of Bell Asbestos Mines, Ltd., is also at Thetford Mines.

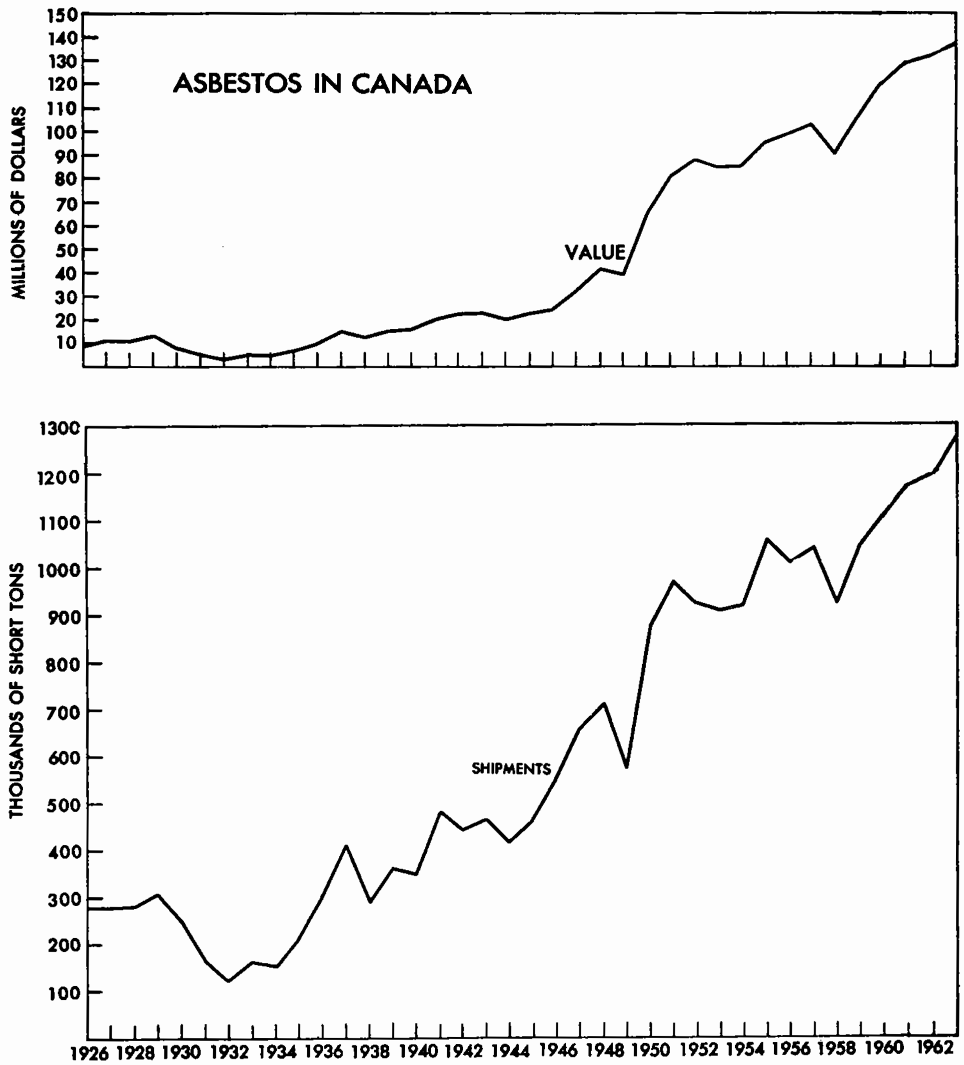
Flintkote Mines Limited and Nicolet Asbestos Mines Ltd. recover asbestos from open-pit mines a few miles east of Thetford Mines and at St. Remi de Tingwick respectively.

Lake Asbestos of Quebec, Ltd., a subsidiary of American Smelting and Refining Company, operates its deposit in the bed of Black Lake. Preparation of the deposit for open-pit mining required extensive dredging and the draining of Black Lake.

Carey-Canadian Mines Ltd., a subsidiary of The Philip Carey Manufacturing Company, is in production at its property near Tring Junction, Beauce County, east of Thetford Mines.

National Asbestos Mines Limited, a subsidiary of National Gypsum (Canada) Ltd., recovers asbestos from a deposit along the Pennington Dike a few miles east of Thetford Mines.

Asbestos Corporation Limited exercised its option to acquire the Asbestos Hill deposit of Murray Mining Corporation Limited 40 miles southeast of Deception Bay in northern Ungava. Exploration and development of this deposit have established a substantial reserve of commercial-grade fibre and it is anticipated that it will be brought into production in a few years' time.



ONTARIO

On July 31 Canadian Johns-Manville Company, Limited, closed the Munro Mine 12 miles east of Matheson in the northern part of the province. This mine had been a source of fibre for the asbestos-cement industry since 1950. The company has in hand an extensive exploration and development program in Reeves Township 40 miles southwest of Timmins. The underground development is proceeding to prove up an interesting asbestos orebody and to facilitate bulk sampling of the deposit.

BRITISH COLUMBIA

Cassiar Asbestos Corporation Limited recovers long- and medium-fibred asbestos from a deposit on Mount McDame in northern British Columbia near the Yukon border. The company increased its mill capacity to 1,700 tons per day to provide additional asbestos-cement grade of fibre.

YUKON TERRITORY

Cassiar Asbestos Corporation Limited continued its exploration program at Clinton Creek and added to the reserves of this promising deposit. Engineering studies are in hand preparatory to considering production.

WORLD REVIEW

World production of asbestos of all types during 1964 was estimated to be 3.5 million short tons. Canadian production is about 40 per cent of this amount. World production growth has been remarkable, having doubled in the past 10-year period.

Particularly noteworthy has been the rapid development of the asbestos industry in the U.S.S.R. where production from deposits near Sverdlovsk in the Urals has increased markedly. Although no statistics are published concerning this mineral, the current level of production is estimated to be in excess of 1 million tons per annum and probably approaches 1.5 million tons per annum. About 15 per cent of this total is exported and competes with Canadian asbestos in overseas markets. A new deposit at Kiembi, Kazakhastan, 300 miles south of Sverdlovsk, is under development, and production is expected during 1965. The potential capacity indicated is 250,000 tons of fibre per annum. The U.S.S.R. is also developing a deposit at Aktrovak in Tannu-Tuva, west of Lake Baikal.

Another important asbestos region is the southern half of the continent of Africa with production from Rhodesia, the Republic of South Africa, Swaziland and Bechuanaland. During 1964, 153,451 tons of high quality chrysotile was produced from deposits in Southern Rhodesia. Because of its freedom from magnetic iron, this fibre finds ready acceptance in asbestos products for the electrical trade.

The Republic of South Africa is the principal world source of amosite and mines much of the world's requirements for crocidolite. Chrysotile is also mined. In 1964 production of all varieties was 215,592 short tons.

With the development of the State of California as an important area of asbestos production, the United States now ships 100,000 tons of fibre from its domestic mines.

USES

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 in much the same manner as the staple organic 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 most important single market for this commodity is the asbestos-cement industry. Asbestos is combined with portland cement for manufacture into a number of products, such as pressure and nonpressure pipe, flat and corrugated sheeting shingles, roofing tile and millboard. This use has grown considerably since the war and the resulting products are well established throughout the world. Although asbestos-cement products are used largely in the construction of buildings, other industrial applications are growing, particularly in the electrical field. The use of asbestos-cement pipe in municipal water distribution systems and in the disposal of sewage waste is now well established. The durability of the pipe and its resistance to corrosion are an advantage in these applications.

In thermal insulation, asbestos is used as a kind of paper. In combination with other materials, it is also widely used in the form of preformed sections or slabs for boiler and steam-pipe covering and in oil-refinery and chemical-plant construction.

The shorter-fibre grades of asbestos have the greatest number of uses. At present the volume of asbestos classified as short-fibre far exceeds that of all other grades combined. This type is used in the moulding of plastics, the manufacture of floor tiling and protective coatings, the paint industry and other applications requiring a fibrous filler with the physical characteristics of asbestos.

The automobile industry uses asbestos products in large quantities; they include woven and moulded brake linings, clutch facings and pressure gaskets. Undercoating compounds provide an important use for very short grades of fibre.

PRICES

Published prices for Canadian asbestos at the end of 1964 were virtually the same as in 1963. Prices, per short ton, f.o.b. mine, Quebec, in Canadian currency, by grades were as follows:

Crude No. 1	$1400 to $1410	Fibre:	
Crude No. 2	750 to 760	4T	$181
Fibre:		5D	142
3 F	565	5R	120
3 K	480	6D	86
3 R	408	7D	75
3 T	370	7M	44
3 Z	345	7R	43
4A	320	8S	27 to 29
4K	200		

The industry in Quebec increased the prices of certain grades effective January 1, 1965, as follows:

Fibre:		Fibre:	
4K	$210	7D	$82
4T	190	7M	47
5D	150	7R	46
5R	132	8S	29
6D	95		

Prices f.o.b. Vancouver, Canadian funds, for western asbestos were as follows:

Crude No. 1	$1522	Fibre:	
Fibre:		AK	$220
AAA	787	AS	181
AA	625	AX	160
A	470	AY	120
AC	325		

TARIFFS

CANADA	British Preferential (%)	Most Favoured Nation (%)	General (%)
Asbestos, crude..................	free	free	25
Asbestos in any form other than crude, and all manufactures thereof, n.o.p.	12½	12½	25

TARIFFS

	British Preferential (%)	Most Favoured Nation (%)	General (%)
CANADA			
Asbestos in any form other than crude, and all manufactures thereof, when made from crude asbestos of British Commonwealth origin, n.o.p.	free	12½	25
Yarns, wholly or in part of asbestos, for use in the manufacture of clutch facings and brake linings	7½	12½	25
Woven fabrics, wholly or in part of asbestos, for use in the manufacture of clutch facings and brake linings	12½	12½	30
UNITED STATES			
Asbestos, not manufactured, crude, 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 valorem		
Articles in part of asbestos and hydraulic cement:			
Pipes and tubes and fittings therefor	0.3¢ per lb		
Other	0.225¢ per lb		
Asbestos articles not specially provided for	9% ad valorem		

Barite

J.S. ROSS*

Because of reduced export demand, Canada's barite production decreased for the second successive year in 1964. Ever since 1942, when Canada's output first became significant, production has fluctuated with, and has been slightly greater than exports. Most of the output is as crude barite, shipped by one producer to processing plants in the United States. These plants are owned by the parent company of that producer. Consequently, the output of Canadian barite depends mainly on the requirements of the one chief foreign customer and does not necessarily fluctuate proportionately with the over-all demand of the chief market, the foreign well-drilling industry.

With a decrease of 4 per cent in exports, production (shipments) declined by 1 per cent to 172,415 tons valued at $1,692,400 (preliminary). As in 1963, 91 per cent of production was in the crude form, although about 15 per cent of the total was eventually pulverized in Canada.

In world production, Canada ranked fifth in 1963 and probably remained in that position in 1964. The leading producers are the United States, West Germany and Mexico, in that order.

The export market is the main outlet for Canada's production. In 1964 exports accounted for 91 per cent of production and amounted to 156,527 tons valued at $1,410,771. As is customary, they were virtually all of the crude product which went to ports in the United States along the Gulf of Mexico. Because of a sizable decrease in the United States import tariff for ground barite in 1964, Canada's exports of this product should increase in the future.

Imports continued to be small and in 1964 amounted to 3,206 tons valued at $164,856. Most were of granular and pulverized barite of chemical quality from the United States.

*Mineral Processing Division, Mines Branch

TABLE 1

Barite – Production, Trade and Consumption

	1963		1964	
	Short Tons	$	Short Tons	$
Production (mine shipments)				
Crushed and lump	157,453	1,361,686	157,100p	
Ground	16,040	331,433	15,315p	
Total	173,503	1,693,119	172,415p	1,692,400p
Imports				
United States	3,752	192,887	3,111	160,698
West Germany	78	3,051	95	4,158
Total	3,830	195,938	3,206	164,856
Exports				
United States	140,292	1,215,540	142,304	1,234,722
Venezuela	3,920	33,318	8,175	69,489
Trinidad	15,680	290,080	6,048	106,560
Total	159,892	1,538,938	156,527	1,410,771
Consumption*				
Well drilling	8,419			
Paints	1,683			
Glass	768			
Rubber goods	178			
Miscellaneous chemicals	148			
Miscellaneous nonmetallic products	147			
Total	11,343			

Source: Dominion Bureau of Statistics.
*These quantities are compiled from information provided by the Dominion Bureau of Statistics.
p Preliminary.

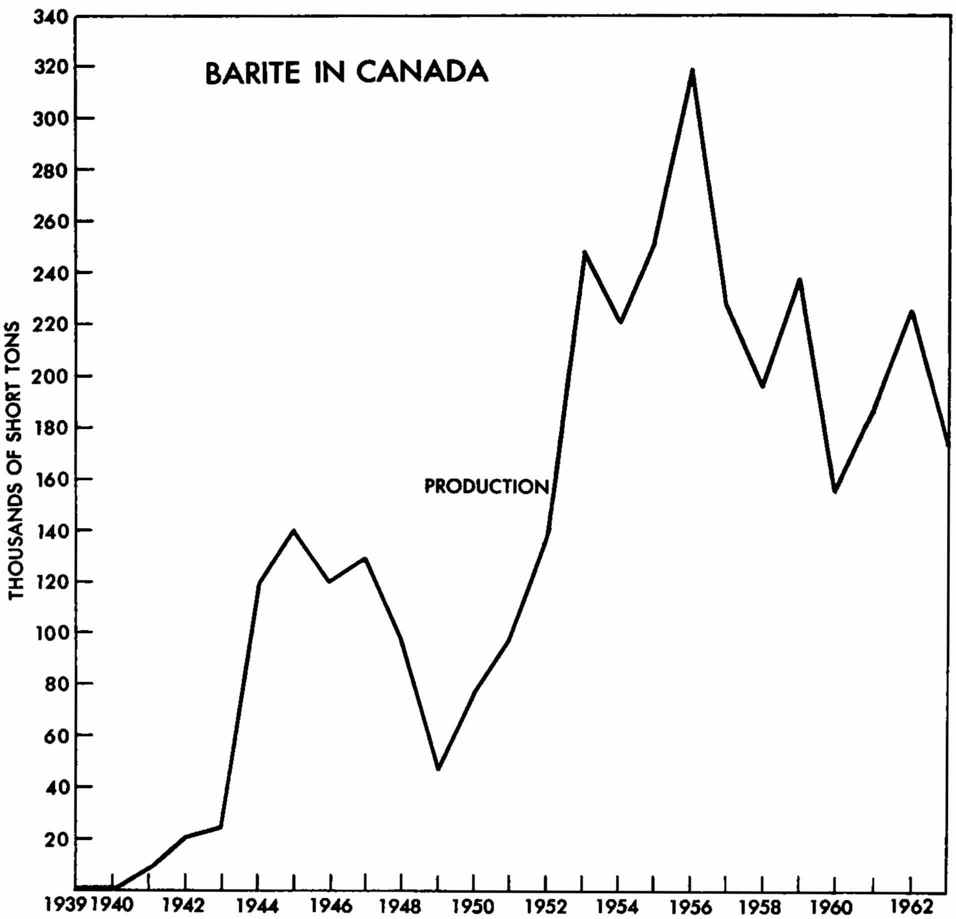
Preliminary estimates indicate that world consumption of barite remained at a moderate level in 1964. However, during that year, Canada's well-drilling industry, the largest user of barite, experienced an 8-per-cent increase in drilling footage. Consequently, domestic consumption probably increased in 1964. In 1963 it amounted to 11,343 tons, 74 per cent of which was used by the well-drilling industry. One third of total consumption is supplied by imports. The remaining domestic requirements are barely adequate to support three mines and part of the output of three separate plants in western Canada and a small part of the output from the one producer in eastern Canada.

TABLE 2

Barite – Production, Trade and Consumption, 1955–64
(short tons)

	Production*	Imports	Exports	Consumption**
1955	253,736	1,449	244,070	11,115
1956	320,835	1,475	312,275	10,035
1957	228,048	1,831	199,785	30,094
1958	195,719	1,382	172,942	24,159
1959	238,967	1,662	221,721	22,404
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	172,415p	3,206	156,527	..

Source: Dominion Bureau of Statistics.
*Mine shipments. **Apparent consumption to 1958, reported consumption 1959 on.
Symbols: p Preliminary; ..Not available.



PRODUCERS

Although this country consumes little barite, it has substantial barite reserves. Occurrences have been noted in all provinces except Alberta, Saskatchewan and Prince Edward Island. Barite was produced from four deposits in 1964 – one in Nova Scotia and three in southeastern British Columbia. The output from Nova Scotia was mainly as crude barite and most was shipped to southeastern United States. That from British Columbia was shipped as crude, mainly to Alberta, for final processing.

Barium and strontium metals are produced in small amounts, principally for export, by Dominion Magnesium Limited at Haley, Ontario.

NOVA SCOTIA

Magnet Cove Barium Corporation operates Canada's largest barite operation, the only barite mine east of British Columbia. This operation is near Walton and normally produces about 90 per cent of Canada's output. Except for small shipments to other provinces, the operation is dependent on the export market. Because it is located near the ocean port of Walton, its product is competitive in eastern Canada and in the world's most important barite-market area – along the south and east coast of the United States and along the north coast of South America.

The company recovers barite from an underground mining operation by the use of block caving. The barite is beneficiated at an adjoining mill and trucked to Walton for shipment. In addition, barite concentrates are recovered as a coproduct from the company's sulphide flotation plant located at the mine. At Walton, a small part of the output is pulverized usually for markets in Trinidad and Venezuela. Most of the barite is shipped as crushed concentrates to pulverizing plants owned by a parent company and located along the Gulf of Mexico. The product is used mostly in the United States and South America as a weighting agent in well drilling.

BRITISH COLUMBIA

Mountain Minerals Limited is the largest barite producer in British Columbia and recovers the mineral by open-pit and underground-mining methods from deposits near Parson and Brisco. Most of the output is shipped to the company's grinding plant at Lethbridge, Alberta, for eventual use in well drilling. The balance is sold in other provinces.

Barite is recovered from the Giant property near Spillimacheen by Baroid of Canada, Ltd. It is shipped to the company's grinding plant at Onoway, Alberta, where it is ground for use in well drilling.

Sheep Creek Mines Limited formerly mined small quantities of barite from its Mineral King lead-zinc mine near Invermere. The crude barite formerly was shipped to Alberta for processing and for eventual sale mainly as a weighting agent for well drilling. However, mine shipments of barite were stopped in the latter part of 1963.

ALBERTA

No barite has been mined in this province. However, almost all barite mined in British Columbia is pulverized by Mountain Minerals at Lethbridge, Magnet Cove Barium Corporation Ltd. at Rosalind, or by Baroid of Canada at Onoway.

QUEBEC

On occasion, barite is pulverized by Industrial Fillers Limited, Montreal.

TABLE 3

World Production of Barite, 1963

(short tons)

United States	803,106
West Germany	460,000
Mexico	282,847
U.S.S.R.	220,000
Canada	173,503
Peru	137,600
Italy	117,505
Yugoslavia	115,176
Other countries	890,263
Total	3,200,000

Source: *U.S. Bureau of Mines Minerals Yearbook, 1963.*

OTHER OCCURRENCES

Barite occurs at many other places in Canada and has been mined from a few of these deposits. Some of the noteworthy deposits are at Buchans mine, Buchans, Newfoundland; near Lake Ainslie, Cape Breton Island; in Penhorwood and Langmuir Townships, northern Ontario; on McKellar Island, Lake Superior; and at Mile 397 on the Alaska Highway, British Columbia. Witherite (barium carbonate) occurs in a large deposit near Mile 497 on the British Columbia section of the Alaska Highway. Witherite, barylite, barytocalcite and other, rarer, barium minerals occur in Canada but have not been used by industry in this country.

USES AND SPECIFICATIONS

Barite (natural barium sulphate) is used mainly because of its physical properties, such as a high specific gravity of at least 4.3, chemical inertness under normal conditions and, on occasion, whiteness. Barite is used to a small extent as the main source of the element barium in the production of barium chemicals.

In Canada, most barite is used by the well-drilling industry. In 1963, 74 per cent of domestic consumption was for that purpose. World consumption of barite for this use comprises about 90 per cent of output. When used in well drilling, barite assists in controlling fluid pressure in the hole and in forcing drill cuttings to the surface. It is the most commonly used material for this purpose. Drilling techniques employing gas and foam as the fluid media are being used under certain conditions but they have not had any noticeable effect on barite consumption. Barite for use in well drilling should have a minimum specific gravity of 4.20 to 4.25 and a particle size of at least 90 per cent minus 325 mesh.

The second most important use is in the application of barite as a filler. In 1963, 18 per cent of domestic consumption went for that purpose. Most was used in paints but small amounts went into the manufacture of rubber products, paper and miscellaneous products. For filler purposes, barite should have a maximum particle size of 200 mesh, should contain at least 94 per cent barium sulphate and, except for some rubber products, should have a high light reflectivity.

The other main use is in the manufacture of glass where barite improves the workability of the melt and provides added lustre. Specifications normally require a minimum of 98 per cent barium sulphate, less than 0.15 per cent ferric oxide and a particle size of 20 to 200 mesh.

A minor use for barite is as a heavy aggregate in concrete used for shielding atomic radiation.

The barium chemicals industry is virtually nonexistent in Canada. The more common barium compounds manufactured throughout the world and some of their applications are as follows: precipitated barium sulphate, or blanc fixe, used as an extender and pigment in paints and as a filler in paper; lithopone, a mixture of barium and zinc sulphate, employed as a white pigment in paints; barium chloride, for case hardening and the prevention of scumming, on brick; and barium carbonate, used for the reduction of scumming on brick and other ceramics and in the manufacture of electronic tubes. Barium oxide, hydrate, titanate, chlorate, nitrate, sulphide, ferrite and phosphate are also manufactured. Several of the barium compounds are used as a source of barium metal. The titanate is receiving increasing attention in electronics because of its high dielectric constant and piezoelectric and ferroelectric properties. Specifications vary for barite for the manufacture of chemicals but commonly require lump barite with a minimum of 94 per cent barium sulphate and a maximum of 1 or 2 per cent ferric oxide.

TABLE 4

Barium Compounds – Imports and Consumption

	1963		1964	
	Short Tons	$	Short Tons	$
Imports				
Lithopone (70% $BaSO_4$)	391	59,181	539	80,987
Blanc fixe and satin white	1,001	108,457	..	..
Barium carbonate	..	..	4,341	391,558
	1961			
Consumption				
of some barium compounds in the chemical and allied-products industries				
Barium carbonate	616			
Barium chloride	360			
Barium nitrate	54			
Blanc fixe	289			
Lithopone	488			

Source: Dominion Bureau of Statistics.
.. Not available.

To a small extent, witherite is used as a source of barium chemicals but there is no record of imports of this mineral into Canada in recent years.

PRICES

Most of Canada's barite is shipped from mining operations in the crude lump, crushed or semiprocessed form. In 1963 this type averaged $8.65 a short ton at the mine or mill. The finished ground product averaged $20.65 a ton. These prices differ greatly from the published prices listed below for Canadian barite.

According to *E & M J Metal and Mineral Markets* of December 28, 1964, the prices for barite, f.o.b. shipping point, were as follows:

	Dollars
CANADA	
Crude, in bulk, per long ton	11.00
Ground, in bags, per short ton	16.50
UNITED STATES	
(car lots, per short ton)	
83–93% $BaSO_4$	
Crude, bulk	12.00 – 16.00
Gulf ports	11.00 – 14.00
Ground	26.75
95% $BaSO_4$, lump, bulk	18.50
96–97½% $BaSO_4$, crushed, bulk	19.00 – 23.50
99½% $BaSO_4$, water ground, 325 mesh, bags	45.00 – 49.00

TARIFFS

The United States tariff for ground barite was recently reduced appreciably from $6.50 a long ton to 12.5 per cent ad valorem.

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

Bentonite

J.S. ROSS*

In 1964, Canada's bentonite consumption, paralleled by imports, again increased appreciably. It reached an estimated 123,000 tons, up from 93,500 tons in 1963, mainly resulting from increased demand by the iron-ore pelletizing industry. Relatively large increases are expected for the next few years at least, chiefly because of the requirements for pelletizing iron-ore concentrates. The quantity required for pelletizing in 1965 should approximate the total used for all purposes in 1963. Although a trend has been established for the use of imported bentonite for pelletizing, sizeable test shipments of the domestic product were made in 1964 for this purpose.

The numerous unusual properties of bentonite are not generally realized and yet the use of the commodity is widespread. Although several definitions have been ascribed to this commodity, bentonite may be defined as a clay composed essentially of minerals of the montmorillonite group. These minerals have exchangeable ions between their structural sheets. When in contact with water, montmorillonite minerals, with sodium as the predominant cation, form gels and swell more readily than montmorillonite minerals with calcium as the predominant cation. Consequently, bentonites may be classified roughly into two main groups – swelling and nonswelling. Bentonite also has the faculty of adsorbing certain impurities and, when activated, may have appreciable adsorptive properties. Fuller's earth is an industrial term that refers to use rather than mineral composition. It commonly contains or is composed entirely of montmorillonite minerals.

PRODUCTION AND TRADE

Statistics on current production are not available. Canada's bentonite industry is relatively small and is estimated to ship between 20,000 and 40,000 tons a year, with a value of over $1 million.

*Mineral Processing Division, Mines Branch

TABLE 1

Trade and Consumption of Bentonite

	1963		1964	
	Short Tons	$	Short Tons	$
Imports[1]				
Bentonite[2]				
United States	..	..	114,446	1,055,405
Activated clays and earths				
United States	..	1,405,725	2,823	408,481
France	—	—	30	10,162
Total	..	1,405,725	2,853	418,643
Fuller's earth				
United States	..	137,122	6,166	179,213
Britain	..	2,607	51	1,896
West Germany	..	1,183	17	3,919
Total	..	140,912	6,234	185,028
Compounds and conditioners for use in drilling mud[3]				
United States	16,892	458,700	12,075	1,095,322
Exports				
Earths or clays artificially activated[4]				
United States	2,302	90,422		
Consumption (incomplete)[5]				
Pelletizing ore concentrates	37,575			
Well drilling	33,932			
Iron and steel foundries	17,642			
Petroleum refining	1,790			
Paper	296			
Miscellaneous chemicals	291			
Miscellaneour nonmetallic products	1,986			
Total	93,512			

Source: Dominion Bureau of Statistics.

[1]Due to changes in statistical classification, import statistics for 1964 are not completely comparable with previous years. [2]Not available as a separate class prior to 1964. [3]Includes some bentonite not otherwise accounted for. [4]From United States Imports of Merchandise for Consumption, Report FT 110. Value is in United States dollars. Not available for 1964. [5]Includes fuller's earth but not bentonite used in construction

Symbols: — Nil; .. Not available.

Most of the domestic output is used in well drilling and consequently varies with the demands of that industry, particularly in western Canada. Because of imports for pelletizing, the proportion of the total domestic market supplied by Canadian production has been decreasing rapidly during the last few years.

As in recent years, three companies produced the most commonly used bentonites – the swelling, nonswelling and acid-activated types. About two-thirds of the total output was of the swelling type shipped from two plants in Alberta, whereas the other types were produced by one company in Manitoba. Magnet Cove Barium Corporation Ltd. recovers several grades of swelling bentonite from the Upper Cretaceous Edmonton formation near Rosalind, Alberta. The clay is dried, pulverized and sized and sold mostly for well-drilling and foundry purposes. Baroid of Canada, Ltd., recovers swelling bentonite from the same formation near its processing plant at Onoway, Alberta. The product is used principally in the well-drilling industry. The nonswelling and activated types are produced by Pembina Mountain Clays Ltd. This company recovers bentonite from the Upper Cretaceous Vermilion River formation near Morden and processes it at Morden for miscellaneous purposes. Much is shipped to the company's Winnipeg plant for activation and eventual sale as bleaching clay for decolourizing animal, vegetable and mineral oils. Much of the activated bentonite is exported to the United States.

TABLE 2

Bentonite – Imports and Consumption, 1955–64

	Imports[1]		Consumption	
	(Short Tons)	($)	Fuller's Earth (short tons)	Bentonite[2] (short tons)
1955	..	1,247,355[3]	1,565	28,821
1956	..	1,484,124[3]	1,783	30,562
1957	..	1,536,512[3]	1,654	26,105
1958	..	980,585[3]	1,595	23,429
1959	..	1,082,593[3]	1,369	60,258
1960	..	1,590,441[4]	..	64,871
1961	..	1,528,170[4]	..	63,268
1962	..	1,524,080[4]	..	57,237
1963	..	2,005,337[4]	..	93,512
1964	123,533[5]	1,659,076[5]	..	..

Source: Dominion Bureau of Statistics.

[1]Incomplete. [2]Statistics beginning with 1959 are due to a larger survey coverage and include fuller's earth. [3]Activated clays and clay catalysts. [4]Also includes fuller's earth and clay for use in well drilling. [5]Bentonite, activated clays and earths, and fuller's earth. Does not include bentonite not separated from other materials imported for use in drilling mud.

..Not available.

Carol Pellet Company processed imported crude bentonite for captive consumption at Labrador City, Labrador, and Arnaud Pellets is constructing a bentonite-processing plant at Pointe Noire, Quebec.

Exports of bentonite are small and usually of the nonswelling and activated types. In 1963 Canada exported 2,302 tons of activated bentonite valued at $90,422 to the United States. Adequate import statistics for bentonite became available for the first time in 1964. That year, Canada imported 123,533 tons valued at $1,659,076 in addition to small amounts of bentonite not separated from import shipments of compounds and conditioners used in drilling mud. Practically all imports came from the United States and about one-third was in the crude state, whereas activated bentonite and fuller's earth were minor in quantity. More than three-quarters of the total was of the swelling type from Wyoming and South Dakota.

CANADIAN OCCURRENCES

Canada's bentonite deposits are in western Canada in formations of Cretaceous and Tertiary age. Those in Alberta have received the most attention because of the greater proportion of swelling bentonite. In Alberta, the better types of swelling bentonite are in the Edmonton and Bearpaw Upper Cretaceous formations. Outcrops occur near such communities as Rosalind, Onoway, Camrose, Drumheller, Irvine and Dorothy.

In Manitoba, nonswelling bentonite occurs in the Vermilion River formation and the swelling and semiswelling varieties occur in the Riding Mountain formation. Both horizons outcrop at intervals between the international border near Morden and Swan River to the northwest.

In Saskatchewan, semiswelling bentonite is in Ravenscrag strata in the south-central part of the province, in the Battle formation in the southwestern part and in the Vermilion River formation in eastern Saskatchewan. Much of the bentonite in British Columbia is of Tertiary age and occurs near Princeton, Merritt, Kamloops and Clinton. Many of the deposits in these western provinces are relatively thick and extensive.

During the year there was increased interest in bentonite deposits in Manitoba, Saskatchewan and British Columbia. Bentonite from several deposits was evaluated for various uses.

CONSUMPTION AND USES

This commodity has numerous uses but normally constitutes a small part of the final product in which it is an ingredient. Practically all is used as a filler and binder although a small amount serves as an absorbent and adsorbent.

Bentonite consumption in 1963 amounted to 93,512 tons exclusive of that used in construction. This was about a two-thirds increase over that for 1962, mainly because of added requirements for iron-ore pelletizing. Comparable consumption statistics are not yet available for 1964, but it is estimated that the requirements were 123,000 tons, although apparent consumption (imports plus production minus exports) for all uses was an estimated 150,000 tons.

In 1963, for the first time, the largest amount went for pelletizing, which accounted for 40 per cent of the total. Thirty-six per cent was used by the drilling industry and 19 per cent by iron and steel foundries. About 90 per cent was of the swelling type, the only variety used in the two largest categories, ore pelletizing and well drilling.

Owing to the growing pelletizing industry, Canada's requirements will continue to expand rapidly at least for the next few years. In addition to the four iron-ore pelletizing plants that were in operation in 1963, Jones & Laughlin Steel Corporation began production in 1964 at the Adams mine near Kirkland Lake, Ontario. Arnaud Pellets and Caland Ore Company Limited started the construction of pelletizing facilities at Pointe Noire, Quebec, and at Steep Rock Lake, Ontario, respectively. The former plant went into operation during the first part of 1965. Announcements are anticipated for similar projects by at least two other companies. Consequently, Canada's consumption for ore pelletizing is estimated at 65,000 tons for 1964 and 95,000 tons for 1965. Total consumption in 1965, excluding that for construction, could reach 150,000 tons, 97 per cent of which would be of the swelling type; with the growing application of swelling bentonite in dam and other construction, the total could be even larger.

Swelling bentonite serves as a binder under normal and high-temperature conditions in the foundry and pelletizing industries. In well drilling it acts as a lubricant, keeps drill cuttings in suspension, assists in preventing the loss of drilling fluids by forming impervious coatings on drill-hole walls and, within limits, controls the viscosity of drilling fluids. Bentonite is also used to plasticize abrasive, ceramic and refractory raw mixes; as a filler in paper, rubber, pesticides, cosmetics, medicinal products, soaps and cleansers; in the grouting of subsurface water-bearing zones; and in sealing such structures as dams and reservoirs. Bentonite slurry is effective in fire-fighting. A relatively new application for bentonite slurry is becoming more popular for use in retaining walls of excavations prior to the placement of concrete or other structural materials.

Activated bentonite is used in decolourizing vegetable, animal and mineral oils, as well as beverages, syrups and other liquids. It is also employed as a catalyst in the refining of fluid hydrocarbons. Small quantities of the natural nonswelling type are used as a binder.

PRICES AND TARIFFS

The price of bentonite varies with the type, quality and quantity of shipment. In 1964 domestic drilling-quality bentonite sold for about $44 a ton at Edmonton. Other types of swelling bentonite normally command much lower prices at the producing plant. Activated bentonite commonly sells for $35 to $60 a ton at the producing plant. Prices quoted for car lots of swelling bentonite at United States mines are about $14 a ton for bags and $7 to $8 a ton for bulk.

Canadian and United States tariffs on this commodity are unchanged from 1963 and are as follows:

	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......	81¼¢		
Clays, artificially activated................	1/10¢ a pound plus 12½% ad valorem		

Bismuth

D.B. FRASER*

Bismuth is obtained in Canada as a byproduct of certain lead-zinc, molybdenum and copper ores. Nearly all production in 1964 came from three companies – The Consolidated Mining and Smelting Company of Canada Limited, which recovers refined bismuth from the treatment of lead-zinc ores at Trail, British Columbia; Molybdenite Corporation of Canada Limited, which recovers impure bismuth metal from molybdenum ore at Val d'Or, Quebec; and Gaspé Copper Mines, Limited, which recovers impure bismuth metal from flue dust in its smelting of copper concentrates at Murdochville, Quebec. Minor amounts are recovered from silver-cobalt ores of the Cobalt-Gowganda area of northern Ontario.

According to preliminary figures, bismuth production in 1964 totalled 387,000 pounds, of which 55 per cent was from British Columbia and 45 per cent from Quebec.

Information on world production of bismuth is incomplete, mainly because of the lack of data for the United States, which is a large producer but does not publish output statistics. World production in 1963, according to an estimate of the United States Bureau of Mines and including the United States figure, totalled 6,500,000 pounds. The leading producer was Peru with 1,243,000 pounds, followed by Mexico (948,000 pounds), Japan (660,000), Bolivia (504,600), Canada (359,000), Republic of Korea (350,000), Yugoslavia (195,000) and Sweden (155,000).

*Mineral Resources Division

TABLE 1

Bismuth – Production, Trade and Consumption

	1963		1964p	
	Pounds	$	Pounds	$
Production				
All forms[1]				
Quebec	201,961	355,197	173,795	310,448
British Columbia	157,099	348,760	213,418	529,277
Ontario	65	146	–	–
Total	359,125	704,103	387,213	839,725
Imports[2]				
Metal and residues				
Bolivia	4,276	3,299	..	..
United States	2,107	5,249	..	..
Total	6,383	8,548	..	..
Salts				
Britain	6,243	16,374	..	..
United States	550	2,790	..	..
Total	6,793	19,164	..	..
Exports				
Refined and semirefined metal	399,772		300,073	
Consumption				
Refined metal				
Fusible alloys and solders	31,707		32,620	
Other uses[3]	16,106		21,056	
Total	47,813		53,676	

Source: Dominion Bureau of Statistics.
[1]Refined metal from Canadian ores plus the bismuth content of bullion and concentrates exported. [2]Commencing 1964 separate import classes for bismuth not available due to statistical reclassification. [3]Includes metal used in manufacture of pharmaceuticals and fine chemicals, other alloys and malleable iron.
Symbols: p Preliminary; – Nil; .. Not available.

TABLE 2

Bismuth — Production, Exports and Consumption, 1955-64
(pounds)

	Production (all forms)[1]	Exports[2]	Consumption[3]
1955	265,896	56,000	92,000
1956	285,861	135,000	131,000
1957	319,941	143,000	55,000
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	425,012	382,182	37,200
1963	359,125	399,772	47,813
1964p	387,213	300,073	53,676

Source: Dominion Bureau of Statistics.
[1]Refined metal from Canadian ores plus the bismuth content of bullion and concentrates exported. [2]From 1954 to 1957 inclusive — refined metal; 1958 and subsequent years — refined and semirefined metal. [3]Refined metal reported by consumers.
p Preliminary.

TABLE 3

World Production of Bismuth
(pounds)

	1963
Peru	1,243,000
Mexico	948,000e
Japan	660,000e
Bolivia	504,600e
Canada	359,125
South Korea (in ore)	350,000e
Yugoslavia (metal)	194,657e
Other countries	2,240,618
Total	6,500,000*

Source: U.S. Bureau of Mines MINERALS YEARBOOK, 1963, and, for Canada, Dominion Bureau of Statistics.
*Includes United States production which is not available for publication.
e Estimate.

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DOMESTIC SOURCES

BRITISH COLUMBIA

Refined bismuth output at Trail by The Consolidated Mining and Smelting Company of Canada Limited was 112 tons* in 1964. The largest source was the lead concentrate produced at the company's Sullivan lead-zinc mine at Kimberley. Other sources were the lead concentrates from other company mines and custom shippers. Lead bullion produced from smelting these concentrates contains about 0.05 per cent bismuth. Bismuth is recovered as 99.99+ per cent pure metal from the electrolytic refining of the bullion. For use in research and in the electronics industry, this bismuth is further treated to give a purity of up to 99.9999 per cent.

QUEBEC

Molybdenite Corporation of Canada Limited in the fiscal year ended September 30, 1964, milled 277,300 tons of ore and recovered 149,088 pounds* of bismuth in impure metal ingots from its operations at Lacorne, 23 miles northwest of Val d'Or. Three principal steps are involved in the process. A bulk concentrate containing about 8 per cent bismuth is obtained by flotation. By leaching the flotation 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 98 per cent bismuth, minor amounts of lead and silver and traces of copper, iron and antimony. A new bismuth plant was built in 1964 to replace the old one, which had been damaged by acids and gases during its years of service.

Preissac Molybdenite Mines Limited, in which Molybdenite Corporation of Canada Limited has a substantial interest, prepared for mining and milling at its molybdenite-bismuth property in Preissac Township, about 20 miles west of Lacorne. A rate of 1,200 tons of ore daily was scheduled for April 1965.

Gaspé Copper Mines, Limited, recovered 58,000 pounds* of bismuth in impure metal ingots from the treatment of flue dust derived from copper-smelting operations at Murdochville.

USES AND CONSUMPTION

The main 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 with the chief additive metals being cadmium, lead and tin. Because bismuth expands on solidification and imparts expansion to its alloys, it is used in making type metal. Bismuth is an important additive

*Company annual report.

to aluminum alloys and malleable irons and steels in which it improves machinability. Another significant use is in the production of compounds for medical and cosmetic preparations.

A thermoelectric bismuth alloy – bismuth telluride – is being used increasingly in the development of nonmechanical refrigerating units. In this type of refrigeration the thermoelectric alloy produces cold when an electric current flows through in one direction and heat when the current flows in the opposite direction.

Table 4 outlines the amounts of bismuth used in its various applications in the United States in 1963 and 1964.

TABLE 4

Bismuth – United States Consumption
by Principal Uses
(pounds)

	1963	1964p
Fusible alloys	763,862	709,578
Other alloys	572,543	541,402
Pharmaceuticals	808,383	711,710
Experimental uses	6,433	6,000
Other uses	23,817	27,493
Total	2,175,038	1,996,183

Source: United States Bureau of Mines, MINERAL INDUSTRY SURVEYS, BISMUTH METAL IN THE FOURTH QUARTER, 1964.
p Preliminary.

PRICES AND TARIFFS

The Canadian price of bismuth from January to July of 1964, as quoted by The Consolidated Mining and Smelting Company of Canada Limited, for bars 99.99 per cent pure, was $2.25 a pound in lots of one ton or more and $2.50 a pound for lots of less than one ton. From July 16 to the end of the year the quoted prices were $2.50 and $2.75 a pound.

The United States price, listed by E & MJ METAL AND MINERAL MARKETS, was $2.25 a pound until July 10 when it was increased to $2.35 a pound.

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The price quoted in the METAL BULLETIN, London, England, for ton lots was 16 shillings a pound until July 10 and then 17 shillings a pound for the rest of the year.

Canadian and United States tariffs on bismuth in 1964 were as follows:

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
Bismuth metal, wrought............	18% ad val
Bismuth compounds	18% ad val

Cadmium

D.B. FRASER*

Cadmium is associated with zinc ores and to a lesser extent with lead ores. It occurs as a sulphide intimately combined with sphalerite, the zinc sulphide, and is recovered with zinc at mills that produce zinc concentrates and finally at zinc refineries as a byproduct of slab zinc production. While practically all zinc ores contain some cadmium the amount is sometimes so small that it is not considered recoverable. Canadian zinc concentrates vary in cadmium content from a negligible amount up to 0.75 per cent (15 pounds) per ton of zinc concentrate.

Production of cadmium in all forms, according to preliminary figures for 1964, was 2.5 million pounds, 42,000 pounds more than in 1963. Output in British Columbia, the source of 70 per cent of Canada's total cadmium recovery, was 11 per cent less in 1964 than in 1963. This decrease was offset by increases in Newfoundland, Manitoba and the Yukon Territory.

Refined cadmium was produced in electrolytic refineries at Trail, British Columbia, by The Consolidated Mining and Smelting Company of Canada Limited and at Flin Flon, Manitoba, by Hudson Bay Mining and Smelting Co., Limited. Output was 2,220,189 pounds, slightly less than in 1963. A third company, Canadian Electrolytic Zinc Limited, recovered cadmium in sponge form at its electrolytic zinc refinery at Valleyfield, Quebec, which was opened in October 1963 to treat Quebec and Ontario zinc concentrates. This recovery is not included in production statistics.

Canadian consumption of cadmium is small in relation to refinery production; about three quarters of output is exported. The principal markets are Britain and the United States, which together took 97 per cent of total exports in 1964. Exports of cadmium in ores and concentrates are not reported separately but are believed to be small, since the main cadmium-bearing supplies of zinc concentrates are treated at domestic refineries.

*Mineral Resources Division

The Free World's largest producers of refined cadmium are those with a large smelter capacity for zinc production. The United States is the leading producer with an output of about 10 million pounds of cadmium annually. Canada, Japan and Belgium are in a group each producing from 2 to 2.5 million pounds annually, followed by Australia, Italy, France and West Germany. Free World production in 1963, as compiled by the U.S. Bureau of Mines, was 20.5 million pounds; Russia and Poland together produced an estimated 5.8 million pounds.

TABLE 1

Cadmium – Production, Exports and Consumption

	1963		1964p	
	Pounds	$	Pounds	$
Production				
All forms[1]				
British Columbia	1,980,004	4,752,010	1,756,580	5,691,319
Quebec	43,546	104,510	28,462	92,217
Newfoundland	–	–	214,900	696,276
Manitoba	183,110	439,464	203,733	611,199
Yukon Territory	135,885	326,124	192,522	577,566
Saskatchewan	132,940	319,056	121,464	364,392
Total	2,475,485	5,941,164	2,517,661	8,032,969
Refined[2]	2,353,815		2,220,189	
Exports				
Cadmium metal				
Britain	1,306,465	2,957,358	1,137,725	3,726,684
United States	584,929	1,375,682	441,117	1,327,774
India	33,390	90,694	21,141	73,925
Netherlands	–	–	10,044	33,061
Italy	–	–	6,328	21,961
Belgium and Luxembourg	–	–	4,500	17,300
Other countries	14,326	33,380	2,824	10,690
Total	1,939,110	4,457,114	1,623,679	5,211,395
Consumption (cadmium metal)[3]				
Plating	185,251		141,099	
Solders	19,645		19,914	
Other products[4]	3,700		17,115	
Total	208,596		178,128	

Source: Dominion Bureau of Statistics.

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

Symbols: p Preliminary; – Nil.

TABLE 2

Cadmium – Production, Exports and Consumption, 1955-64
(pounds)

	Production		Exports Cadmium Metal	Consumption[3]
	All Forms[1]	Refined[2]		
1955	1,919,081	1,714,000	1,562,337	220,000
1956	2,339,421	1,932,000	1,922,685	206,000
1957	2,368,130	2,018,000	1,941,680	177,000
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
1964p	2,517,661	2,220,000	1,623,679	178,000

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

TABLE 3

World Production of Cadmium Metal
('000 pounds)

	1963
United States	9,990
U.S.S.R.	4,850e
Canada	2,475
Japan	2,185e
Belgium	2,000e
Poland	930
Other countries	3,870
Total	26,300

Source: U.S. Bureau of Mines MINERALS YEARBOOK 1963 and, for Canada, Dominion Bureau of Statistics.

e Estimate.

Following the sale in 1963 of 2 million pounds of cadmium from the National Stockpile to domestic consumers, the United States government in June 1964 authorized the release of a further 5 million pounds, the disposal to be made in quarterly amounts of 600,000 pounds over a two-year period. By the end of 1964 only about 23,000 pounds had been sold, indicating that the shortage of cadmium that had prevailed during 1963 had been largely relieved. Total U.S. government stocks at December 31, 1964, were 15,148,000 pounds, of which 10,048,000 pounds were surplus to the maximum objective of 5,100,000 pounds. United States consumption is between 10 and 12 million pounds annually.

DOMESTIC SOURCES

BRITISH COLUMBIA

The main source of cadmium is the lead-zinc-silver ore of the Sullivan mine at Kimberley, operated by The Consolidated Mining and Smelting Company of Canada Limited (COMINCO). Byproduct cadmium was produced also at other COMINCO mines – the H.B. and the Bluebell – and at other zinc mines in the province. Most of the mine output was recovered as refined cadmium at Trail where production in 1964 was 945 tons, 74 tons less than the previous year.

YUKON TERRITORY

The only producer was United Keno Hill Mines Limited, which mined silver-lead-zinc ore at Elsa, 200 miles north of Whitehorse. Production in the calendar year 1964 totalled 197,782 pounds of cadmium in concentrates.

TABLE 4

Principal Mine Producers of Cadmium, British Columbia, 1964

Company	Location of Mine	Cadmium Production (pounds)
COMINCO	Kimberley (Sullivan mine)	736,200
	Salmo (H.B. mine)	344,000
	Riondel (Bluebell mine)	132,500
The Anaconda Company (Canada) Ltd.	Britannia	19,600
Canadian Exploration, Limited	Salmo	223,500
Mastodon-Highland Bell Mines Limited	Beaverdell	5,600
Reeves MacDonald Mines Limited	Remac	161,100
Sheep Creek Mines Limited	Toby Creek	51,300

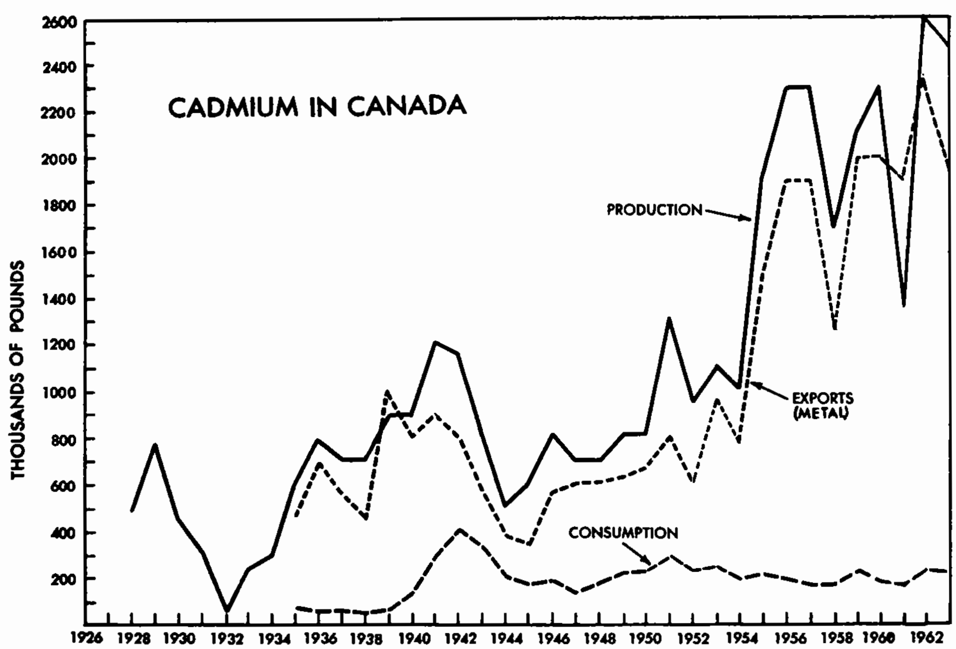
SASKATCHEWAN AND MANITOBA

Hudson Bay Mining and Smelting Co., Limited, produced 329,552 pounds of metallic cadmium, 13,500 more than in 1963, in its electrolytic cadmium refinery at Flin Flon. The source was the company's mines (Flin Flon, Chisel Lake, Stall Lake, Coronation and Schist Lake) at Flin Flon and Snow Lake.

EASTERN CANADA

Canadian Electrolytic Zinc Limited at Valleyfield, Quebec, recovered cadmium sponge from the treatment of zinc concentrates from the Matagami Lake and Noranda districts of Quebec and from Manitouwadge, Ontario. The sponge or precipitate is obtained during the purification stage preceding the electrolysis of zinc-bearing solutions.

Of the cadmium exported from eastern Canada in zinc concentrates, the cadmium content was reported only when it was paid for. The amount so reported was 28,000 pounds from Quebec mines and 214,900 pounds from Newfoundland mines.



USES

The main use of cadmium is as an anticorrosive coating applied by electroplating to steel and, to a lesser extent, to copper-base alloys. Like zinc coatings, cadmium coatings on less active metals protect the metals electrochemically as well as by physical enclosure. Thus, metals that are commonly used as protective coatings, other than cadmium and zinc, must be applied in greater thicknesses to give the same protection. Cadmium is preferred to zinc as a coating because it can be deposited more uniformly especially in recesses of intricately shaped parts, is more ductile, is slightly more resistant to atmospheric corrosion and can be electrodeposited with less electric current per unit of area covered.

Cadmium-plated articles include a wide range of parts and accessories used in the construction of aircraft, automobiles, military equipment and household appliances.

The second-largest use is in the manufacture of pigments. Cadmium sulphides give yellow to orange colours while cadmium sulphoselenides give pink to red and maroon. Cadmium pigments are valued for their clarity and brilliance and for their chemical stability.

Cadmium is also used in making solders, particularly of the cadmium-silver type. Low-melting-point fusible alloys of the cadmium-tin-lead-bismuth type have long been used in automatic sprinkler systems, fire-detection apparatus and valve seats for high-pressure gas containers. Owing to its high strength, high conductivity, ductility and resistance to wear, low-cadmium copper (about 1 per cent) is used in the manufacture of trolley and telephone wires. Cadmium is also used in devices to control the fissionable elements in atomic reactors. Cadmium, because it has a hardening effect when small amounts are added to silver, is used in the manufacture of sterling silverware.

Production of nickel- and silver-cadmium storage batteries is an important outlet for cadmium. These batteries have a longer life than the standard lead-acid battery, are smaller and are superior during low-temperature operation. Because of these characteristics, they are being used in airplanes, earth 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 AND TARIFFS

The Canadian price of cadmium f.o.b. Montreal and Toronto throughout 1964 was $3.25 a pound in lots of 5,000 pounds or more, $3.45 a pound in lots under 5,000 pounds. The United States price throughout 1964 according to E & MJ METAL AND MINERAL MARKETS was $3 a pound in one-ton lots, $3.05 a pound in less than one-ton lots.

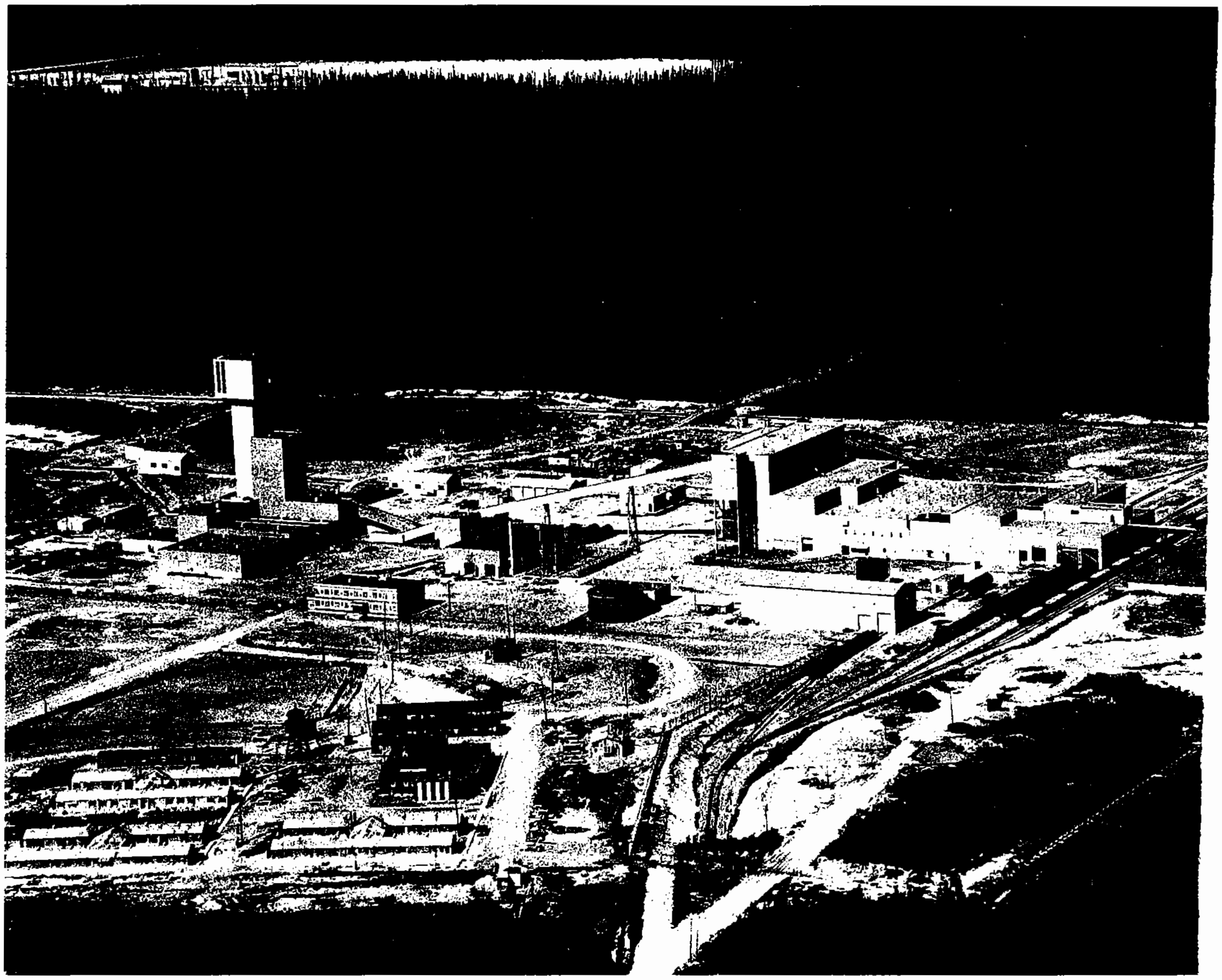
Tariffs in Canada and the United States during 1964 were as follows:

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

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

98115—9½



Mattagami Lake Mines property.

Calcium

W.H. JACKSON*

Commercial shipments of calcium metal were consigned mainly to export markets, because Canadian demand is only a few hundred pounds a year in lead-calcium alloys. Current world demand for calcium is low but an increase in consumption is likely as more diversified uses are further developed and more widely adopted. Such uses include the desulphurization of steels, the production of calcium hydride and of lead-calcium alloys for battery plates.

Dominion Magnesium Limited is the only Canadian producer of calcium. The metal is made with the same equipment and by methods similar to those used for the production of magnesium, which is the main product of the company at its Haley, Ontario, smelter. Thorium, titanium, zirconium and small quantities of strontium and barium are also produced at Haley. The company reported that calcium shipments from its smelter were 138,358 pounds compared with 98,647 pounds in 1963.

To produce Grade 4 calcium, purchased high-purity powdered lime 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 vapor condenses as crystalline rings in a temperature range of 680 to 740°C. Higher purities are obtained by subsequent refining operations.

The five grades of calcium metal available from Haley range in purity from the 95 per cent of Grade 5 to the nominal 99.9 per cent of Grade 1. The maximum allowable impurities in Grade 4 are 0.5 to 1.5 per cent magnesium, 1.0 per cent nitrogen and 0.35 per cent aluminum. They become progressively less in other grades and are present only in trace amounts in Grade 1 which is available only in the form of granules in the size range of minus 4 to plus 80 mesh. Grade 4 is available as crystal lumps, granules of minus 4 mesh, extruded rods and bars, cast billets and five-pound ingots.

*Mineral Resources Division

TABLE 1

Commercial Grades and Typical Applications of Calcium

Grade	Purity	Uses
1	chemical standard 99.9% Ca	chemicals, isotope separation
2	nuclear quality 99.9% Ca + Mg	reducing agent, alloy additive
3	low nitrogen	manufacture discontinued
4	commercial 98% Ca	debismuthizing lead, calcium hydride production
5	95% Ca	steel additive

TABLE 2

Canadian Calcium Production and Exports, 1963–64

	1963		1964p	
	Pounds	$	Pounds	$
Production, metal*	98,673	117,247	158,875	174,762
Exports (metal)				
United States	26,100	32,969	135,300	58,535
Belgium and Luxembourg	13,300	11,015	15,600	9,815
West Germany	19,300	22,700	15,400	14,000
India	16,100	23,667	14,600	20,174
Netherlands	—	—	13,200	14,881
Britain	9,600	11,663	9,600	13,702
Japan	—	—	7,000	6,244
Other countries	7,700	7,055	100	330
Total	92,100	109,069	210,800	137,681

Source: Dominion Bureau of Statistics
* Smelter use and shipments
Symbols: p Preliminary; — Nil.

TABLE 3

Calcium Production and Exports, 1956–64
(pounds)

	Production*	Exports
1956	394,900	499,300e
1957	221,225	60,500e
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
1964p	158,875	210,800

Source: Dominion Bureau of Statistics.

*Production from 1956 to 1960 inclusive; shipments from 1961.

Symbols: e Estimated; p Preliminary.

Production figures by country are not available. Dominion Magnesium is an important commercial source of calcium. Calcium is produced in France by Société Planet and in the United States by Nelco Metals Inc., Div. of Charles Pfizer Company, whose output is mainly used as a reducing agent. There is also a small amount of captive production in the United States by American Smelting and Refining Company and Union Carbide Metals Company.

USES

Calcium metal is a reducing agent used in the manufacture of uranium, thorium and their compounds. The metal can also be used to reduce chromium, vanadium, zirconium, titanium and beryllium.

In nonferrous metallurgy, the main uses are in debismuthizing lead in fire refining and as a lead alloy additive for storage battery grids. For the latter use an alloy comparable to one containing 8 per cent antimony contains only 0.1 per cent calcium but has better conductivity, resistance to sulphation and similar hardness. Such high-quality batteries are standard for telephone transmission systems but the use does not yet extend to automobile-type batteries where new and recycled antimonial lead is the basis of manufacturing. A similar additive application in lead alloys is for cable sheaths to improve their strength, fatigue-resistance and hardness. Minor amounts are used for deoxidizing, for general alloying mainly with aluminum and magnesium, and with silver in the preparation of catalysts.

In ferrous metallurgy, calcium-silicon or calcium-manganese-silicon are the common additives. These low-cost alloys are made by reducing a charge of lime and silica in an electric furnace. The calcium helps to deoxidize, desulphurize and scavenge the steel melt, reduces the effect of nonmetallic impurities in steel and controls the size and distribution of graphitic carbon in cast iron. Higher-cost calcium metal is desirable when impurity control is important and this use for the metal is expanding.

In chemical processes, it is an absorbant for oxygen, nitrogen and hydrogen in purifying argon and other rare gasses. It is also used for sulphur removal in petroleum products, for high-purity chemicals and in isotope separation. The manufacture of calcium hydride is a major outlet for world production. It is used as a portable source of hydrogen gas and as a reducing agent. Demand is variable owing to changing defence requirements.

PRICES

The Canadian prices quoted by Dominion Magnesium Limited throughout 1964 ranged from 80 cents a pound for Grade 4 to $3.50 a pound for Grade 1 f.o.b. Haley. As indicated by the export data, the less pure grades are the most in demand.

The nominal price for calcium, 97 to 98 per cent pure quoted in New York as reported by *E & MJ Metal and Mineral Markets* was $2.05 a pound in ton lots, slabs.

TARIFFS

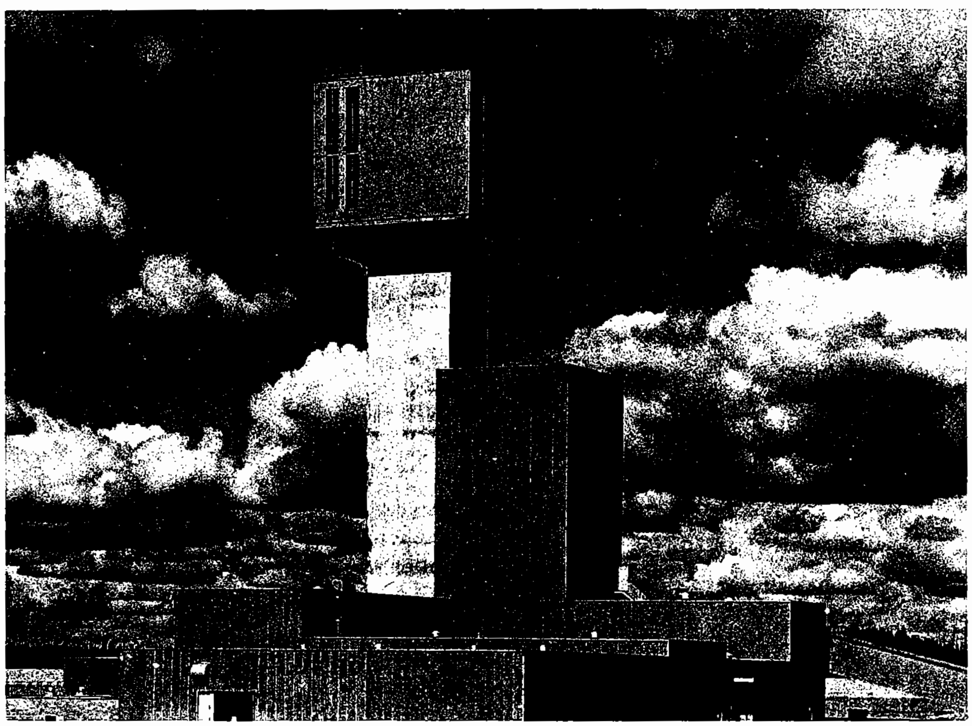
	British Preferential (%)	Most Favoured Nation (%)	General (%)
CANADA			
Calcium metal, pure, in lumps, ingot, powder*	free	15	25
Calcium metal alloys, or calcium metal in rods, sheet or any semi-processed form	15	20	25

UNITED STATES

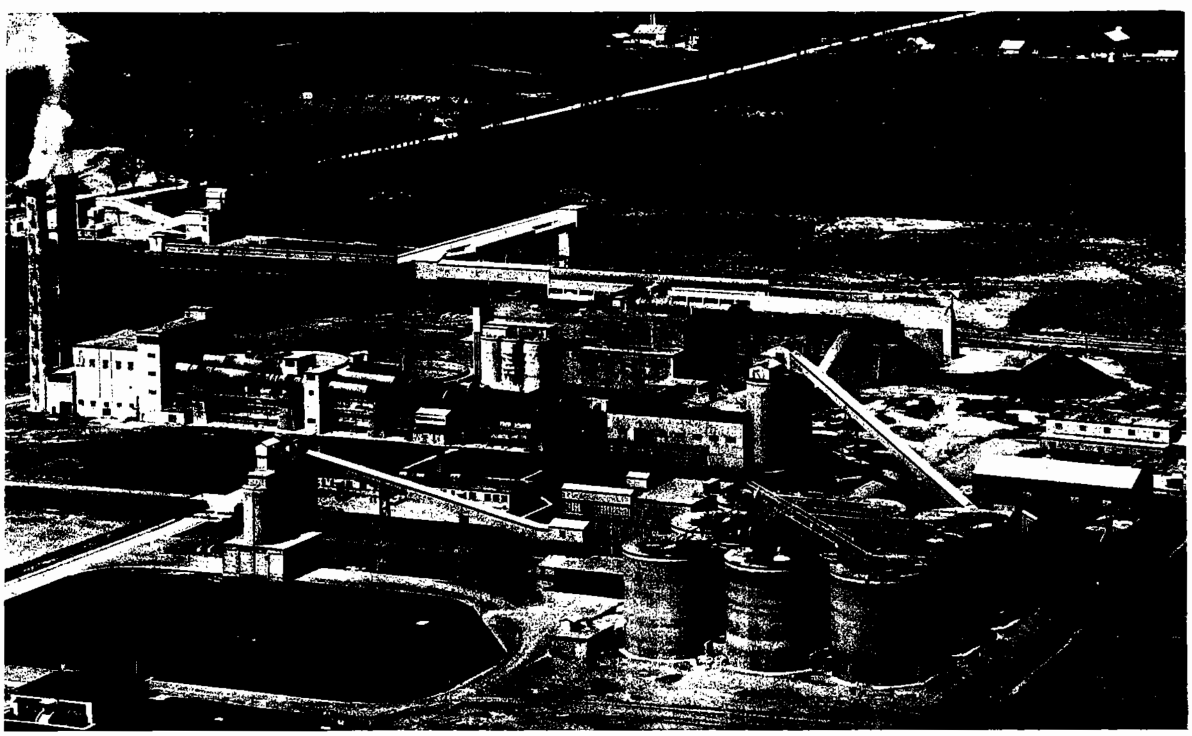
Calcium metal, unwrought	15%
Calcium metal, wrought	18%

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

Mattagami Lake Mines Ltd., Mattagami, Quebec, showing the headframe and auxilliary buildings. The room at the top of the concrete headframe houses the friction-type hoist.



The Woodstock, Ontario cement plant of Canada Cement Company, Limited. Its two 450-foot kilns have a rated output capacity of 3.4 million barrels of cement a year.



Cement

J.S. ROSS*

Cement production increased appreciably to a new record in 1964 and rose from eleventh to ninth place in the value of Canadian mineral production. Shipments were higher from every province but Manitoba and more than half the gain was registered in Ontario. At the same time, the cement industry undertook considerable expansion of production facilities.

Major expansion and new plant construction amounting to $40 million took place at clinker-producing facilities in Newfoundland, Nova Scotia, Quebec, Ontario and Manitoba. Of the seven plants involved, two are new. Work was completed at two plants, continued at two and was started at three others. Consequently in 1964, Canada's annual production capacity of cement at clinker-producing plants increased by 5 per cent to 57.2 million barrels. The industry operated at a moderately high 79 per cent of this year-end capacity as compared with 73 per cent for 1963.

In addition, announcements have been made for construction to start in 1965 on two new plants, on expansion of three others and on a new separate grinding plant.

Construction underway or planned during 1964 is scheduled to increase Canada's annual production capacity by 9.6 million barrels in 1965 and by 2.6 million barrels in 1966. Consequently, capacity should reach 69.3 million barrels a year in 1966, an increase of 21 per cent over that of 1964.

A gradual trend continues toward the establishment of more cement-distribution facilities in western Canada. In this region, the distances between cement-producing plants are relatively great and the long haulage distances and competition between producers have encouraged the construction of distribution plants.

*Mineral Processing Division, Mines Branch

One such terminal went into operation in Saskatchewan and a separate cement-finishing plant is scheduled for construction in that province. A new cement-distribution plant was built in Quebec.

The forecast for 1965 is for another year of record production resulting in the absorption of about half the scheduled increase in production capacity for that year.

TABLE 1

Cement—Production and Trade

	1963		1964_p	
	Short Tons	$	Short Tons	$
Production[1]				
By province				
Ontario	2,552,665	39,551,719	2,975,590	47,768,953
Quebec	2,330,641	36,938,775	2,582,781	41,755,259
Alberta	727,122	13,713,527	771,361	14,777,775
British Columbia	476,071	8,546,768	538,467	10,104,465
Manitoba	455,325	9,684,760	364,421	7,839,789
Saskatchewan	217,545	5,672,084	240,000	5,996,100
New Brunswick	161,833	2,658,949	176,584	2,947,363
Newfoundland	92,460	1,848,347	95,312	1,897,662
Total	7,013,662	118,614,929	7,744,516	133,087,366
Final	7,013,662	118,614,929	7,910,321[2]	..
By type				
Portland	6,818,276	114,786,857	7,684,958[2]	..
Masonry	195,369	3,827,804	225,344[2]	..
Other	17	268	19[2]	..
Total	7,013,662	118,614,929	7,910,321[2]	133,087,366
Exports				
Portland cement				
United States	272,803	4,201,720	288,206	4,538,001
Ceylon	—	—	8,400	127,630
Ghana	—	—	1,063	23,009
Total	272,803	4,201,720	297,669	4,688,640
Cement and concrete products				
United States		280,231		306,495

Table 1 (Cont.)

	1963		1964p	
	Short Tons	$	Short Tons	$
Imports[3]				
Portland cement				
United States	54	1,648	250	5,862
Britain	56	1,049	—	—
Netherlands	50	1,030	—	—
Total	160	3,727	250	5,862
White cement				
United States	586	34,009	5,232	236,055
Britain	4,193	131,470	4,340	136,243
Denmark	3,025	94,046	4,034	119,965
Belgium and Luxembourg	5,851	170,952	2,836	86,846
Japan	2,149	50,966	2,193	58,530
France	2,046	57,205	1,418	41,642
West Germany	2,953	101,681	1,269	45,172
Mexico	—	—	31	797
Total	20,803	640,329	21,352	725,250
Cement, not elsewhere specified				
Britain	7,871	265,555	7,054	242,064
United States	1,192	118,868	2,383	205,307
West Germany	1,542	83,792	1,641	94,233
Yugoslavia	11	347	—	—
Total	10,616	468,562	11,078	541,604
Total cement imports	31,579	1,112,618	32,680	1,272,716
Refractory cements and mortars[4]				
United States				1,143,852
Ireland				42,339
Norway				8,002
Britain				4,887
West Germany				2,683
France				1,320
Total				1,203,083

Table 1 (cont.)

	1963		1964	
	Short Tons	$	Short Tons	$
Cement and concrete basic products, not elsewhere specified				
United States		250,252		231,573
Netherlands		–		19,287
West Germany		–		4,500
Britain		301		2,006
Mexico		201		1,566
Italy		7,149		–
Total		257,903		258,932
Cement clinker				
United States	18,168	469,479	17,317	446,921
France	263	7,320	–	–
Total	18,431	476,799	17,317	446,921

Source: Dominion Bureau of Statistics.

[1] Producers' shipments plus quantities used by producers. [2]Compilation of monthly shipments as reported by companies but subject to minor revision. [3]The new import classification system went into effect in 1964 resulting in some classes not being completely comparable with previous years. [4]Not available as a separate class prior to 1964.

Symbols: p Preliminary (for production only); – Nil: .. Not available.

TABLE 2

Cement – Production, Trade and Consumption, 1955–64

(short tons)

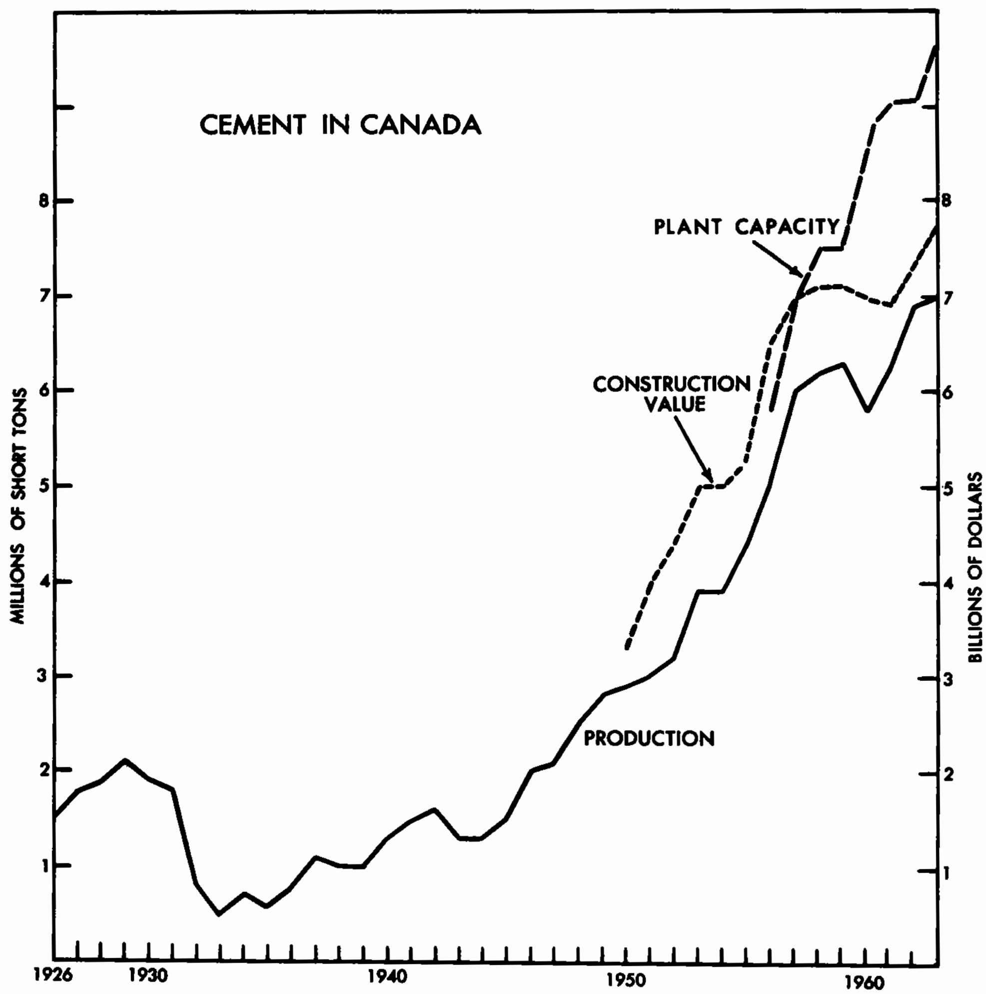
	Production[1]	Exports[2]	Imports[2]	Apparent Consumption[3]
1955	4,404,480	168,907	517,890	4,753,463
1956	5,021,683	124,566	599,624	5,496,741
1957	6,049,098	338,316	92,380	5,803,162
1958	6,153,421	141,250	41,555	6,053,726
1959	6,284,486	303,126	29,256	6,010,616
1960	5,787,225	181,117	22,478	5,628,586
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	7,910,321[4]	297,669	32,680	7,645,332

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. [4]Subject to minor revision.

PRODUCTION

Portland, masonry and oil-well cement, and white cement from imported clinker are produced in Canada. Small amounts of special cements are also sold. Most of the output is of normal portland cement, although other types of portland cement have been produced in increasing amounts in recent years owing to additional activity in dam construction and in concrete products. In 1964, 97 per cent of shipments was of the portland type and practically all the rest was of masonry cement.



Cement shipments reached major proportions in 1964, amounting to a record 7,910,321 tons. Statistics indicate that the preliminary output value of 7.7 million tons was $133,087,366, placing cement ninth in the value of Canada's mineral production. This represents an increase of 13 per cent in quantity and 12 per cent (preliminary) in value over 1963. Although most of the increase was in Ontario and Quebec, all provinces except Manitoba registered increased output. Ontario and Quebec, with almost two-thirds of Canada's population, accounted for 72 per cent of the output.

Cement was produced in all provinces except Prince Edward Island and Nova Scotia. However, the latter province is scheduled to begin shipments in mid-1965. In 1964, cement clinker was produced at 19 plants containing 47 kilns. Fifteen of these operations employed the wet process and four used the dry method. These plants are listed in Table 3 and their locations are indicated on the accompanying map. Eleven are in Ontario and Quebec and account for 67 per cent of the total rated capacity. In 1963, the raw materials consumed in the production of cement included 9,384,412 tons of limestone, 1,025,896 tons of clay, 323,234 tons of gypsum, 297,265 tons of shale, 262,382 tons of high-silica rock and 35,483 tons of iron oxide.

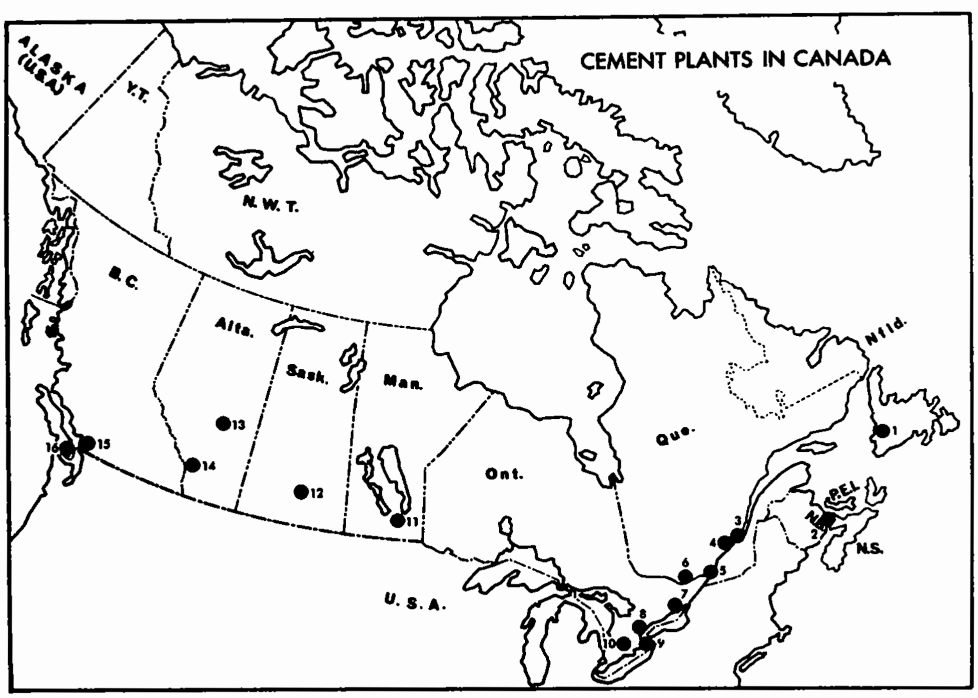


TABLE 3

Approximate Cement-Plant Capacities[1] at End of 1964
(Numbers in parentheses refer to locations on the accompanying map.)

Company and Location	Barrels per Year	Short Tons per Year[2]
Newfoundland		
North Star Cement Limited, Corner Brook (1)	600,000	105,000
New Brunswick		
Canada Cement Company, Limited, Havelock(2)	1,000,000	175,000
Quebec		
St. Lawrence Cement Company, Villeneuve(3)	2,000,000	350,000
Ciment Québec Inc., St. Basile(4)	2,500,000	438,000
Miron Company Ltd., St. Michel(5)	4,000,000	700,000
Canada Cement Company, Limited, Montreal(5)	8,000,000	1,400,000
Canada Cement Company, Limited, Hull(6)	1,200,000	210,000
Ontario		
Lake Ontario Cement Limited[3], Picton(7)	2,600,000	455,000
Canada Cement Company, Limited, Belleville(7)	4,400,000	770,000
St. Lawrence Cement Company, Clarkson(8)	4,200,000	735,000
Canada Cement Company, Limited, Port Colborne(9)	1,200,000	210,000
Canada Cement Company, Limited, Woodstock(10)	3,400,000	595,000
St. Mary's Cement Co., Limited, St. Mary's(10)	4,250,000	744,000
Manitoba		
Canada Cement Company, Limited, Fort Whyte(11)	5,200,000	910,000
Saskatchewan		
Saskatchewan Cement Company Limited, Regina(12)	1,300,000	228,000
Alberta		
Inland Cement Company Limited, Edmonton(13)	3,400,000	595,000
Canada Cement Company, Limited, Exshaw(14)	3,100,000	542,000
British Columbia		
Lafarge Cement of North America Ltd., Lulu Island(15)	1,500,000	262,000
Ocean Cement Limited, Bamberton(16)	3,300,000	577,000
Total	57,150,000	10,001,000

Source: Correspondence with companies.

[1]Not including the capacities of the separate grinding plants. [2]Calculated. [3]Previously Lake Ontario Portland Cement Company Limited.

TABLE 4

Cement – Rated Production Capacity[1], 1956–64

	No. of Plants[2]	No. of Kilns[2]	Approximate Capacity[2] (barrels /year)	Approximate Capacity[2] (short tons /year)	Av. Capacity[2] per Plant (million bbl./year)	Av. Capacity[2] per Kiln (million bbl./year)	Production (shipments) (short tons)	Production as % of Year-end Capacity
1956	16	34	33,300,000	5,827,500	2.08	0.98	5,021,683	86
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	7,910,321[4]	79
1965[3]	21	52	66,710,000					
1966[3]	22	54	69,260,000					

[1]Of clinker-producing plants. [2]At year-end. [3]Scheduled to date. [4]Subject to revision.

TABLE 5

World Production of Cement, 1963

(short tons)

United States	69,260,328
U.S.S.R.	67,240,268
Japan	33,011,672
West Germany	32,205,904
Italy	24,347,692
France	19,620,996
Britain	15,432,168
India	10,311,988
China	9,920,760
Poland	8,454,736
Spain	7,875,884
Canada	7,013,662
Other countries	109,121,834
Total	413,817,892

Source: U.S. BUREAU OF MINES MINERALS YEARBOOK, 1963.

The history of Canada's production capacity since 1956 is summarized in Table 4. In that period, average rated plant capacity increased 45 per cent whereas average kiln capacity increased 25 per cent, indicating a trend towards more kilns per plant and higher productivity per kiln. In the last three years the industry has operated at a moderately substantial rate for an industry that experiences large seasonal fluctuations in the demand for its products.

In addition, a separate clinker-grinding or cement-finishing plant was operated at Clover Bar, Alberta, by Canada Cement Company, Limited. Medusa Products Company of Canada, Limited, grinds imported clinker at Paris, Ontario, for the production of white cement.

In world output, Canada ranked twelfth in 1963, but produced less than 2 per cent of the total. World output reached a record 414 million short tons with the United States, Russia, Japan and West Germany the leading producers in that descending order.

TRADE

Although cement is traded between most nations, only a minor proportion of world production undergoes international trade. Because most nations have the raw materials for cement manufacture, they are virtually self-sufficient in the main product, the normal portland type. For instance, 1963 exports and imports for the world's largest producer, the United States, were respectively 0.1 and 1.1 per cent of that country's production. For Canada, these proportions were 3.8 and 0.4 per cent in 1964. Canada's exports increased slightly over the previous year to 297,669 tons valued at $4,688,640. Practically all went to the United States. Canada supplied about one-third of the imports into the United States, mainly to New York State. Imports continued to be insignificant in proportion to production. However, they were mostly of white and other special cements from United States and Britain having a high unit value and amounting to 32,680 tons valued at $1,272,716. In addition, Canada imported refractory cements and mortars valued at $1,203,083 and 17,317 tons of white cement clinker valued at $446,921.

DEVELOPMENTS

For the second successive year this industry experienced considerable expansion activity, which is scheduled to continue at least into 1966. To summarize these main developments, in 1964 expansion was completed at two plants, construction started at one new plant and at two established operations, and work was scheduled for one new and on four established plants in addition to a separate grinding plant. In 1965, Nova Scotia will be the ninth province to produce cement. New Brunswick's output capacity is scheduled to double in 1966 and Quebec is to have its sixth cement plant that year. Manitoba will have a second producer in 1965 and a rated capacity of about three times 1964 shipments. Plans have been announced for Saskatchewan's second cement-finishing plant and a tentative announcement has been made concerning a third producer for British Columbia. These additions will involve at least seven new kilns and should increase Canada's output capacity for 1966 by 21 per cent over that of 1964.

During 1964, Canada Cement and St. Mary's Cement each installed a kiln at Fort Whyte and St. Mary's, respectively. Construction of the new plant of British-American Construction at Rosser, Manitoba, was discontinued early in 1964 as a result of the purchase of the plant by Inland Cement. Work was started on the new one-kiln plant of Inland Cement at Tuxedo and continued at the new plant of Maritime Cement. One-kiln expansions are being made by St. Lawrence Cement at Villeneuve and Lake Ontario Cement. North Star Cement began to convert its facilities for dry processing and for increased capacity. These expansions were in addition to the usual smaller alterations and additions made to accessory facilities.

Canada Cement completed construction of a $1 million storage and packing facility at Floral, Saskatchewan. This development was the first planned by this company at Floral. A $4.5-million grinding plant is scheduled for the site in 1966.

Ciment Québec added new packing and storage facilities amounting to $1 million and St. Lawrence Cement built a new distribution plant at Jacques Cartier, Quebec.

For the first time in several years no new major integration of cement and concrete-products companies took place.

During the year, the Portland Cement Association established five new offices in Canada at Edmonton, Toronto, Ottawa, Montreal and Halifax. Headquarters are at Ottawa. A sixth office, at Vancouver, was established in 1920.

TABLE 6

Cement – Plant Expansion

Company and Location	Capacity Increase (million barrels/year)	Year Started	Year Scheduled for Completion	Approximate Cost ($ million)
NEWFOUNDLAND				
North Star Cement	0.26[2]	1964	1965	3.5
NOVA SCOTIA				
Maritime Cement Company Limited, Brookfield	1.4[1]	1963	1965	12
NEW BRUNSWICK				
Canada Cement, Havelock	1.0[2]	1965[3]	1966	4
QUEBEC				
St. Lawrence Cement, Villeneuve	2.4[2]	1963	1965	5
Miron Company, St. Michel	2.2[2]	1965[3]	1965	9
Independent Cement Inc., Joliette	1.25[1]	1965[3]	1966	7
ONTARIO				
Lake Ontario Cement, Picton	1.8[2]	1964	1965	6
St. Mary's Cement, St. Mary's	0.75[2]	1963	Completed 1964	..
MANITOBA				
Canada Cement, Fort Whyte	1.8[2]	1963	Completed 1964	4
Inland Cement, Tuxedo	1.5[1]	1964	1965	9
British-American Construction & Materials Limited, Rosser	1.0[1]	1963	Discontinued 1964	8
SASKATCHEWAN				
Canada Cement, Floral	(Grinding Plant)[1]	1965[3]	1966	4.5
BRITISH COLUMBIA				
Lafarge Cement, Lulu Island	0.3[2]	1965[3]	1966	..
Peace River Cement Limited[4], Prince George	1.0[1]	1965(?)	?	12

[1]New plant. [2]Expansion. [3]Scheduled. [4]Tentative.

.. Not available.

CONSUMPTION AND USE

Because practically all cement is used as a construction material, its consumption, and thus production, varies directly with construction expenditures. This relationship is indicated by the accompanying graph. For 1964, the preliminary estimate of new and repair construction in Canada increased to $8.7 billion, an appreciable 12 per cent over the actual value of construction for 1963. For the same period, cement shipments and apparent consumption each increased 13 per cent. For 1965, the Dominion Bureau of Statistics has forecast another record expenditure for new and repair construction amounting to $9.8 billion, a noteworthy rise of 13 per cent. Consequently, cement consumption, and thus production, should also attain a respectable record to counterbalance much of the sheduled increase in output capacity.

TABLE 7

Destination of Domestic Cement Shipments*, 1964

(short tons)

Ontario	2,788,061
Quebec	2,598,251
Manitoba, Saskatchewan, Alberta and British Columbia	1,823,255
Newfoundland, Prince Edward Island, Nova Scotia, New Brunswick	367,894
Yukon and Northwest Territories	9,701
Total	7,587,162
Exports	273,498
Total shipments	7,860,660

Source: Dominion Bureau of Statistics.

*Only direct sales from producing plants.

The destination of domestic cement shipments is depicted by Table 7. Ontario and Quebec are by far the largest consuming provinces and both experienced the greatest increase in consumption in 1964. The gain in Ontario was due mainly to general construction. In Quebec, It was mainly the result of construction in the Montreal area and by the Quebec Hydro-Electric Commission at the Manicouagan-Outardes River hydroelectric project. This project, to be completed about 1974 at a cost of $2 billion will be one of the world's largest power-dam complexes, involving five dams. Construction on the World's Fair (Montreal) project and on access facilities to the fair will consume increasingly larger amounts of cement until 1967.

Cement consumption in British Columbia remained at a high level because of continued requirements by the Peace River hydroelectric project.

The use of soil-cement for road bases continues to increase at a slow rate. Alberta is by far the largest user but the Maritime provinces and Saskatchewan are gradually using the application more extensively.

Cement is used to stabilize hydraulically-placed fill in underground mines. Although it was first employed on a large scale as recently as 1962, the application has become an important outlet for producers, particularly in Ontario. This commodity is also used in the construction of permanent stope floors in underground mining.

Cement is also used in grouting, in cementing oil and gas wells, in certain paints and in the manufacture of asbestos-cement products.

Statistics are not available to provide a breakdown of consumption by use. However, most cement is used in general construction. About half is consumed in the manufacture of concrete products such as ready-mixed concrete, blocks, bricks, pipe, tile and other shapes. More than one-third of cement output goes into the production of ready-mixed concrete. The proportion of the total consumption used for ready-mixed concrete and other concrete products has been increasing steadily in the last few years. In 1964 the output of all categories increased appreciably over 1963. In terms of the quantity of cement consumed, the 21-per-cent increase in ready-mixed concrete is noteworthy.

TABLE 8

Production of Concrete Products

		1963	1964
Concrete bricks	(no.)	97,541,366	103,145,400
Concrete blocks (except chimney blocks)			
Gravel	(no.)	116,374,946	133,037,916
Cinder	(no.)	5,428,494	8,512,121
Other	(no.)	28,522,704	35,304,673
Concrete drain pipe, sewer pipe, water pipe and culvert tile	(tons)	999,157	1,667,204
Concrete, ready mixed	(cu. yd.)	9,825,703	11,845,196

Source: Dominion Bureau of Statistics.

SPECIFICATIONS, PRICES AND TARIFFS

Cement produced in Canada conforms to the specifications of the Canadian Standards Association. The types not covered by the association generally meet specifications of the American Society for Testing and Materials.

Prices vary depending on supply and demand, quantity of shipment, location and type of cement. In 1964, the average value of producers' shipments for all types was $17.18 a ton (preliminary) compared with $16.91 in 1963. It ranged from a low of $16.05 in Ontario up to $24.98 in Saskatchewan. The latter province has only one producer and imports all its limestone raw material.

Canadian import tariffs per 100 pounds, unchanged from 1962, were as follows:

	British Preferential (¢)	Most Favoured Nation (¢)	General (¢)
Portland cement and hydraulic (water) lime, in bulk or barrels or in casks, the weight of the barrel, bag or cask to be included in the weight for duty	5	8	8
White portland-cement clinker for use in the manufacture of white portland cement........................	2	3½	6

The United States import tariff on portland, roman and other hydraulic cements and cement clinker remained at 2¼ cents per 100 pounds including the weight of the containers. For white, nonstaining portland cement it is 3 cents per 100 pounds including the weight of the containers.

Chromium

V.B. SCHNEIDER*

Chromium content of chromium ore (chromite) imported in 1964 amounted to 20,794 tons valued at $1.6 million, a decrease of $101,000 from 1963. A quantity comparison with previous years' imports is not possible because in 1964 for the first time the Dominion Bureau of Statistics reported chromium content of imported chromite instead of the gross weight of chromite. However, a comparison based on dollar values and allowing for a slight decline in ore prices in 1964 indicates that imports for 1964 were equal to or only slightly less than those of 1963.

Consumption of chromite in 1964 was 57,734 tons, compared with 56,016 tons in 1963. Ferrochromium consumption amounted to 11,212 tons containing 6,664 tons of chromium metal. Chromium ore on hand as of December 31, 1964, was 44,095 tons, down some 3,000 tons from a year earlier.

Canadian ferrochromium producers continued to be harrassed by imports from Africa and Europe where the manufacturers have much lower labour costs and in the case of The Republic of South Africa and Rhodesia, also have much cheaper raw material costs. It requires slightly more than 2 tons of chromite to produce 1 ton of ferrochromium. Thus the North American ferroalloy manufacturer pays much higher freight charges for a ton of ferrochromium delivered to a customer in North America than does an African manufacturer.

The prices quoted for chromite in 1964 were a few dollars a ton less than during 1963 but ferrochromium prices increased a few cents a pound.

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 ores are basically a combination of oxides of chromium and iron with alumina and magnesia being present in varying quantities as impurities. Chromite ores seldom contain more than 50 per cent Cr_2O_3.

Canada has no known deposit of commercial-grade chromium ore. During the 1940-50 period some chromite was produced in the Province of Quebec; peak production, reached in 1943, amounted to 29,595 tons. The Bird River deposits

*Mineral Resources Division.

in the Lac du Bonnet district of southeastern Manitoba are large but of low grade – about 26 per cent chromic oxide and 12 per cent iron with a chromium-to-iron ratio of about 1.41:1.

TABLE 1

Chromium – Trade and Consumption

	1963		1964p	
	Short Tons	$	Short Tons	$
Imports*				
United States	13,912	477,866	8,824	817,449
Philippines	18,256	664,162	6,542	483,055
Southern Rhodesia	14,131	446,458	4,711	248,322
Republic of South Africa	1,115	19,284	499	19,175
Mozambique	–	–	218	19,484
Turkey	2,240	80,798	–	–
Total	49,654	1,688,568	20,794	1,587,485
Chromic acid (chromium trioxide)				
United States	638	384,654	692	418,945
Britain	180	116,322	238	154,528
Australia	55	26,762	57	28,514
West Germany	7	3,947	16	8,754
Total	880	531,685	1,003	610,741
Chromium sulphates, basic, for tanning				
United States	2,256	491,745	1,853	391,008
Britain	59	12,639	128	26,717
West Germany	156	36,725	28	4,897
Total	2,471	541,109	2,009	422,622
Chrome dyestuffs				
United States	35	68,344	51	102,658
West Germany	33	59,502	54	100,625
Switzerland	61	108,097	35	70,106
Britain	25	42,153	28	52,412
Other countries	14	33,836	20	40,913
Total	168	311,932	188	366,714
Ferrochromium**				
United States			4,573	1,201,783
Southern Rhodesia			3,126	935,948
Republic of South Africa			1,746	371,922
Norway			921	206,484
Sweden			90	24,047
West Germany			26	8,762
Total			10,482	2,748,946

Table 1 (cont.)

	1963		1964p	
	Short tons	$	Short tons	$
Exports				
Ferrochromium				
Britain	–	–	120	29,011
Belgium and Luxembourg	2	539	45	2,069
India	20	3,515	5	1,185
Brazil	–	–	2	334
United States	2,749	483,989	–	–
Venezuela	137	21,730	–	–
Dominican Republic	2	89	–	–
Total	2,910	509,862	172	32,599
Consumption				
Chromite	56,016	..	57,734	..

Source: Dominion Bureau of Statistics.
*Prior to 1964, gross weight of chromite; 1964, Cr content of chromite. **Not available as a separate class prior to 1964.
Symbols: p Preliminary; — Nil; .. Not available.

TABLE 2

Chromium – Trade and Consumption, 1955–64
(short tons)

	Imports		Exports	Consumption	
	Chromite	Ferrochromium*	Ferrochromium	Chromite	Ferrochromium
1955	51,854		12,354	49,176	6,406
1956	64,965		9,897	69,835	7,091
1957	111,453		10,332	70,971	7,000
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
1964p	23,791	10,482	172	57,734	11,212

Source: Dominion Bureau of Statistics.
*Not available as a separate class prior to 1964.
p Preliminary.

Chromite is consumed in Canada by Union Carbide Canada Limited, Metals and Carbon Division, at Welland, Ontario, where high-carbon ferrochromium and ferrochromium silicon are produced; by Chromium Mining & Smelting Corporation,

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Limited, at Beauharnois, Quebec, where high-carbon and charge-grade ferrochromium and ferrochromium silicon are produced; by Canadian Refractories Limited at Marelan, Quebec, about 50 miles west of Montreal; and by General Refractories Company of Canada Limited, Smithville, Ontario.

WORLD PRODUCTION AND TRADE

Preliminary reports indicate that world production of chromite was about 5 million tons in 1964, an increase of about 25,000 tons from 1963. Russia, the Republic of South Africa, Southern Rhodesia, the Philippines and Turkey supply about 76 per cent of the world's chromite requirements.

The Ministry of Mines and Lands for Southern Rhodesia reported that chromite production was 493,371 tons, up 20 per cent from 1963. It also reported an increase of 80,000 tons in exports of chromite to 407,495 tons, valued at slightly more than £2 million. The volume of trade, however, is almost entirely determined by the operations of captive mines owned by Union Carbide Corporation and by Vanadium Corporation of America.

TABLE 3

World Production of Chromium Ore, 1963–64

('000 short tons)

	1963	1964e
U.S.S.R.	1,355	1,500
Republic of South Africa	873	936
Philippines	502	500
Turkey	445	350
Southern Rhodesia	412	500
Albania	310	400
Iran	110	..
Yugoslavia	103	..
India	72	..
Cuba	56	..
Japan	48	..
Other countries	188	..
Total	4,475	5,000

Sources: U.S. Bureau of Mines MINERALS YEARBOOK 1963; U.S. Bureau of Mines COMMODITY DATA SUMMARIES, January 1965; U.S. Bureau of Mines MINERAL TRADE NOTES; Republic of South Africa Department of Mines, MINERALS (quarterly information circular), October-December 1964; and Ministry of Mines, Southern Rhodesia, 1964 ANNUAL REPORTS.

Symbols: e Estimated; p Preliminary; .. Not available.

The ministry also reported that the domestic ferrochromium alloy industry operated at full capacity throughout the year and consumed over 42,000 tons of domestic chromite. Near the end of 1964 there were indications of an upsurge in the export of chromite and the outlook for 1965 appeared very good even though no improvement in the market price was foreseen.

The Department of Mines of the Republic of South Africa reported in MINERALS, October to December, 1964, that chromite production in 1964 amounted to 936,468 tons, up from 873,212 tons in 1963; exports were 693,781 tons valued at 4.7 million Rands, also an increase from 1963. Statistics on the export of ferrochromium from South Africa are not available but, based on the difference between the amount of chromite production and exports, it seems safe to assume that South Africa's exports of ferrochromium also increased in 1964 from those of 1963.

According to the U.S. Bureau of Mines, MINERAL TRADE NOTES, Vol. 60, No. 4, April 1965, exports of chromite from Turkey in 1964 at 351,283 tons were 65 per cent higher than the previous year. Apparently the effects of Russian chromite exports, which contributed to the dramatic decline in exports from Turkey during the period 1950-63 lessened somewhat in 1964.

United States is the largest importer and consumer of chromite. In 1964, imports and consumption were 1.41 and 1.45 million pounds*. Consumption was the highest since 1957; the metallurgical industry accounted for 57.4 per cent of the total, the refractories industry for 29.7 per cent and the chemical industry 12.9 per cent. The Republic of South Africa was the major supplier, followed by Southern Rhodesia, the U.S.S.R. and the Philippines. Turkey, which at one time was the major source of chromite for the United States, ranked fifth and supplied only 95,404 tons.

In only a few countries have chromium ore resources been thoroughly explored and estimates of reserves are mostly broad approximations. Some important producing countries have published nothing on their reserves. In 1960, the chromite reserves of Southern Rhodesia were estimated at 608 million tons, of which some 300 million were considered to be of metallurgical grade. South Africa's reserves of chromium ore were recently estimated to be 2,000 million tons**. The U.S.S.R. and Albania are known to have large economic deposits of chromium ore.

USES

Chromite consumed in industry is graded as metallurgical, refractory or chemical. These grades are based on physical and chemical properties but technological advances are making them interchangeable to an increasing extent.

*U.S. Bureau of Mines, MINERAL INDUSTRY SURVEYS, CHROMIUM IN DECEMBER 1964, March 25, 1965.

**Republic of South Africa, NATIONAL RESOURCES DEVELOPMENT COUNCIL INVESTIGATION REPORTS ON THE PROCESSING OF CERTAIN MINERALS IN THE REPUBLIC OF SOUTH AFRICA AND IN SOUTH AFRICA, Volume IV.

METALLURGICAL-GRADE CHROMITE

Metallurgical-grade chromite should contain 45 to 50 per cent Cr_2O_3 and have a chromium-iron ratio of at least 2.8:1. It is used for making ferrochromium alloys by electric smelting processes; they, in turn, are used for making alloy steels. Manufacturers of chromium exothermic additives may use ores of less rigid specifications than those outlined.

Several grades of ferrochromium are made. They are distinguished by their carbon and silicon content. Low-carbon ferrochromium of various grades, ranging from 0.02 to 2 per cent carbon maximum, is used in stainless and heat-resistant steels. High-carbon ferrochromium, in which the carbon content varies from 4 to 9 per cent, is used in the production of other chromium-bearing steels and alloy cast irons. Chromium greatly increases corrosion resistance in steels and hardness, strength and resistance to corrosion in cast irons.

Chromium metal is used in high-temperature corrosion-resistant alloys and and in chromium-bronze, hard-facing alloys, welding-electrode tips, certain high-strength aluminum electrodes and aluminum-base hardener alloys used by fabricators and foundries making alloys. High-temperature alloys contain from 13.5 to 27 per cent chromium together with varying amounts of cobalt, columbium, nickel, tungsten, molybdenum, manganese, titanium and vanadium. High-temperature alloys are used mainly in the highly stressed parts of missiles and in gas and steam turbines, jet-engine compressor blades and jet-engine exhaust systems.

REFRACTORY-GRADE CHROMITE

Specifications for refractory-grade chromite are not as rigid as for metallurgical grade. Nevertheless, for brick of the best quality, the mineralogical constitution is of great importance. Because the silica content should be kept as low as possible and because refractoriness is inversely proportional to the iron content, the chromic oxide and alumina combined should not be less than 57 per cent and the iron and silica should not be above 10 and 5 per cent respectively. The ore must be hard and lumpy and above 10-mesh size. Chromite fines are suitable for the manufacture of brick cement and chrome-magnesite brick. Bricks made from refractory-grade chromite are used extensively for lining furnaces. Chrome refractories are also used for patching brickwork and in making ramming mixtures for furnace bottoms.

CHEMICAL-GRADE CHROMITE

In chemical consumption, specifications are not as rigid as for metallurgical and refractory grades. Standard chemical ores contain a minimum of 45 per cent Cr_2O_3 and, within reasonable limits, iron is not a problem. The ores should not contain more than 15 per cent aluminum oxide (Al_2O_3) and 20 per cent iron oxide (FeO), or less than 8 per cent silicon dioxide (SiO_2); the sulphur must be low. The chromium-iron ratio is usually about 1.6:1. Fines are preferred because the ore is ground in processing to make sodium and potassium chromates and bichromates.

Sodium bichromate or its derivatives are used as pigments in the paint and dye industries, as mordants and waterproofing material in the textile industry, in the surface treatment of metals and as a source of electrolytic chromium.

Chromium plating is used extensively to produce brilliant, nontarnishing and durable finishes. Many articles such as dyes, gauges and punches are plated with a relatively thick layer to improve their wear-resisting qualities and performance. Chromic acid is the main constituent of commercial-plating solutions.

Experimental electroplating of plastics started during World War II but for a long time the problem of getting a coating of chromium to adhere to plastics was insurmountable. However, within the last 2 years the art of chromium plating on plastics has improved tremendously and more than three dozen parts in automobiles, appliances and home furnishings are now being produced. An interesting and informative article in the November 23, 1964, issue of STEEL suggested that almost innumerable new applications can be envisaged, provided plastic parts were designed properly and the plating techniques were properly adhered to.

PRICES

E & MJ METAL AND MINERAL MARKETS of December 28, 1964, quotes chrome prices in United States currency as follows:

Chromium metal, per lb, delivered		
exothermic 98.5%, .05%C	\$ 1.15 -\$ 1.19	(depending on size of lot)
electrolytic 99.8%	1.15 - 1.19	(depending on size of lot)
Chrome ore, per long ton, dry basis, subject to penalties if guarantees are not met, f.o.b. cars Atlantic ports		
Rhodesian		
48% Cr_2O_3, 3:1 ratio	32.00 - 35.00	
48% Cr_2O_3, no ratio	30.00 - 31.00	
South African (Transvaal)		
44% Cr_2O_3, no ratio	18.00 - 19.00	
Turkish		
48% Cr_2O_3, 3:1 ratio, lump and concentrates	30.00 - 32.00	

Ferrochromium, per lb Cr, contained carload lots, lumps, bulk, f.o.b. shipping point	
High-carbon 67-71% Cr, all grades C	$0.19
Low-carbon 67-73% Cr, 0.025% C	0.24½
Charge chrome 61-66% Cr, 5.5% C	0.13½
Refined chrome 61-68% Cr, 4.25% C	0.22

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%
Materials for use in manufacture of chromium oxide (expires June 30, 1965)	free	free	20%

UNITED STATES	
Chrome ore	free
Chromium metal	10½%
Ferrochromium	
Less than 3% C	8½
3% or more C	5/8¢ per lb on Cr content
Chromic acid	12½%
Chromium carbide	12½
Chrome brick	25
Chrome colours	10

Clays and Clay Products

J. G. BRADY*

Deposits of high-quality, refractory clays such as china clay (kaolin), fire clay, ball clay and stoneware clay are scarce in Canada. Consequently, a substantial proportion of these materials is imported. Common clays and shales occur in most regions of Canada and are the principal raw material used for brick and tile.

The term 'clay products' applies to such materials as fire clay 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 to wall tile, floor tile, electrical porcelain, sanitary ware, 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.

Numerous plants exist in Canada for the manufacture of all types of clay products. A list of these plants is shown in Operators List 6, CERAMIC PLANTS IN CANADA, which is published yearly by the Mineral Resources Division, Department of Mines and Technical Surveys, Ottawa.

PRODUCTION, TRADE AND CONSUMPTION

In previous 'Clay and Clay Products' reviews little statistical detail was published. The production and trade figures have often been misleading and difficult to present in an orderly fashion. This year more figures are presented in Tables 1 to 4, including figures for refractories.

The figures in Table 1 show that production of clay and clay products from domestic sources rose by 6.3 per cent but the total is slightly less than the high of $41.9 million in 1959. Imports of clay, clay products and refractories (Table 2) increased over 1963 by 3.2 per cent while exports of these materials increased by 18.6 per cent.

*Mineral Processing Division, Mines Branch

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TABLE 1

Production of Clays and Clay Products from Domestic Sources

		1963		1964p	
		Quantity	$	Quantity	$
Production (shipments) from domestic sources by main classes					
Clays, including bentonite ...			1,213,766		1,266,761
Clay products from					
Common clay			28,986,042		30,019,339
Stoneware clay...........			5,649,449		6,429,810
Fire clay			683,733		734,763
Other			1,621,294		2,084,095
Total			38,154,294		40,534,768
By products					
Clay					
Fireclay..................	s.t.	4,488	64,795	3,596	64,761
Other clay, including bentonite	"	..	1,148,981	..	1,202,000
Fireclay blocks and shapes....		..	47,621	..	81,487
Firebrick...................	No.	4,774,810	636,112	4,638,000	653,276
Brick					
Soft mud process					
Face..................	No.	40,732,309	2,132,170		
Common	"	5,563,746	116,833		
Stiff mud process					
Face..................	"	304,037,351	15,409,529		
Common	"	40,303,183	1,137,435		
Dry press					
Face..................	No.	53,050,705	2,512,050	512,159,000	24,643,222
Common	"	6,579,210	201,049		
Fancy or ornamental	"	16,436,833	1,247,398		
Sewer brick	"	1,024,726	39,054		
Paving brick	"	1,388,997	136,438		
Structural tile					
Hollow blocks..............	s.t.	99,322	2,024,309	93,176	1,898,044
Roofing tile................		—	—	—	—
Floor tile..................	sq.ft.	191,837	82,775	..	..
Drain tile....................	No.	64,378,356	3,974,002	55,016,000	3,478,073
Sewer pipe.................	ft.	6.558,456	3,625,761	7,650,204	4,246,526
Flue linings	"	1,454,705	940,864	1,290,710	845,256
Pottery....................		..	1,082,824		1,338,028
Other products		..	1,621,294		2,084,095
Total................			38,154,294		40,534,768

Symbols: p Preliminary; — Nil; .. Not available.

TABLE 2

Imports and Exports of Clay, Clay Products and Refractories

		1963		1964p	
		Quantity	$	Quantity	$
Imports*					
Clay, clay products and refractories					
Bentonite	s.t.	..	..	114,446	1,055,405
Drilling mud	"	16,892	458,700	12,075	1,095,322
China clay, ground or unground	"	173,758	3,649,438	169,744	3,572,757
Fire clay, ground or unground .	"	72,912	447,014	73,171	555,150
Clays ground or unground.....	"	..	1,109,955	91,371	1,115,393
Clays and earth, activated....	"	..	1,405,725	2,853	418,643
Brick, building					
Glazed....................	M	3,776	373,635	3,290	299,939
N.e.s.	"	25,107	1,585,580	21,543	1,244,378
Building blocks	"	..	798,742	..	770,478
Earthenware tiles					
Under 2½ x 2½"	sq.ft.	7,758,838	1,783,758	9,123,122	2,111,408
Over 2½ x 2½"	"	7,880,189	1,460,493	9,437,432	1,783,269
Clay bricks, blocks, tiles, n.e.s.		..	144,053	..	208,134
Firebrick					
Alumina...................	M	..	..	3,239	2,533,090
Chrome	"	..	253,721	351	474,734
Magnesite	"	..	215,209	733	834,073
Silica	"	..	1,281,854	3,193	1,564,216
N.e.s.	"	..	11,904,316	36,074	9,561,803
Refractory cements and mortars		..	..	..	1,203,083
Pottery settings and firing supplies		..	232,910	..	244,351
Crude refractory materials	s.t.	..	..	3,080	256,439
Grog (refractory scrap).......	"	16,122	499,914	19,180	619,146
Refractories n.e.s.	"	..	..	..	2,134,286
Acid-proof brick		..	..	..	166,223
Tableware, china or porcelain.		..	14,468,603	..	8,163,388
Porcelain insulating fittings ..		..	1,584,773	..	3,020,123
Total clay, clay products and refractories..........			43,658,393		45,005,231

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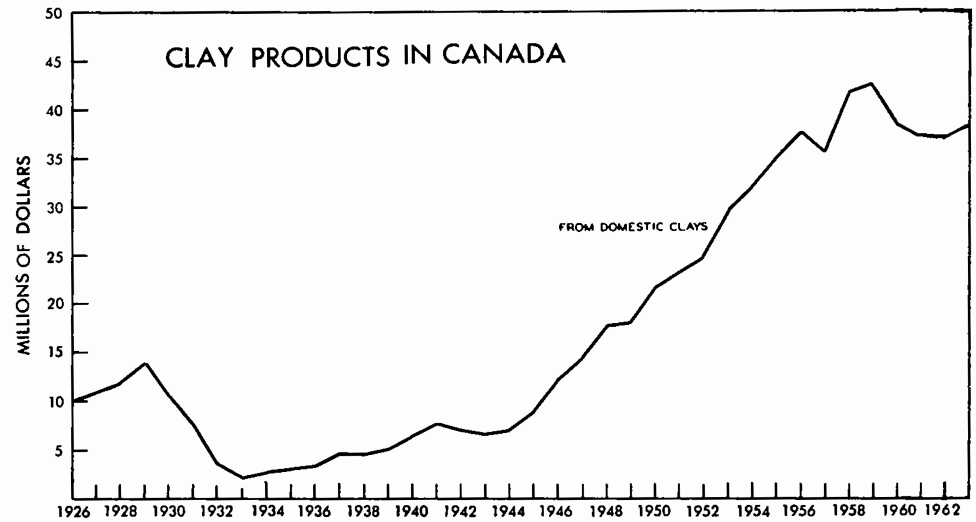
Table 2 (cont.)

		1963		1964p	
		Quantity	$	Quantity	$
By main countries					
United States			24,382,905		30,009,179
Britain			14,502,273		9,495,500
Japan			3,578,104		3,794,108
West Germany			623,414		731,164
France			126,998		500,823
Italy			110,403		95,069
Denmark			117,868		87,524
Other countries			216,428		291,864
Total			43,658,393		45,005,231
Exports					
Clays, clay products and refractories					
Clays, ground and unground	s.t.	1,078	30,164	1,058	34,198
Crude refractory materials	"	774,395	1,577,821	1,150,072	2,240,324
Building brick, clay	M	7,364	448,306	8,106	470,773
Clay bricks, blocks, tiles n.e.s.		..	239,321	..	351,917
Firebrick and similar shapes		..	3,950,497	..	4,700,323
Refractories, n.e.s.		..	627,705	..	337,237
High tension insulators and fittings		..	310,049	..	312,993
Tableware, n.e.s.		..	373,465	..	448,517
Stone, clay and concrete end products		..	11,783	..	9,590
Total clays, clay products and refractories			7,569,111		8,905,872
By main countries					
United States			4,114,036		6,659,110
Chile			109,242		278,999
Australia			221,191		171,777
Puerto Rico			184,047		171,613
Britain			114,455		153,114
Venezuela			29,566		129,246
Other countries			2,796,574		1,342,013
Total			7,569,111		8,905,872

Source: Dominion Bureau of Statistics.
*New classification for imports, effective 1964. Certain classes not completely comparable with previous years.
Symbols: p Preliminary; — Nil; .. Not available.

Because current production figures of clay products made from imported clays are not available, the latest ones for 1962 are reported (Tables 3 and 5). These figures include mainly whitewares such as electrical porcelain, sanitary ware, dinnerware, pottery, etc., but do not include refractories.

Shipments of refractories made in Canada are shown in Table 4. These products include basic refractories as well as refractories and refractory specialties in which fire clay is a principal ingredient. According to the report entitled 'Consumption of Refractories in Canada 1963', published by the Clay Refractories Association, the value of refractories consumed in Canada in 1963 amounted to \$36.6 million of which \$22.9 million was attributed to goods manufactured in Canada and the balance to imported products. Because of the lack of many suitable Canadian raw materials a substantial proportion of the refractories made in Canada contain imported raw materials.



Seventy-six plants were producing such clay products as facing brick (glazed and unglazed), common brick, structural tile, drain tile and quarry tile.

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

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

Three sanitary ware plants, seven electrical porcelain plants, three wall tile plants, two dinnerware plants and numerous souvenir and art potteries were the principal users of ceramic-grade china clay and ball clay which is imported mainly from the United States and the United Kingdom.

TABLE 3

Shipments of Clay Products Manufactured in Canada from Imported Clays*

		1960		1961		1962	
		Quantity	$	Quantity	$	Quantity	$
Glazed floor and wall tile	sq. ft.	7,286,000	3,193,000	8,117,000	3,634,000	12,613,000	4,859,000
Electrical porcelains		..	5,484,000	..	5,357,000	..	5,703,000
Pottery, art and decorative ware..........		..	453,857	..	788,760	..	802,000
Pottery, tableware......................			1,449,525	..	1,167,852	..	1,377,000
All other products (sanitaryware, etc)		..	11,421,977	..	9,040,595	..	10,378,000

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

TABLE 4

Shipments of Refractories Manufactured in Canada

		1960		1961		1962	
		Quantity	$	Quantity	$	Quantity	$
Fireclay blocks and shapes	s.t.	..	263,010	..	301,945	..	..
Firebrick	M	4,397	553,196	3,873	476,327	3,035	392,000
Other firebrick and shapes*	s.t.	94,915	12,809,666	85,815	11,629,868	88,534	12,143,000
Refractory cements, mortar, castables.....	s.t.	31,721	3,676,307	37,848	4,385,721	57,237	5,758,000
Other refractories	s.t	11,773	1,600,566	16,084	2,186,918	..	1,743,000

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

TABLE 5

Clays and Clay Products Production and Trade 1955 – 1964
($ millions)

	Production			Imports	Exports
	Domestic Clays[1]	Imported Clays[2]	Total		
1955........	35.3	18.4	53.7	41.0	2.7
1956........	37.8	20.9	58.7	52.4	3.5
1957........	35.9	19.9	55.8	47.4	4.3
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[3]	56.4	47.1	5.8
1962........	37.8	22.5[3]	60.3	48.3	5.4
1963........	38.2	..	..	43.9	7.6[5]
1964p	40.5	..	..	45.0[4]	8.9[5]

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. [3]Commencing in 1961 production from imported clays on the new Standard Commodity Classification. Figures from 1961 not completely comparable with previous years (does not include refractories). [4]Classification changes in Imports in 1964 result in 1964 total not being completely comparable with previous years. [5]Includes additional categories of refractories. Totals not completely comparable with years prior to 1963.
Symbols: p Preliminary; .. Not available.

The use of kaolin in Canada has increased slightly in the past few years (Table 6). No statistics on consumption of fire clay and ball clays are available. About 2 million tons of domestic clay are consumed in the products included in Table 1.

TABLE 6

Consumption China Clay by Industries
(short tons)

	1962	1963	1964p
Ceramic products	13,906	12,515	
Paint and varnish................	2,306	2,131	
Paper and paper products	84,079	92,625	
Rubber and linoleum.............	12,247	11,805	
Other products*..................	8,762	10,939	
Total......................	121,300	130,015	140,692**

Source: Dominion Bureau of Statistics.
*Includes miscellaneous chemicals, cleaners, detergents, soaps, medicinals and pharmaceuticals and others miscellaneous products. **Breakdown not available.
p Preliminary.

raw materials having a PCE (pyrometric cone equivalent) of about 31½ to 32½ (approximately 1,699°C 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 or 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 fire clays are sufficiently refractory for the manufacture of super-duty refractories without the addition of some very refractory material such as alumina.

Good-quality fire clays are low in alkali, alkaline-bearing materials and iron-bearing minerals. The Canadian deposits are made up mainly of a kaolinite-group mineral and quartz. The clays usually fire to a cream or buff colour and the products generally have dark specks caused by iron-bearing minerals. Ordinarily, fire clay is not beneficiated.

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

Fire clay and kaolin occur in the James Bay watershed of northern Ontario along the Missinaibi, Abitibi, Moose and Mattagami rivers. Adverse terrain and climate have made past exploration difficult. One of the various interested companies did some sampling in the area in 1962 and another took samples in 1963. Some seams of clay in the deposit at Shubenacadie, Nova Scotia, are sufficiently refractory for medium-duty refractories and 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 domestic sources of fire clay. These industrial provinces import most of their requirements from the United States.

STONEWARE CLAY

Stoneware clays are similar to low-grade plastic fire clays. They are used extensively in sewer pipe, flue liners, facing brick, pottery, stoneware crocks and jugs and chemical stoneware.

Stoneware clays are plastic buff-firing materials that fire to a dense condition over a wide temperature range. In general, they are of intermediate composition, being between common noncalcareous clays and good-quality fire clays. They usually contain more alkalis, alkaline-bearing materials and other low-melting substances than fire clays. The main clay mineral found in Canadian stoneware clays is of the kaolinite group. The principal impurities are quartz and small quantities of such nonplastic materials as mica, feldspar and pyrite.

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, Alberta. Stoneware clay pits are now located in the Alberta Cypress Hills, southeast of Medicine Hat, and at Avonlea, Saskatchewan.

Stoneware or low-grade fire clays 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, which were developed recently, are used principally for the manufacture of buff facing brick. Musquodoboit clay is used in small quantities by foundries in the Maritimes. 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 to a salmon or red colour. 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 fire clays. 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 kaolinite group and 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 nonplastic 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 to a buff colour 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, fire clays 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 other 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. Good plasticity and suitable drying and firing properties are all essential for such extruded products as stiff-mud brick, lding tile and drain tile. The raw materials for dry-press clay products need not be very plastic and drying is not a critical problem. In the clays used in soft-mud bricks, which are made in Canada only in relatively small quantities, good drying and firing properties are essential.

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 fire clays are about the same as those of most china clays. Low-grade fire clays 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 fire clays, stoneware clays and common clays and shales are usually sold in bulk.

According to OIL, PAINT AND DRUG REPORTER, December 28, 1964, prices in the United States were as follows:

	(Dollars per Short Tons)
Ball clay	
Domestic, air-floated, bags, car lots, f.o.b. Tennessee	18.00-22.00
Domestic, crushed, moisture repellant, bulk, car lots, f.o.b. Tennessee	8.00-11.25
China clay	
Domestic, dry-ground, calcined, air-floated, bags, car lots, f.o.b. works	45.00-68.00
Domestic, dry-ground, uncalcined, air-floated, 99% 325 mesh, f.o.b. Georgia, bags, car lots, f.o.b. works	17.50
Domestic, water-ground, bags, car lots, f.o.b. works	22.50-51.00

Coal and Coke

Coal

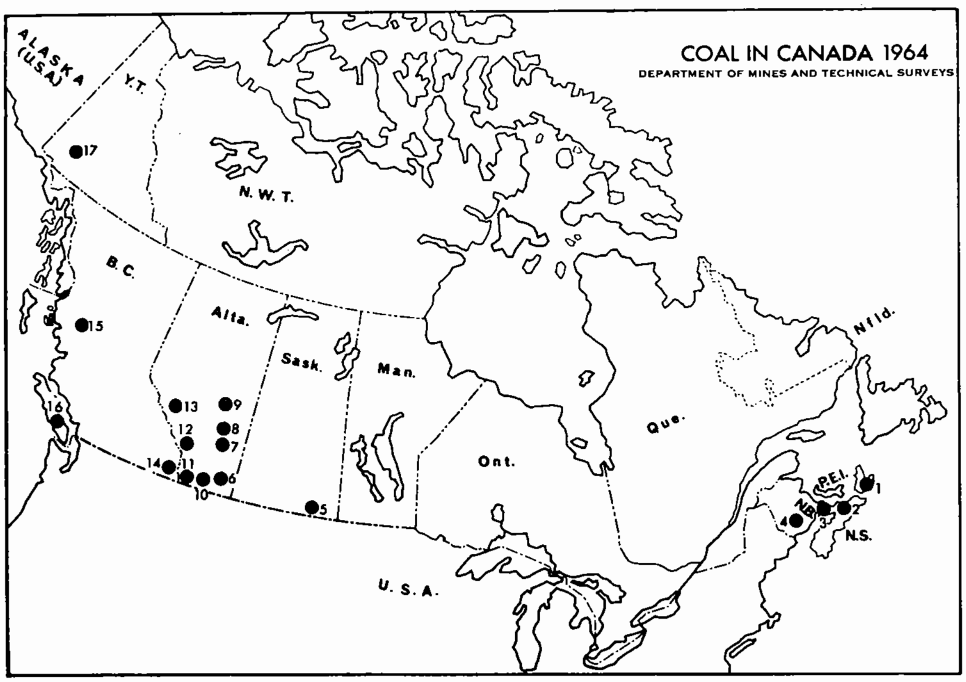
T.E. TIBBETTS*

Significant increases in production, trade and consumption of coal were realized in Canada in 1964 notwithstanding continued competition from petroleum and natural gas. Exports of high grade coking coals from western Canadian mines to Japan were again higher to continue a trend that has been almost steady since 1958. In 1964, Alberta and British Columbia producers completed negotiations with Japanese steel mills for the sale of 800,000 tons of coking coal a year during a 3-year period commencing with 1964. Increased capacity of coal-fired thermal electric generating units throughout Canada resulted in demands for coal in that market which more than offset losses to coal in other markets.

Technological advances, particularly in strip mining, aided in increasing productivity. Significant progress was also achieved in the beneficiation of Canadian coals with particular emphasis on cleaning and drying slack and fine sizes. A trend towards increased quality control was evidenced by the incorporation of mechanical coal sampling systems in new thermal electric generating stations. The completion of construction and initial service in 1964 of a 22,000-ton ocean-going, self-unloading coal carrier, operating between Sydney, Nova Scotia, and thermal electric generating stations in the Toronto, Ontario, area resulted in significant savings in shipping and handling costs to that market.

Subvention assistance and research in the interest of the coal industry were continued and expanded by the federal and provincial governments.

*Fuels and Mining Practice Division, Mines Branch



COAL AREAS AND PRINCIPAL PRODUCERS

(with approximate production in thousands of short tons)

NOVA SCOTIA

1. Sydney and Inverness areas (high-volatile bituminous)	
Bras d'Or Coal Co. Ltd. (Four Star mine)	97
Chestico Mining Corporation Limited	35
Dominion Coal Company, Limited	2,979
Dominion Steel and Coal Corporation, Limited, Old Sydney Collieries Division	663
Evans Coal Mines Limited	48
2. Pictou area (medium- and high-volatile bituminous)	
Dominion Steel and Coal Corporation, Limited, Acadia Coal Company Division	228
Drummond Coal Company Limited	70
Greenwood Coal Company, Limited	22
3. Springhill and Joggins areas (high-volatile bituminous)	
River Hebert Coal Company Limited	53
Springhill Coal Mines Limited	79

NEW BRUNSWICK

4. Minto area (high-volatile bituminous)	
A.W. Wasson, Limited	12

Avon Coal Company, Limited	289
D.W. & R.A. Mills Limited	271
Dufferin Mining Limited	31
Knox, Harold	33
Michiels Limited	18
Miramichi Lumber Company Limited	232
L.T. Rogers	2
R. Hawkes	4
C.H. Nichols Co. Ltd.	42
Norman I. Swift, Ltd.	4
V.C. McMann, Ltd.	45
C.J. Hoyt	19

SASKATCHEWAN

5. Souris Valley area (lignite)

Great West Coal Company, Limited	624
Manitoba and Saskatchewan Coal Company Limited	349
North West Coal Co. Ltd.	41
Utility Coals Ltd.	981

ALBERTA

6. Brooks and Taber areas (subbituminous)

Alberta Coal Sales Limited	27
The Kleenbirn Collieries, Limited	7

7. Drumheller, Sheerness and Carbon areas (subbituminous)

Amalgamated Coals Ltd.	127
Century Coals Limited	15
Alfred Fox	2
Fox Coulee Coals Ltd.	26
Great West Coal Company, Limited	164
Halbert Coal Mine	2
Nottal Brothers	9
Subway Coal Limited	15

8. Castor, Ardley and Camrose areas (subbituminous)

Battle River Coal Company Limited	229
Burnstad Coal Ltd.	7
Camrose Collieries Ltd.	16
Forestburg Collieries Limited	378
John Lynass	11
R.C. Sissons	21
Stettler Coal Company Limited	9
R.R. Straub	2

9. Edmonton, Tofield and Pembina areas (subbituminous)

Alberta Coal Ltd. (mines Nos. 419 and 1757)	820
Black Gem Coal Company Ltd.	11
Black Nugget Coal Ltd.	3
Egg Lake Coal Company Limited	13
Jet Construction Ltd.	12
Charles Ostertag	10
Slide Hill Coal Co. Ltd.	2

Star-Key Mines Ltd.	46
Warburg Coal Co. Ltd.	12
Whitemud Creek Coal Co. Ltd.	15
10. Lethbridge area (high-volatile bituminous)	
Lethbridge Collieries, Limited	65
11. Crowsnest area (medium-volatile bituminous)	
Coleman Collieries Limited	550
12. Cascade area (low-volatile bituminous and semianthracite)	
The Canmore Mines, Limited	241
13. Coalspur area (high-volatile bituminous)	
The MacLeod River Hard Coal Company Limited	6
BRITISH COLUMBIA	
14. East Kootenay (Crowsnest) area (medium-volatile bituminous)	
The Crow's Nest Pass Coal Company, Limited	979
15. Northern area (medium- and high-volatile bituminous)	
Bulkley Valley Collieries, Limited	7
16. Vancouver Island area (high-volatile bituminous)	
Comox Mining Company Limited	63
YUKON TERRITORY	
17. Carmacks area (high-volatile bituminous)	
Yukon Coal Company Limited	7

PRODUCTION

Production of coal increased 7.0 per cent to 11.3 million tons in 1964 from the previous year. Production of bituminous coal increased 2.4 per cent; subbituminous coal mines, located only in Alberta, increased their production 27.2 per cent; and production of lignite in Saskatchewan increased about 6.4 per cent.

Provincial production of coal as a percentage of the national output was: Nova Scotia, 37.9 per cent; Saskatchewan, 17.6 per cent (all lignite); Alberta, 26.2 per cent; British Columbia, 9.3 per cent (including small amount produced in the Yukon Territory); New Brunswick, 8.9 per cent. Nova Scotia's production, all bituminous coal, was down by about 3 per cent. In Alberta, increases in production of bituminous coal of 36 per cent and of subbituminous coal of 27.2 per cent resulted in an overall increase of 29.7 per cent. Production in British Columbia increased 9.1 per cent, and in New Brunswick it increased 13.2 per cent.

The average output per man-day for all coal mines in Canada increased 0.354 tons to 5.082 tons. The most significant increase was in strip mining, which accounted for 42.9 per cent of the coal production, with an average output of 18.57 tons per man-day compared with 15.778 tons the previous year. Average output for underground mines was 3.287 tons per man-day, which is a slight decrease from 1963. Productivity had shown a steady increase during the previous few years reflecting the influence of increasing and improved mechanization in both underground and strip mining. A large decrease in the productivity of strip mines of British Columbia from 38.799 tons in 1962 to 21.615 tons in 1963 reversed this trend but the loss was largely regained in 1964. A significant increase in productivity was also realized in Alberta's subbituminous strip mines.

TABLE 1

Coal – Production, Trade and Consumption, 1955-64

(short tons)

	Production	Imports[1]	Exports	Consumption		
				Domestic[2]	Imported[3]	Total
1955	14,818,880	19,742,531	592,782	14,060,039	19,322,134	33,382,173
1956	14,915,610	22,613,374	594,166	14,115,095	22,198,049	36,313,144
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
1964p.......	11,319,323	14,996,254	1,291,664	9,989,776	14,987,656	24,977,432

Source: Dominion Bureau of Statistics.

1. Imported coal referred to by D.B.S. as 'Entered for Consumption' represents amounts cleared from customs ports, duty paid. Prior to 1962, 'Landed Imports' were shown; these were the amounts which actually entered the country, recorded prior to customs clearance. 2. The sum of sales at Canadian coal mines, colliery consumption, coal supplied to employees and coal used in making coke and briquettes, less the coal exported. 3. Deductions have been made to take into account foreign coal re-exported from Canada and bituminous coal removed from the warehouse for ships' stores. Imports of briquettes are not included.

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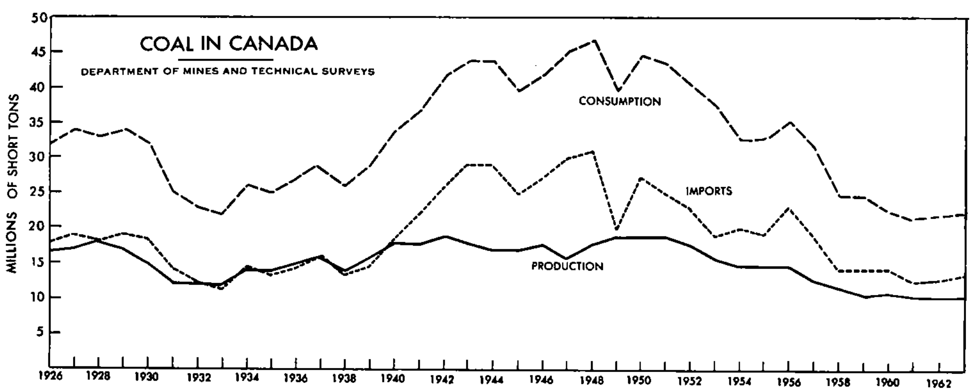


TABLE 2

Coal Production, by Types, Provinces and Territories

	1963		1964p	
	Short Tons	$	Short Tons	$
Bituminous*				
Nova Scotia..............	4,554,944	44,693,053	4,293,130	42,827,600
New Brunswick...........	886,336	7,232,170	1,003,362	8,454,868
Alberta..................	635,650	4,503,825	866,221	5,751,602
British Columbia and Yukon Territory	970,915	6,252,480	1,057,659	6,364,592
Total	7,047,845	62,681,528	7,220,372	63,398,662
Subbituminous*				
Alberta..................	1,654,293	5,361,065	2,104,912	5,431,231
Lignite*				
Saskatchewan	1,873,556	3,713,988	1,994,039	3,905,202
All types				
Canada total	10,575,694	71,756,581	11,319,323	72,735,095

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-388-38).

p Preliminary.

TABLE 3

Coal Production, by Type of Mining and Average Output per Man-day, 1964p

(short tons)

	Production		Average Output Per Man-day	
	Underground	Strip	Underground	Strip
Nova Scotia	4,293,130	–	2.813	–
New Brunswick	141,769	861,593	1.699	5.859
Saskatchewan	–	1,994,039	–	45.018
Alberta	1,060,224	1,910,909	4.931	28.244
British Columbia..........	959,961	90,469	6.787	35.024
Yukon	7,229	–	3.111	–
Canada	6,462,313	4,857,010	3.287	18.57
Total, all mines	11,319,323		5.082	

Source: Dominion Bureau of Statistics.

Symbols: p Preliminary; – Nil.

TABLE 4

Comparison of Average Values of Canadian Coals, 1964p

	Average Btu/lb*	Average Value per Short Ton** $	Average Value per Million Btu ¢
Nova Scotia, bituminous	13,450	9.98	37.10
New Brunswick, bituminous	11,900	8.43	35.42
Saskatchewan, lignite	7,400	1.96	13.24
Alberta			
Bituminous	12,950	6.64	25.64
Subbituminous	9,000	2.58	14.33
British Columbia, bituminous	13,800	6.02	21.81
Yukon Territory, bituminous	11,450	13.58	59.30
Total			
Bituminous	13,210	8.78	33.23
Subbituminous	9,000	2.58	14.33
Lignite	7,400	1.96	13.24
Average, Canada	11,520	6.43	27.91

*Department of Mines and Technical Surveys, "Analysis Directory of Canadian Coals, Supplement No. 2 – 1960" (Mines Branch Monograph No. 868). **Dominion Bureau of Statistics.

p Preliminary.

TABLE 5

Interprovincial Shipments of Coal, 1964

(short tons)

Destination	Originating Province				
	Nova Scotia	New Brunswick	Saskatchewan	Alberta	British Columbia
Newfoundland	71,355	–	–	–	–
Prince Edward Island	27,806	–	–	–	–
Nova Scotia	–	1,123	–	–	–
New Brunswick	196,101	–	–	–	–
Quebec	1,471,072	67,846	–	–	–
Ontario	820,270	6,750	132,564	32,488	22,563
Manitoba	–	–	614,351	122,363	140,789
Saskatchewan	–	–	–	279,171	385
Alberta	–	–	–	–	336
British Columbia and Yukon	–	–	–	261,527	–
Total	2,586,604	75,719	746,915	695,549	164,073

Source: Dominion Bureau of Statistics.

– Nil.

TABLE 6

Exports of Coal, 1964

(short tons)

Destination	Shipments from Mines by Province*					
	Nova Scotia	New Brunswick	Saskatchewan	Alberta	British Columbia	All
Norway	–	–	–	–	–	–
St. Pierre	4,288	–	–	–	–	4,288
United States ...	–	154,427	5,956	14,805	2,055	177,243
Japan	–	–	–	612,630	393,490	1,006,120
Total	4,288	154,427	5,956	627,435	395,545	1,187,651

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

More than 85 per cent of New Brunswick's and all of Saskatchewan's production is from strip mines. The proportion of coal mined by stripping in Alberta increased to 64.3 per cent from 58 per cent in 1963 but in British Columbia it decreased to 8.6 per cent from 10.2 per cent. Nova Scotia has no strip mines.

Coal produced in Canada in 1964 averaged $6.43 a ton and totalled more than $72.7 million. Bituminous coal accounted for 87.2 per cent of the total value and averaged $8.78 a ton, a decrease of about 11 cents a ton from the previous year. Bituminous coals from eastern Canada increased in value while those in western Canada decreased. The largest decrease, excluding the small tonnage mined in the Yukon Territory that decreased in value by $1.45 a ton, was for Alberta coals which decreased 45 cents a ton.

The value of lignite decreased two cents a ton and that of subbituminous coal 66 cents a ton. The costs of various coals in terms of heat units did not change greatly from the previous year except for the subbituminous which decreased more than three cents per million Btu. Nova Scotia coal is still the most expensive, excepting that from the Yukon Territory, and Saskatchewan lignite, at 13.24 cents per million Btu, is the cheapest source of coal-derived energy in Canada.

DISPOSITION OF COAL

NOVA SCOTIA AND NEW BRUNSWICK

High-volatile bituminous coking coal is produced in the Sydney, Cumberland and Pictou areas of Nova Scotia; noncoking high-volatile bituminous coal is produced in the Inverness area of the same province. New Brunswick produces only high-volatile bituminous coking coal, mainly in the Minto area but also from strip mines in the Chipman and Coal Creek areas.

A large part of the output of the two provinces 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 in the generation of thermal electric power. This is followed by its use in the manufacture of metallurgical coke for the steel industry at Sydney.

Much of the coal produced in Nova Scotia and New Brunswick is shipped to Quebec and Ontario. Nova Scotia shipped about 60 per cent of its output to other parts of the country; more than 88 per cent of this went to central Canada where it was used for industrial steam-raising, commercial heating and thermal electric power generation. A small amount of Nova Scotia coal was exported to the island of St. Pierre. New Brunswick shipped about 7.5 per cent of its output to central Canada and about 15.4 per cent to the United States.

SASKATCHEWAN

The only lignite coalfields in Canada that are in use are in the Bienfait and Estevan areas of Saskatchewan's Souris Valley.

More than 37 per cent of Saskatchewan's coal production was shipped to Manitoba and Ontario. The entire output from one operation in the Estevan area, amounting to more than 49 per cent of total lignite production, provided the fuel for the new Boundary Dam thermal electric generating station. The remainder of the lignite was used within the province for commercial and household heating and industrial purposes.

ALBERTA

Alberta produced coal ranging from semianthracite, mined in the Cascade area, to subbituminous (almost lignite).

The largest output was from the subbituminous mines; 43 such mines operating in 1964 produced almost 71 per cent of Alberta's coal. These mines are in the following areas, listed in order of decreasing output: Pembina, Castor, Drumheller, Sheerness, Edmonton, Ardley, Taber, Camrose, Westlock, Tofield, Carbon, Brooks, Champion, Wetaskiwin, Redcliff, Gleichen. More than 88 per cent of the total production of subbituminous coal is from seven mines in the Castor, Pembina, Drumheller and Sheerness areas.

The subbituminous coals were used mainly for commercial and household heating but increasing quantities are being employed industrially, particularly for thermal electric power generation.

A large part of the bituminous coking coals produced in the Crowsnest area was exported to Japan where it was used to upgrade the Japanese coal blends for metallurgical use. A total of 612,630 tons of Alberta coal were destined for Japan and more than 14,800 tons for the United States.

In the Lethbridge and Coalspur areas, lower quality bituminous noncoking coals were produced mainly for household and commercial heating but also for the production of industrial steam.

More than 23 per cent of Alberta's coal production was shipped to other provinces, Saskatchewan and British Columbia taking, respectively, 9.4 and 8.8 per cent. About 4.1 per cent went to Manitoba and 1.4 per cent to Ontario.

BRITISH COLUMBIA AND YUKON TERRITORY

The Crowsnest area (East Kootenay district on the mainland of British Columbia) is the main coal-producing area of that province; it accounts for more than 93 per cent of the production. More than 395,000 tons of medium-volatile bituminous coking coal from this area were destined for export, mainly to Japan with some to the United States, for metallurgical use. Most of the remainder of the province's output, high-volatile bituminous, was mined in the Comox area of Vancouver Island. This was mainly for domestic use as were the small amounts produced in the Northern district of the mainland.

About 14.6 per cent of the output of the province was shipped to Manitoba, 2.3 per cent went to markets in Ontario and small amounts were shipped to Saskatchewan and Alberta.

The Yukon Territory produced about 7,000 tons of coal from a single underground mine for local use.

SUBVENTION ASSISTANCE

Payments by the Federal Government through the Dominion Coal Board, to assist the movement of coal to markets, were continued in 1964. The amount to which such assistance was applied increased by more than 434,000 tons; the value of this assistance decreased almost $350,000 to $17.2 million in 1964.

Subvention assistance amounting to about $2.9 million was applied to the export of 1,001,116 tons of coal from the Crowsnest area of Alberta and British Columbia.

Payments under the Atlantic Provinces Power Development Act, 1958, totalled $1,741,281.

TABLE 7

Coal Moved Under Subvention

(short tons)

Origin of Coal	1963	1964
Nova Scotia	2,428,819	2,336,571
New Brunswick	191,766	407,120
Saskatchewan	89,311	128,215
Alberta and British Columbia	780,085	1,052,526
Total	3,489,981	3,924,432
Value of Subvention Assistance	$17,543,915	$17,194,381

Source: Dominion Coal Board.

IMPORTS

There was an increase of 14.4 per cent in coal imports in 1964. Imports of bituminous coal from the United States increased almost 17 per cent whereas imports of anthracite, mainly from the United States with some from Britain, decreased 22.8 per cent. More than 34 per cent of the bituminous coal imported was high-grade coking coal used in the metallurgical industry, mainly in Ontario and some in Nova Scotia.

TABLE 8

Imports of Coal for Consumption

(short tons)

Country of Origin		Anthracite	Bituminous*	Total
United States	1964p	648,260	14,342,416	14,996,254
	1963	826,225	12,523,080	13,349,305
United Kingdom	1964p	5,578	–	5,578
	1963	21,101	–	21,101
Total	1964p	653,838	14,342,416	14,996,254
	1963	847,326	13,349,305	13,370,406
Value	1964p	$ 8,007,743	$78,464,583	$86,472,326
	1963	$10,700,317	$67,963,036	$78,663,353

Source: Dominion Bureau of Statistics.

*Includes coal dust and coal not otherwise provided for and coal exwarehoused for ships' stores.

Symbols: p Preliminary; – Nil.

CONSUMPTION

Consumption of coal in Canada increased 10.5 per cent in 1964 to about 25 million tons. Almost 60 per cent of the coal consumed was imported.

Railway locomotives, once great consumers of coal, no longer use significant quantities.

The decline in the use of coal in the household and commercial building heating market since the Second World War has been great. During the period 1947-63, coal and coke consumption for this use declined from about 13.1 million tons to about 3.2 million tons. During the same period consumption of fuel oil and distillates in this market increased from about 16.3 million barrels to about 93.2 million barrels and natural gas consumption increased from 28.2 million M cubic feet to 216.2 million M cubic feet. In 1964 use of coal in this market amounted to about 2.6 million tons.

Industrial consumption of coal, including that used by thermal electric generating stations, increased 11.8 per cent in 1964. The proportion of Canadian coal used industrially was about 50 per cent, the remainder being mainly bituminous coal from the United States. Use of coal in thermal electric generating stations in 1964 is estimated at about 6.3 million tons.

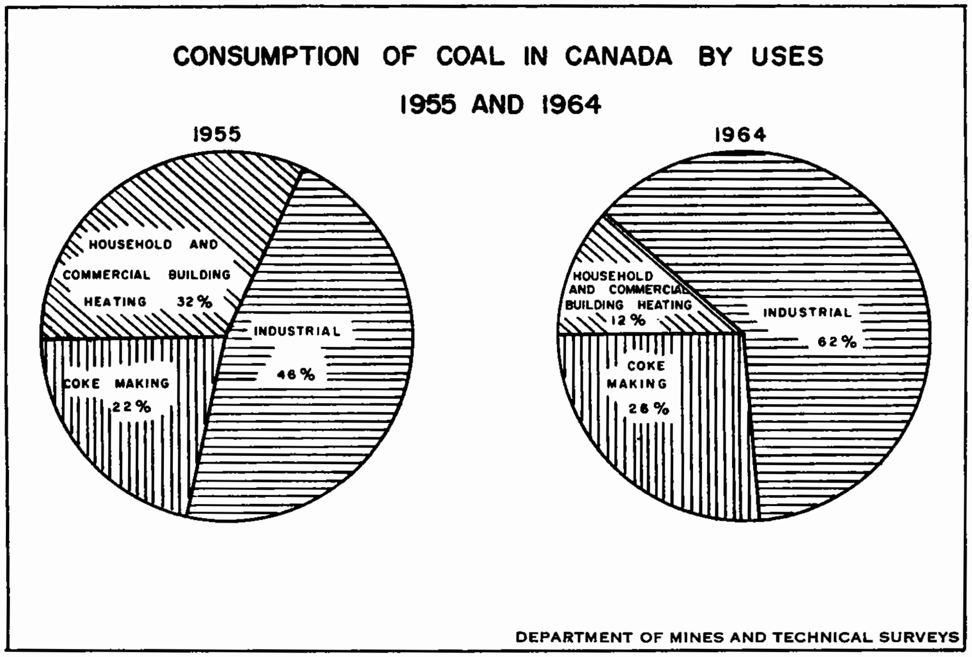


TABLE 9

Consumption of Canadian and Imported Coal, 1955-64

	Canadian		Imported		
	Short Tons*	% of Consumption	Short Tons**	% of Consumption	Total Short Tons
1955.....	14,060,039	42.1	19,322,134	57.9	33,382,173
1956.....	14,115,095	38.9	22,198,049	61.1	36,313,144
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
1964p....	9,989,776	40.0	14,987,656	60.0	24,977,432

Source: Dominion Bureau of Statistics.

*The sum of Canadian coal-mine sales, colliery consumption, coal supplied to employees, and coal used in making coke and briquettes, less the tonnage of coal exported.

**Deductions have been made to take into account foreign coal re-exported from Canada and bituminous coal removed from the warehouse for ships' stores. Imports of briquettes are not included.

p Preliminary.

TABLE 10

Consumption of Coal – Major Uses, 1963 and 1964

(short tons)

	1963	1964p
Household and Commercial-Building Heating		
Canadian		
Bituminous	429,393	434,878
Subbituminous	442,706	398,916
Lignite	280,923	227,978
Total	1,153,022	1,061,772
Imported		
Anthracite	483,998	331,710
Bituminous	1,252,479	1,089,413
Total	1,736,477	1,421,123
Unspecified	166,280	113,345
Total, all types	3,055,779	2,596,240
Industrial*		
Canadian		
Bituminous	4,019,260	4,208,791
Subbituminous	743,945	1,224,461
Lignite	1,323,882	1,499,177
Total	6,087,087	6,932,429
Imported		
Anthracite	220,912	250,115
Bituminous	6,125,889	6,723,928
Total	6,346,801	6,974,043
Total, all types	12,433,888	13,906,472
Coke Making		
Canadian		
Bituminous	663,890	654,085
Imported		
Bituminous	5,074,733	5,212,743
Total	5,738,623	5,866,828

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, 1963 and 1964

(000s short tons)

	1963	1964p
Nova Scotia	540	589
New Brunswick	107	245
Ontario	2,870	3,080
Manitoba.......................	65	149
Saskatchewan	1,060	1,109
Alberta........................	570	1,093
Total, Canada	5,212	6,265

Source: Dominion Coal Board.

p Preliminary.

There was an increase of about 2.2 per cent to about 5.9 million tons in the use of coal to manufacture coke, the increased consumption being imported coal. Use of Canadian coal for this purpose was only 11.1 per cent of the total coal used for coke manufacture.

BRIQUETTES

There was a 38 per cent decrease in the production of lignite coal briquettes and a small increase in the production of bituminous coal briquettes in 1964. Apparent consumption of briquettes was about 19 per cent less than in 1963.

TABLE 12

Briquettes – Production and Consumption

(short tons)

	1963	1964p
Production		
Saskatchewan	35,000e	21,683
Alberta* and British Columbia....................	37,358	38,230
Total, Canada................................	72,358	59,913
Consumption – briquettes available for consumption**	76,224	61,559

Source: Dominion Bureau of Statistics.

*Alberta production excludes 11,677 tons of char in 1963, and 19,971 tons produced in 1964. (Carbonized briquettes previously known as 'char' are now defined as 'coke').

**Production (excluding char) plus 'landed' imports less exports.

Symbols: e Estimated; p Preliminary.

Coke

J.C. BOTHAM*

Of the 25.1 million tons of coal consumed in Canada in 1964 about 5.9 million tons were carbonized 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 The Crow's Nest Pass Coal Company, Limited, collieries in Michel, British Columbia. About 95 per cent of the coal used in the production of coke is processed at these six plants.

There is interest in North America toward a return of the use of non-recovery ovens. The Mitchell oven and modifications of this design are the ovens of this type that are of principal interest at present. Their growing popularity stems primarily from the loss of markets for coke oven byproducts to the petro-chemical industry. Some incentives for their use are lower capital cost and lower labour costs than the early beehive oven through improved coal- and coke-handling facilities. Also these ovens can 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.

In the Cascade area of Alberta a carbonizing retort commenced 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; however, markets other than the chemical industry – mainly for metallurgical applications – are envisaged.

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, Que.

*Fuel and Mining Practice Division, Mines Branch

TABLE 1

Standard Slot-Type Byproduct Coke Oven Plants in Canada

Coke Plant	Battery	Type of Oven	Number of Ovens	Year Built	Byproduct Recovered	Plant Capacity	Coke Distribution
The Algoma Steel Corporation, Limited, Sault Ste. Marie, Ont.	No. 6	Koppers-Becker Underjet	57	1953	Tar, sulphate of ammonia, pyridine oil, benzole, toluene, xylene, solvent naphtha, naphthalene, light oil, gas	4 batteries of 253 ovens with an annual rated capacity of 2,100,000 tons of coal	Blast furnace use – 3½ x ¾ inch; base metal industry ¾ x 3/8 inch and 3/8 x 3/16 inch; sintering – 3/16 x 0 inch.
	No. 5	Koppers-Becker Underjet	86	1943			
	No. 2	Wilputte gun flue	53	1938			
	No. 7	Wilputte Underjet	57	1958			
The Steel Company of Canada, Limited, Hamilton, Ont.	No. 5	Wilputte Underjet	47	1953	Tar, sulphate of ammonia, naphthalene, pyridine, benzole, toluene, xylene, solvent naphtha, sodium phenolate, gas	3 batteries of 191 ovens with an annual rated capacity of 1,470,000 tons of coal	Blast furnace use – plus 5/8 inch; domestic heating – 5/8 x 5/16 inch; sintering – minus 5/16 inch.
	No. 3	Wilputte Underjet	61	1947			
	No. 4	Wilputte Underjet	83	1952			
Dominion Foundries and Steel, Limited, Hamilton, Ont.	No. 1	Koppers-Becker Gun Type Comb.	25	1956	Tar, light oil, gas	3 batteries of 105 ovens with an annual capacity of 930,000 tons of coal	Blast furnace use – plus ¾ inch; sintering – 1/8 x 0 inch; other uses – ¾ x 1/8 inch.
	No. 2	Koppers-Becker Gun Type Comb.	35	1951			

	No. 3	Koppers-Becker Gun Type Comb.	45	1958			
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 — 3½ x 1½ inch, 2½ x 1½ inch domestic heating — 2½ x 1½ inch, 1½ x 7/8 inch, 7/8 x ¼ inch; sintering — ¼ x 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, rock-wool producers.
	No. 2	Koppers-Becker	15	1947			

TABLE 2

Other Carbonization Plants in Canada

Coke Plant	Type of Unit	No. of Units	Year Built	Coal Capacity of Each Unit (tons/day)	Byproducts Recovered	Plant Capacity	Product Distribution
Husky-Dominion Briquets,* Bienfait, Sask.	Lurgi carbonizing retort	2	1925	175 – 200	Creosote, lignite tar, lignite pitch	2 units with an annual rated capacity of 120,000 tons of coal	Domestic heating fuel 29,000 tons char and other – 650 tons
Shawinigan Chemicals Limited, Shawinigan, Que.	Travelling grate coking stoker	8	1939	70	Low grade producer gas	8 units with an annual rated capacity of 200,000 tons of coal	Manufacture of calcium carbide in electric furnaces.
The Canmore Mines, Limited, Canmore, Alta.	Vertical retort	1	1963	100	Crude tar, gas	1 unit with an annual rated capacity of 30,000 tons of agglomerated coal	Chemical industries.
The Crow's Nest Pass Coal Company, Limited, Fernie, B.C.	Mitchell	3	1963	7	No by-products	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 with an annual capacity of 243,000 tons of coal	Base metal industry – 7 x 3 inch; beet sugar industry – 7 x 3 inch; iron reduction in electric furnaces, 7 x 3 inch and 3 x 1 inch; sintering use – minus ¼ inch.
		10	1943	5.5			
		16	1949	7.5			
		16	1952	7.5			
Lethbridge Collieries, Limited, Lethbridge, Alta.	Rotary hearth	1	1964	**	No by-products	**	Iron reduction in electric furnaces; sintering use.

*Formerly Dominion Briquettes and Chemicals Ltd. **Not established at time of reporting.

In 1964 Lethbridge Collieries, Limited entered the carbonization field with completion, late in the year, of a 26-foot diameter rotary hearth oven. The product is used in electric furnaces for the production of iron.

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 nonexistent and the markets are largely supplied by natural gas, liquid petroleum gases and oil.

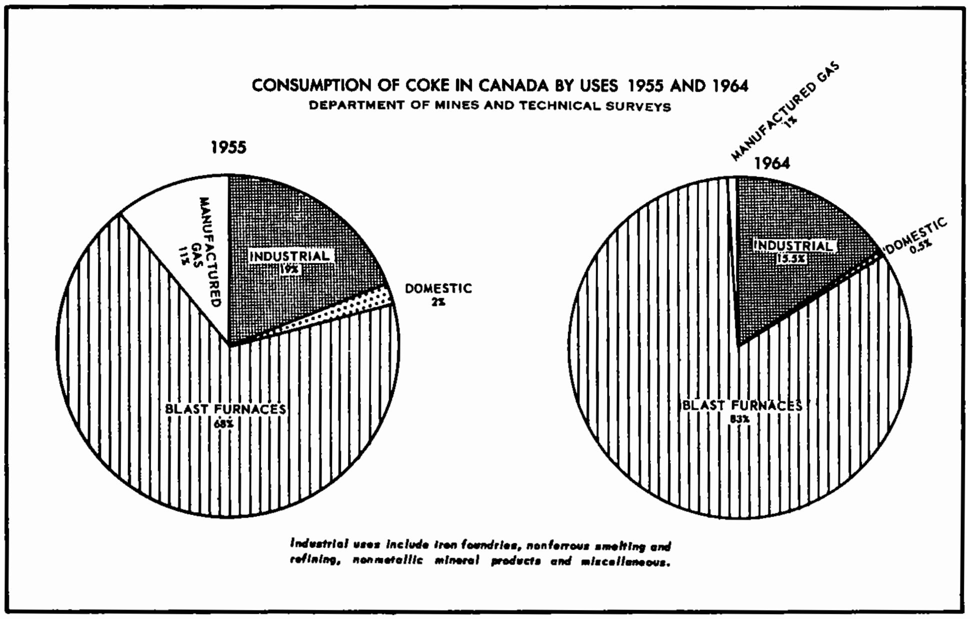
Recently the uses of metallurgical coke have changed because of alterations in the methods of producing pig iron and steel. An increase in the use of agglomerated ores in the iron blast furnace has resulted in an increase in the demand for small sizes of coke and coke breeze. This has made possible,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

TABLE 3

Coke – Production and Trade

	1963		1964p	
	Short Tons	$	Short Tons	$
Production*				
Coal coke				
Ontario	3,416,047		3,495,544	
Other provinces	864,750		847,438	
Total	4,280,797		4,342,982	
Pitch coke	–		–	
Petroleum coke**	199,636		241,980e	
Total	4,480,433		4,584,962	
Imports (all types)				
United States	603,535	10,525,932	315,742	6,507,207
United Kingdom	112	3,818	21	791
Total	603,647	10,529,750	315,763	6,507,998
Exports (all types)				
United States	149,909	1,761,197	101,243	1,338,158
United Kingdom	2,103	92,725	5,918	228,446
Other countries	2,320	41,450	13,579	128,544
Total	154,332	1,895,372	120,740	1,695,148

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.
Symbols: p Preliminary; e Estimated; – Nil.



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. The production of pig iron in electric furnaces has increased with an increase in the demand for high-carbon fuels.

Cobalt

V.B. SCHNEIDER*

Cobalt production in 1964 was 3.2 million pounds valued at $6.5 million. This compares with 3 million pounds valued at $6.1 million in 1963. The increase is attributable to increased production of nickel during the recovery of which cobalt is obtained as a byproduct.

No cobalt ores have been produced in Canada since 1957, but cobalt has been obtained as a byproduct from the smelting and refining of nickel-copper ores from Sudbury, Ontario, from Lynn Lake and Thompson, Manitoba, and as a byproduct of silver refined at Cobalt, Ontario, by Cobalt Refinery Limited. The prices for primary cobalt products, which were established on March 1, 1960, remained unchanged throughout 1964.

PRODUCERS

ONTARIO

The International Nickel Company of Canada, Limited (INCO), recovers cobalt from its nickel-refining operations at Port Colborne. Cobalt oxide and high-purity electrolytic cobalt are produced at the Port Colborne refinery and cobalt oxide and salts are produced by The International Nickel Company (Mond) Limited, a British subsidiary, at Clydach, Wales, from nickel-oxide sinter shipped to Britain from Ontario. In 1964, INCO reported production of 2.2 million pounds of cobalt from all operations, up from 1.9 million pounds in 1963.

Falconbridge Nickel Mines, Limited, produced electrolytic cobalt at its refinery at Kristiansand, Norway, from the refining of nickel-copper matte produced at Sudbury. Falconbridge also reported that cobalt deliveries for 1964 were up over those of 1963.

*Mineral Resources Division

98115—13

TABLE 1

Cobalt – Production, Trade and Consumption

	1963		1964p	
	Pounds	$	Pounds	$
Production[1], all forms	3,024,965	6,122,169	3,196,322	6,484,255
Exports				
Cobalt metal				
United States	558,902	921,881	556,460	958,576
Britain	148,289	215,595	20,100	31,800
Republic of South Africa	3,528	27,872	8,443	66,795
France	10,950	22,995	6,400	10,511
Australia	–	–	1,700	2,907
West Germany	6,920	11,464	500	800
Japan	250	405	4	108
India	5,988	9,461	–	–
Argentina	4,400	5,302	–	–
Total	739,227	1,214,975	593,607	1,071,497
Cobalt oxides and salts[2]				
Britain	1,088,900	1,496,341	1,600,900	2,127,734
United States	9,400	11,987	53,800	62,969
Jamaica	–	–	200	123
Total	1,098,300	1,508,328	1,654,900	2,190,826
Imports				
Oxides[2],[3]				
Britain	26,295	32,403		
United States	1,996	2,344		
Total	28,291	34,747		
Cobalt ore[2],[3]				
United States	2,500	288		
Consumption[4], cobalt metal and cobalt contained in oxides and salts	364,594		365,851	

Source: Dominion Bureau of Statistics.
[1]Production (cobalt content) from domestic ores of cobalt metal and cobalt in alloys, oxides and salts. Excludes the cobalt content of nickel-oxide sinter shipped to Britain by INCO but includes the cobalt content of Falconbridge shipments of nickel-copper matte to Norway. [2]Gross weight. [3]Not available as a separate class commencing 1964. [4]As reported by consumers.
Symbols: p Preliminary; – Nil.

TABLE 2

Cobalt Production, Trade and Consumption, 1955-64
(pounds)

	Production[1] (all forms)	Exports				Imports		Consumption[2]
		Cobalt in Ores and Concentrates	Metallic Cobalt	Cobalt Alloys[3]	Cobalt Oxide and Salts[3]	Cobalt Ores	Cobalt Oxides[3]	
1955	3,318,637	–	1,542,988	12,357	1,640,282	37,800	8,000	224,000
1956	3,516,670	16,000	1,432,884	11,343	1,289,145	1,900	11,353	262,000
1957	3,922,649	15,100	2,155,742	12,400	620,042	800	10,340	153,000
1958	2,710,429	–	1,024,667	9,712	522,144	–	16,230	260,000
1959	3,150,027	–	680,323	3,280	1,100,734	–	24,716	188,000
1960	3,568,811	–	844,293	1,938	1,175,206	–	20,227	182,000
1961	3,182,897	..	603,931	..	1,521,000	–	28,364	307,000
1962	3,481,922	..	542,565	..	1,629,900	–	40,936	299,000
1963	3,024,965	..	739,227	..	1,098,300	2,500	28,291	270,000
1964p	3,196,322	..	593,607	..	1,654,900	..	..	276,000

Source: Dominion Bureau of Statistics.
[1]Production from domestic ores of cobalt metal and cobalt contained in alloys, oxides and salts. Excludes the cobalt content of nickel-oxide sinter shipped to Britain by INCO but includes the cobalt content of Falconbridge shipments of nickel-copper matte to Norway.
[2]Refined metal only. Producers' domestic shipments 1954-59; as reported by consumers 1960-63. [3]Gross weight.
Symbols: p Preliminary; – Nil; .. Not available.

Cobalt Refinery Limited recovers cobalt as a byproduct from its silver smelting and refining of silver-cobalt ores of the Cobalt and Gowganda areas. The company sells its cobalt as a black cobalt oxide, mostly to Canadian manufacturers of frit for base-coat enamelling.

Eldorado Mining and Refining Limited developed a process for the recovery and purification of cobalt, nickel and arsenic from silver-cobalt concentrates. Silver recovery by Eldorado from the concentrates will be shipped to Cobalt Refinery for refining. Eldorado will begin commercial operations in 1965 at its Port Hope refinery, which has sufficient capacity to handle all available concentrates from the Cobalt and Gowganda areas. These developments by Eldorado will probably result in Cobalt Refinery Limited placing the emphasis of its operation on the recovery and refining of silver; Eldorado Mining and Refining Limited would recover and upgrade cobalt, nickel and arsenic.

MANITOBA AND ALBERTA

Sherritt Gordon Mines, Limited, produced 594,249 pounds of cobalt during 1964, about 13,000 pounds less than was produced in 1963. Sherritt Gordon recovers cobalt as a byproduct of its nickel-refining operations at Fort Saskatchewan, Alberta; this refinery treats nickel-copper-cobalt ore from the company's Lynn Lake, Manitoba, mine and from purchased cobalt-bearing material. The company reports that sales of cobalt for the year exceeded production and amounted to 621,535 pounds. Sales to the chemical industry were about the same as in 1963 but there was an appreciable increase in the sale of cobalt briquettes and a nominal increase in the sale of cobalt strip to meet a newly-developed catalytic use. Also in 1964, Sherritt Gordon offered, for the first time, pure cobalt in the form of fine expanded metal for catalyst applications.

INCO produced cobalt oxide at its Thompson, Manitoba, refinery as a byproduct of its nickel-refining operations.

WORLD MINE PRODUCTION

The Cobalt Information Centre* reported that cobalt production for 1964 amounted to 15,100 short tons, about 300 tons less than in 1963. A compilation of world production from a number of other sources indicates that production may have been as low as 14,600 tons in 1964. However, it is fairly certain that production increased in the Republic of the Congo, Morocco and Canada, and decreased in Zambia and Germany.

The Republic of the Congo (Leopoldville) is by far the largest producer of cobalt. Its production in 1964 was 8,488 tons, all derived as a byproduct from the copper-refining operations of Union Minière du Haut-Katanga.

Cobalt was produced in Zambia by Rhokana Corporation Limited and Chibuluma Mines Limited. According to the Copper Industry Service Bureau Limited, Kitwi, Zambia, Rhokana produced 644 tons of cobalt metal and Chibuluma produced 69 tons. Low-grade matte production at Chibuluma ceased and upgrading operations commenced during March 1963. The cobalt plant closed in February 1964 without any announcement as to its possible reopening. Sales of cobalt from Zambia in 1964 amounted to 1,736 tons valued at £1,836,813 which compares with the sale of 815 tons valued at £871,441 in 1963.

In French Morocco, cobalt is derived from the cobalt-bearing deposits in the Bou Azzer district by the Société Minière du Bou Azzer et du Graaza. Preliminary reports indicate that production for 1964 was about 1,901 tons. Most of the French Moroccan cobalt concentrates are refined in France, the remainder in Belgium. Like the ores of Cobalt, Ontario, those from Morocco are arsenical and must be treated at smelters that specialize in this raw material.

In the United States, primary cobalt is recovered in small quantities as a byproduct of iron-ore production. As there is only one producer, official production figures are not released but an estimate in the February 1965 issue of ENGINEERING AND MINING JOURNAL place production for 1964 at about 250 tons, which is the same as for each of the previous two years. Bethlehem Steel Corporation treats calcined ore from its Cornwall, Pa., mine at a sulphuric acid leaching plant at Sparrows Point, Md. This leaching operation produces a

*COBALT, No. 26, March 1965, published by Centre d'Information du Cobalt, Brussels.

copper-cobalt concentrate that is further processed by Pyrites Company Inc., at Wilmington, Del. In the United States, about 25 refineries and processors produce primary cobalt products from imported ores, concentrates, metal, waste and scrap, all of which are imported duty-free.

TABLE 3

World Production of Cobalt, 1963-64
(short tons)

	1963	1964p
Republic of the Congo	8,131	8,488
Zambia	1,599	708
Germany	1,582	1,527
Canada	1,512	1,598
Morocco	1,764	1,901
United States[e]	250	250
Other	136	128
Total	14,974	14,600

Sources: COBALT, No. 26, March 1965, Centre d'Information du Cobalt, Brussels; The Dominion Bureau of Statistics.
Symbols: p Preliminary; e Estimated.

USES

The most important application of cobalt is in high-temperature cobalt-base alloys used for such parts as nozzle guide vanes and turbine rotor blades in jet engines, gas-turbine engines and in guided missiles. The metal is an important constituent of permanent-magnet alloys, cemented carbides, hard-facing rods and high-speed steel. A radioisotope, Cobalt 60, is widely used for radiographic examinations by industry and also in the 'cobalt bomb' treatment of cancer.

Cobalt oxide is used in ground-coat frit for bonding porcelain enamel to a metal base. It is also used as a colouring agent in making glass and ceramics.

Organic salts of cobalt are used as driers in paint, varnish, enamel, ink, etc. Inorganic salts such as cobalt sulphate and cobalt carbonate are used in animal feeds.

CONSUMPTION

The United States is the largest consumer of cobalt and, according to the United States Bureau of Mines, MINERAL INDUSTRY SURVEYS, COBALT, MONTHLY SUPPLEMENT, April 21, 1965, consumption in 1964 was 10.6 million pounds. This compares with 10.5 million pounds in 1963. According to the Cobalt Information Centre, cobalt consumption in other parts of the noncommunist world was fairly high, reflecting the high level of economic activity that prevailed throughout the year. Canadian consumption of cobalt in the form of metal, oxide and salts at 365,851 pounds was up only slightly above that of 1963.

Table 4, which illustrates the distribution of cobalt consumption by end uses in the United States, shows a slight decrease in the relative amount of cobalt used in the manufacture of magnets but total metallic applications continued to increase; the amount of cobalt used in alloy hard-facing rods and materials and in cemented carbides was at an all-time high. The continuing decrease in the amount of cobalt used in permanent magnets partly reflects competition from ferrites but more properly reflects the effects of imports of these alloys into the United States.

TABLE 4

United States Consumption of Cobalt by Uses, 1963-64
(percentages of total consumption)

	1963	1964
Metallic, steel		
High-speed steel	3.8	2.9
Other tool and alloy steel	7.9	6.7
Permanent-magnet alloys	22.3	20.8
Cutting and wear-resisting materials	2.6	3.2
High-temperature high-strength materials	23.3	23.1
Alloy hard-facing rods and materials	5.8	7.5
Cemented carbides	3.9	4.1
Nonferrous alloys and other metallic uses	5.6	7.1
Total, metallic	75.2	75.4
Nonmetallic, exclusive of salts and driers		
Ground-coat frit	5.5	5.6
Pigments	2.1	2.0
Other materials	5.8	5.0
Total, nonmetallic	13.4	12.6
Salts and driers: lacquers, varnishes,paints, inks, pigments, enamels, feeds,electroplating, etc. (estimated)	11.4	12.0
Grand total	100.0	100.0

Source: U.S. Bureau of Mines, MINERALS YEARBOOK, 1963.

TABLE 5

Cobalt Consumption in Canada, 1963 and 1964
(pounds of contained cobalt)

	1963	1964p
Cobalt metal	270,136	276,313
Cobalt oxide	61,565	52,991
Cobalt salt	32,893	36,547
Total	364,594	365,851

Source: Dominion Bureau of Statistics.
p Preliminary.

PRICES

Prices in the United States according to E & MJ METAL AND MINERAL MARKETS, December 28, 1964, were as follows:

Cobalt metal, per lb f.o.b. New York

Shot – 99% +
- less than 100-lb lots $1.57
- less than 100-lb lots 1.52
- less than 500-lb lots 1.50

Powder – 99% +
- 300 mesh, 100-lb lots 1.82
- extra fine, 5-50 kilo lots 2.32
- S grade, 10-ton lots 1.53

Fines – 95-96% 1.50
- 300 mesh.......................... 1.65

Briquettes, 10-ton lots 1.68

Cobalt oxide, per lb, contained ceramic, delivered, 3¢ more west of Mississippi
- 70-71%............................ 1.12
- 72 1/2 - 73 1/2%..................... 1.15

Metallurgical – 75–76% 1.65

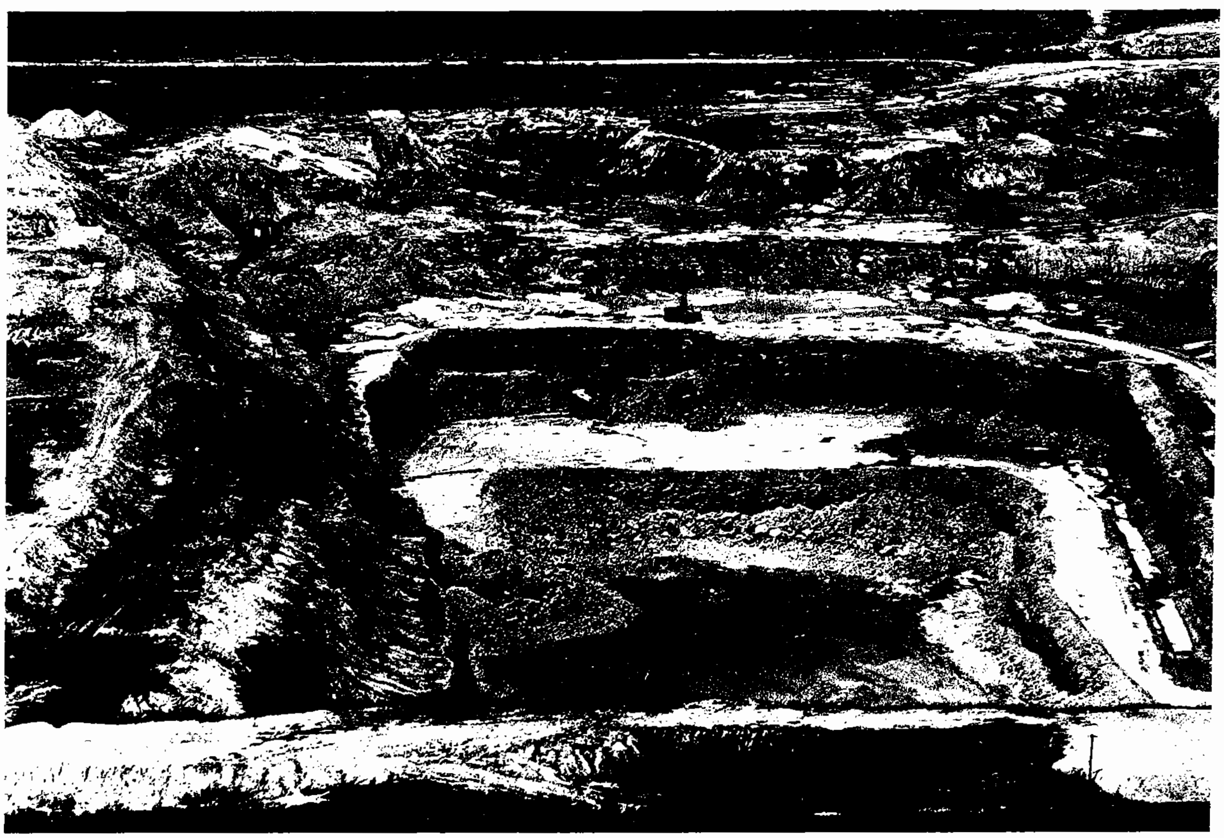
Cobalt ore, per lb, free market
- 10% cobalt content .... 0.60 (nominal)
- 11% cobalt content .... 0.70 (nominal)
- 12% cobalt content .... 0.80 (nominal)

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
Cobalt bars	10	10	25

UNITED STATES

Ore	free
Metal	free
Cobalt oxide	1.5¢ lb
Cobalt sulphate	1.5¢ lb
Cobalt linoleate	7.25¢ lb
Other cobalt compounds and salts	12



Quarry at Canada Cement Co. Woodstock plant.

Copper

A.F. KILLIN*

The high level of industrial activity that carried over from the fourth quarter of 1963 into 1964 was accompanied by a sharp increase in copper consumption. The supply-demand balance that had been achieved by production curtailments maintained by many of the large copper producers in Africa, United States, Chile and Canada, was threatened by the possibility of prolonged work stoppages at the major United States producers where contract negotiations were scheduled to start at mid-year. Consumers who had allowed their inventories to dwindle during the period of assured supply were alarmed at the thought of short supply and increased their purchases to replenish inventories and to cover the expected increase in consumption. A shortage of copper developed and although idle capacity at the mines throughout the world was reactivated in January, delays in achieving full production coupled with work stoppages at many of the producing facilities prevented production from overtaking demand and the shortage persisted to the end of the year.

The London Metal Exchange (LME) price reacted quickly to the threat of a copper shortage but price stability was maintained by the establishment of a producers price for copper sales in Europe. Although the price on the London Metal Exchange reached a high of 66 cents in the year, producers' prices were held at reasonable levels (see graph "Copper Prices 1964").

With all mines producing at or near capacity for the year, Canada's mine production of copper set a record of 494,017 tons valued at $328,233,604 which were 41,458 tons and $43,829,914 more than in 1963.

The output of refined copper reversed the trend of the last two years and at 408,505 tons was 29,594 tons higher than in 1963. Domestic consumption of refined copper (producers' domestic shipments) continued to increase and a 19-per-cent rise over 1963 brought consumption in 1964 to 202,101 tons.

*Mineral Resources Division

TABLE 1
Copper – Production, Trade and Consumption

	1963		1964p	
	Short Tons	$	Short Tons	$
Production				
All forms				
Ontario	178,960	112,048,454	201,031	132,519,010
Quebec	141,400	89,081,976	160,288	107,072,207
British Columbia	62,218	39,184,967	57,506	38,413,747
Manitoba	16,980	10,697,506	29,192	19,500,052
Saskatchewan	29,772	18,756,028	20,688	13,819,624
Newfoundland	14,012	8,827,797	14,505	9,689,729
New Brunswick	8,964	5,647,307	10,523	7,029,479
Nova Scotia	237	149,394	284	189,756
Northwest Territories	16	10,281	–	–
Total	452,559	284,403,710	494,017	328,233,604
Refined	378,911		408,509	
Exports				
In ore and matte				
Japan	57,325	28,275,298	65,211	32,112,839
United States	15,685	7,352,160	13,223	6,533,306
Norway	15,261	7,087,306	12,359	5,707,620
Sweden	–	–	7,168	4,802,712
West Germany	948	394,654	2,546	1,046,577
Belgium and Luxembourg	991	238,421	1,968	651,489
Britain	1,815	882,640	1,598	864,907
Mexico	–	–	287	102,967
France	–	–	190	47,086
Portugal	905	400,498	–	–
Total	92,930	44,630,977	104,550	51,869,503
Refinery shapes				
Britain	98,703	61,361,375	110,396	72,208,723
United States	74,098	49,308,036	85,293	58,400,833
France	6,112	3,795,267	15,666	9,677,849
West Germany	7,013	4,348,320	2,907	1,919,921
Sweden	3,695	2,289,505	2,303	1,518,209
Belgium and Luxembourg	2,255	1,388,714	1,835	1,235,573
Italy	1,829	1,141,577	1,735	1,149,048
Switzerland	225	148,221	1,373	905,180
Poland	3,807	2,360,550	952	598,998
Czechoslovakia	896	555,367	784	530,879
Portugal	897	600,280	505	334,949
India	13,834	8,503,391	420	260,058
Other countries	1,623	997,497	104	68,672
Total	214,987	136,798,100	224,273	148,808,892

Table 1 (cont'd)

	1963		1964p	
	Short Tons	$	Short Tons	$
Exports (Cont.)				
Scrap, slag, skimmings, sludge				
Japan	6,356	3,475,310	6,439	4,359,162
West Germany	124	57,984	2,582	1,795,177
Spain	1,753	962,677	1,527	1,024,813
United States	1,123	379,683	1,521	1,115,699
Yugoslavia	971	588,988	464	311,675
India	243	132,233	407	245,298
Netherlands	76	39,000	279	218,270
Other countries	38	19,737	266	161,971
Total	10,684	5,655,612	13,485	9,232,065
Bars, rods and shapes (sections) not elsewhere specified and plates, sheet, strip and flat products				
United States	2,294	2,052,448	6,797	5,821,100
Norway	7,768	4,988,845	6,673	4,487,296
Switzerland	4,723	2,859,163	6,205	3,894,528
Pakistan	3,508	2,173,343	3,758	2,339,697
Britain	2,025	1,353,338	2,883	2,115,888
Denmark	2,587	1,590,775	2,022	1,353,425
Spain	811	505,710	1,823	1,191,291
Venezuela	1,445	1,000,080	1,576	1,262,934
Colombia	497	361,838	747	582,198
Ireland	6	3,478	526	335,916
Other countries	705	601,312	1,958	1,738,070
Total	26,369	17,490,330	34,968	25,122,343
Pipe and tubing				
New Zealand	1,776	1,834,812	2,386	2,614,049
United States	2,435	2,120,691	2,109	1,861,270
Britain	521	575,991	916	1,011,191
Puerto Rico	394	373,811	514	519,979
Philippines	433	449,751	412	479,252
Israel	164	150,396	404	427,382
Venezuela	332	333,945	394	400,675
Colombia	262	248,110	199	205,737
Hong Kong	93	83,585	175	159,601
Other countries	1,105	1,173,943	1,424	1,530,400
Total	7,515	7,345,035	8,933	9,209,536

Table 1 (cont.)

	1963		1964p	
	Short Tons	$	Short Tons	$
Exports (cont.)				
Wire and cable, not insulated				
Britain.................	—	—	258	226,601
United States	49	40,283	119	117,365
Colombia...............	1	952	86	67,657
Switzerland.............	—	—	56	36,054
Barbados...............	—	—	45	33,890
Jamaica................	..	183	36	21,540
New Zealand	21	19,473	31	31,272
Cuba	26	28,244	28	32,884
Japan..................	—	—	27	18,000
Other countries	360	235,413	162	141,497
Total................	457	324,548	848	726,760
Wire and cable insulated[2]				
United States	4,760	4,625,113	8,659	11,366,533
Philippines.............	48	22,907	586	789,605
Venezuela..............	247	283,904	290	294,694
New Zealand	93	106,013	218	265,521
Chile	56	57,090	165	180,560
Panama	83	69,293	138	104,197
Dominican Republic	219	204,344	135	158,794
Bermuda	125	116,220	129	121,039
Other countries	1,238	1,277,122	1,042	1,041,275
Total................	6,869	6,762,006	11,362	14,322,218
Imports[3]				
Copper in ores, concentrates and scrap	3,254	1,983,494	2,300	1,383,000
Copper refinery shapes.......	6,549	3,817,125	6,770	4,444,000
Copper bars, rods and shapes (sections), n.e.s...........	215	171,205	926	819,000
Copper plates, sheet, strip and flat products..............	83	144,362	122	201,000
Copper pipe and tubing.......	315	433,346	431	617,000
Copper wire and cable, except insulated.................	22	42,651	266	316,000
Copper alloy scrap	120	49,359	223	107,000
Copper alloy refinery shapes, bars, rods and sections	2,663	1,701,469	1,105	1,320,000
Copper alloy plates, sheet, strip and flat products	324	384,793	964	1,008,000

Table 1 (cont.)

	1963		1964p	
	Short Tons	$	Short Tons	$
Copper alloy pipe and tubing..	762	1,105,343	737	1,091,000
Copper alloy cable, except insulated.................	..	182,456	886	1,265,000
Copper and alloy fabricated materials, n.e.s.		1,121,170		3,087,000
Consumption[4]				
Refined..................	169,750		202,101	

Source: Dominion Bureau of Statistics.
[1] Blister copper plus recoverable copper in matte and concentrates exported. [2] Includes also small quantities of noncopper wire and cable, insulated.[3] Due to import classification changes commenced in 1964, import classes for 1964 are not completely comparable with those of previous years. [4] Producers' domestic shipments.
Symbols: p Preliminary; — Nil; ..Not available.

TABLE 2

Copper – Production, Trade and Consumption, 1955–64

(short tons)

	Production		Exports			Imports	Consumption**
	All forms*	Refined	In ore and matte	Refined	Total	Refined	Refined
1955	325,994	288,997	41,565	153,199	194,764	35	138,559
1956	354,860	328,458	40,993	174,844	215,837	2,541	145,286
1957	359,109	323,540	46,548	198,794	245,342	4,175	118,225
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	117,636
1961	439,088	406,359	42,894	266,247	309,141	3	141,807
1962	457,385	382,868	89,374	223,043	312,417	147	151,525
1963	452,559	378,911	92,930	214,987	307,917	6,549	169,750
1964p	494,017	408,509	104,550	224,273	328,823	6,770	202,101

Source: Dominion Bureau of Statistics.
*Blister copper plus recoverable copper in matte and concentrate exported. **Producers' domestic shipments, refined copper.
› Preliminary.

Six new mines contributed to the rise in 1964 mine production. Exploration r new properties and development of known deposits continued in most of nada's copper-bearing areas. New mines were brought into production in New-ındland, New Brunswick, Quebec, Ontario, Manitoba and British Columbia;

mines were being developed in each of these provinces and in the Yukon Territory. One mine was closed by a strike in British Columbia. Copper production increased in Newfoundland, New Brunswick, Quebec, Ontario and Manitoba; it declined in Saskatchewan and British Columbia.

PRODUCTION AND DEVELOPMENTS

Details of individual mine production and development are given in Table 3. The following résumé gives the production and significant developments by provinces.

NEWFOUNDLAND

Consolidated Rambler Mines Limited became Newfoundland's fourth copper producer when production started at its mine near Baie Verte in October. Newfoundland's 1964 production at 14,505 tons was 493 tons more than in 1963.

The 500-ton-a-day mill at the Rambler property will be enlarged to 1,500 tons a day in 1965 to mill the ore from the East Zone orebody, which is presently under development. First Maritime Mining Corporation Limited failed to find sufficient ore to maintain reserves at its Tilt Cove mine on the east coast of Burlington Peninsula. The mine was on a salvage basis toward the end of the year, but a reappraisal of some exploration results brought about a postponement of closure and it is expected that the mine will operate at least until the end of 1965. First Maritime started the construction of a 1,500-ton-a-day mill at the Gull Pond mine of Gullbridge Mines Limited, near Badger. Shaft sinking and underground development were underway and production is scheduled for mid-1965. The property was partially developed and explored in 1953 when 570,000 tons of ore averaging 1.44 per cent copper were indicated.

Atlantic Coast Copper Corporation Limited completed a program of shaft sinking to 1,525 feet below the surface and started exploration and development of its orebody on the 1,100- and 1,350-foot levels. Results were encouraging and a new hoist and a higher headframe will be installed to allow a faster production rate and further deepening of the shaft. Diamond drilling to explore the ore zone below the 1,350-foot level will be done in 1965. British Newfoundland Corporation Limited was preparing its Whalesback Pond orebody, six miles southwest of Little Bay, for production at 1,500 tons of ore a day. Reserves are calculated at 3,000,000 tons averaging 1.80 per cent copper. The concentrates will be trucked to Little Bay and loaded into ships over the Atlantic Coast dock from a storage shed built adjacent to that of the latter company. Production from the Whalesback mine is scheduled for July 1965.

NEW BRUNSWICK

Production of copper increased to 10,523 tons in 1964 from 8,964 tons in 1963. Most of this increase was contributed by New Brunswick's newest producer, Brunswick Mining and Smelting Corporation Limited. This property started

TABLE 3

Producing Companies, 1964

Company and Location	Mill Capacity (tons ore/day)	Ore Produced 1964 (1963) (short tons)	Grade (%) Copper	Zinc	Nickel	Developments
Newfoundland						
American Smelting and Refining Company (Buchans Unit), Buchans	1,250	383,000 (376,000)	1.09	13.04	–	Normal exploration and development.
Atlantic Coast Copper Corporation Limited, Little Bay	1,150	317,529 (376,403)	0.89	–	–	Exploration by diamond drilling on the north and main zones. Development of stopes started between the 1,300- and 1,000- foot levels. New headframe will be built over the shaft, a larger hoist will be installed and the shaft will be deepened.
Consolidated Rambler Mines, Limited, Baie Verte	500	57,381 (–)	1.26	2.23	–	Production started September 1 from the Rambler orebody. Surface drilling and shaft sinking on the East Zone orebody. Mill capacity will be expanded to 1,000 tons a day and production from the East Zone is scheduled for 1966.
First Maritime Mining Corporation Limited, Tilt Cove	2,350	792,313 (831,641)	1.15	–	–	Mining continued on a salvage basis in 1964. It is planned to complete 1,600 feet of drifting and 50,000 feet of diamond drilling in 1965.
Nova Scotia						
Magnet Cove Barium Corporation, Magnet Cove	125	48,927 (49,058)	0.64	1.52	–	Ore contains 3.69 per cent lead and 12.7 ounces of silver per ton. Routine exploration and development.

Table 3 (cont.)

Company and Location	Mill Capacity (tons ore/day)	Ore Produced 1964 (1963) (short tons)	Grade (%)			Developments
			Copper	Zinc	Nickel	
New Brunswick						
Brunswick Mining and Smelting Corporation Limited, Bathurst	4,500	777,902 (–)	0.30	9.47	–	Mill operated about 260 days. Mine development and exploration continued.
The Consolidated Mining and Smelting Company of Canada Limited (Wedge Mine), Nepisiquit River, Bathurst-Newcastle.	750 (trucked to Heath Steele mill)	281,656 (263,000)	..	..	–	Routine development. Exploration continued at depth.
Heath Steele Mines Limited, Bathurst–Newcastle	1,500	290,000 (265,939)	0.90	6.40	–	Mills 750 tons of ore a day from the Wedge mine. Routine exploration and development.
Quebec						
Campbell Chibougamau Mines Ltd. (Main, Kokko Creek, Cedar Bay, and Henderson Mines), Doré Lake, Chibougamau.	3,500 (treated at central mill)	896,706 (833,286)	1.84	–	–	Routine exploration and development. Mill will be moved from Main mine to the Henderson mine.
Gaspé Copper Mines, Limited Murdochville	7,300	2,725,300 (2,694,100)	1.24	–	–	Preparing Copper Mountain orebody for production. Mill capacity will be increased to 11,000 tons of ore a day in 1967.
Lake Dufault Mines, Limited, Noranda	1,300	139,956 (–)	5.00	7.56	–	Mill tune-up started in September. Mine production started in October and 1,219 tons of ore a day milled. Routine exploration and development.

Company and Location	Mill Capacity (tons ore/day)	Ore Produced 1964 (1963) (short tons)	Grade (%) Copper	Zinc	Nickel	Developments
Manitou Barvue Mines Limited, Val d'Or	1,300	244,980 (293,000)	0.82	–	–	Routine exploration and development. Improved metal prices will allow the economic mining of 311,000 tons of zinc ore averaging 0.50 ounce of silver and 2.97 per cent zinc.
		142,925 (174,365)	–	5.12	–	
Mattagami Lake Mines Limited, Matagami	3,850	1,282,072 (166,725)	0.71	13.10	–	Routine exploration and development. Mill capacity increased to 3,850 tons of ore a day from 3,000 tons.
Merrill Island Mining Corporation, Ltd., Doré Lake, Chibougamau	650	133,552 (143,087)	2.46	–	–	Exploration of the orezone below the 2,000-foot level. Drilling on the 300-foot level to the orebody on Chib-Kayrand property.
New Hosco Mines Limited, Matagami	900 (trucked to the Orchan mill)	330,155 (44,000)	2.44	–	–	Exploration by diamond drilling below the 900-foot level.
Noranda Mines Limited, Noranda	3,200	897,341 (1,236,000)	2.01	–	–	Smelter capacity was increased. Exploration of the orebody at depth from the shaft that was deepened in 1963.
Normetal Mining Corporation, Limited, Normetal	1,000	348,924 (345,384)	1.89	7.17	–	Routine exploration and development. Main shaft will be deepened from the 6,765-foot level to the 8,000-foot level.
Opemiska Copper Mines (Quebec) Limited, Chapais	2,000	748,990 (737,543)	2.82	–	–	Routine mining and development in both the Springer and Perry zones. Extensive underground diamond drilling in the Springer and Perry zones has maintained reserves at the 1963 total and has indicated the possibility of finding new orebodies.

Table 3 (cont.)

Company and Location	Mill Capacity (tons ore/day)	Ore Produced 1964 (1963) (short tons)	Grade (%) Copper	Zinc	Nickel	Developments
Orchan Mines Limited, Matagami	1,900	369,272 (35,955)	1.06	12.79	–	Mills 900 tons of ore a day from the New Hosco mine. Normal development and exploration. Mining method will be changed in 1965 from open stoping to cut-and-fill mining, utilizing deslimed mill tailings for fill.
The Patino Mining Corporation, Copper Rand Division (Machin Point, Chibougamau Jaculet, Portage Island and Quebec Chibougamau Goldfields mines), Gouin Peninsula, Chibougamau	1,800 (treated at central mill at Machin Point mine)	674,131 (675,730)	2.36	–	–	Routine exploration and development.
Quemont Mining Corporation, Limited, Noranda	2,300	752,691 (803,000)	1.16	2.38	–	Routine development.
Solbec Copper Mines, Ltd., Stratford Place	1,000	424,127 (188,943)	1.80	4.56	–	Production started from the open pit in May 1964 and mill capacity was increased to 1,500 tons a day. The open pit will supply the bulk of production until mid-1965 at which time custom milling of 600 tons of ore a day from the Cupra mine is scheduled.
Sullico Mines Limited, Val d'Or	3,000	988,023 (1,007,046)	0.60	0.15	–	Routine exploration and development.
Vauze Mines Limited, Noranda	350	126,756 (115,878)	1.41	–	–	Mine operated on a salvage basis in the latter half of 1964 and will close in 1965 owing to lack of ore reserves.

Table 5 (cont.)

Company and Location	Mill Capacity (tons ore/day)	Ore Produced 1964 (1963) (short tons)	Grade (%) Copper	Zinc	Nickel	Developments
Ontario						
Copperfields Mining Corporation Limited (Temagami Mining Co., Limited), Timagami	200	56,894 (55,009)	6.60	–	–	Routine exploration and development in 1964. Shaft will be deepened 450 feet and three new levels established in 1965.
Falconbridge Nickel Mines, Limited (Falconbridge, East, Hardy, Onaping and Fecunis mines), Falconbridge	3,000 (Falconbridge) 1,500 (Hardy) 2,400 (Fecunis)	1,960,000 (2,065,259)	..	–	..	Routine development and exploration at producing mines. Shaft sinking, diamond drilling and stope development at the Strathcona mine. North mine discovered adjacent to the Fecunis orebody.
Geco Mines Limited, Manitouwadge	3,300	1,299,300 (1,281,165)	2.09	5.52	–	A zinc concentrate drier was installed. Sinking of the No. 4 shaft continued.
The International Nickel Company of Canada, Limited (Frood–Stobie, Creighton, Garson, Levack, Murray and Crean Hill mines and Clarabelle open pit mine), Copper Cliff	30,000 (Copper Cliff) 12,000 (Creighton) 6,000 (Levack)	14,007,969 (11,208,443)	..	–	..	The Crean Hill mine started production in 1964. A new oxygen-producing plant will be added to existing capacity at the Copper Cliff smelter. Total oxygen capacity will be 1,000 tons a day.
Kam–Kotia Porcupine Mines, Limited, Timmins	1,500	638,000 (400,091)	1.26	1.00	–	Development of underground orebodies continued in 1964. Underground mining will supply over 90 per cent of the mill feed in 1965. Mining in the open pit planned to be completed in 1965.

Table 3 (cont.)

Company and Location	Mill Capacity (tons ore/day)	Ore Produced 1964 (1963) (short tons)	Grade (%) Copper	Grade (%) Zinc	Grade (%) Nickel	Developments
McIntyre–Porcupine Mines, Limited, Schumacher	1,000	383,060 (156,400)	0.93	–	–	Normal exploration and development. A hydraulic backfill system was installed. Mill will be enlarged in 1965 to treat 1,500 tons of copper ore.
Metal Mines Limited, Gordon Lake	700	192,874 (..)	0.58	–	1.22	Routine exploration and development.
North Coldstream Mines Limited, Kashabowie	1,100	366,950 (367,677)	2.06	–	–	Routine exploration and development.
Rio Algom Mines Limited, Pronto Division, Spragge	750	256,226 (258,499)	1.83	–	–	Development for mining of the ore between the 2,705–foot and 2,105–foot levels was almost complete at year end. Sinking of the No. 2 Pater shaft from the 2,705–foot level to the 4,000–foot level will start in 1965. A hydraulic fill system was installed.
Willroy Mines Limited, Manitouwadge	1,500	530,151 (483,800)	1.10	3.34	–	Routine mining development. Exploration by drifting on the 1,600–foot level. Development of the Willicho orebody.
Manitoba – Saskatchewan						
Hudson Bay Mining and Smelting Co., Limited (Flin Flon, Coronation, Schist Lake, Chisel Lake and Stall Lake mines), Flin Flon and Snow Lake	6,000 (central mill at Flin Flon)	1,585,394 (1,618,617)	2.83	4.10	–	Underground development in Osborne Lake mine at Snow Lake, Manitoba. Extensive field exploration. Anderson Lake orebody discovered near Snow Lake and underground development planned for 1965.

Company and Location	Mill Capacity (tons ore/day)	Ore Produced 1964 (1963) (short tons)	Grade (%) Copper	Zinc	Nickel	Developments
Sherritt Gordon Mines, Limited, Lynn Lake, Manitoba	3,500	1,362,693 (1,346,192)	..	—	..	Exploration and development of the B, K, O and N zones. Diamond drilling for the extensions of known orebodies and to find new orebodies.
British Columbia						
The Anaconda Company (Canada) Ltd., Britannia Beach	4,000 (operating rate 2,550)	444,757 (493,700)	1.24	0.57	—	Mine struck by members of United Mine Mill and Smelter Workers union on August 11 and has remained closed.
Bethlehem Copper Corporation Ltd., Highland Valley	4,000	1,379,429 (1,203,750)	0.91	—	—	Jersey orebody prepared for mining by stripping overburdens. Exploration of the Iona zone by surface diamond drilling. Mill expansion to 6,000 tons of ore a day started.
The Consolidated Mining and Smelting Company of Canada Limited, Coast Copper Mine, Benson Lake, V.I.	750	306,132 (281,347)	..	—	—	Rehabilitation of No. 2 winze and development of orebody below the main haulage.
Craigmont Mines Limited, Merritt	5,000	1,874,321 (1,787,717)	1.63	—	—	Final phase of open—pit mining started. Routine development of underground stopes.
Giant Mascot Mines, Limited, Hope	1,250	324,635 (313,836)	0.34	—	0.78	Routine exploration and development at Giant Mascot mine. Canam property near Hope, B.C. optioned and exploration started.
The Granby Mining Company Limited, Phoenix Division, Greenwood	2,000	686,267 (645,083)	0.71	—	—	Routine exploration and mining.
Mt. Washington, Copper Co. Ltd., Courtenay, V.I.	1,000	.. (—)	..	—	—	Started production in December. Concentrates are shipped to Japan.

Source: Company reports.
Symbols: .. Not available; — Nil.

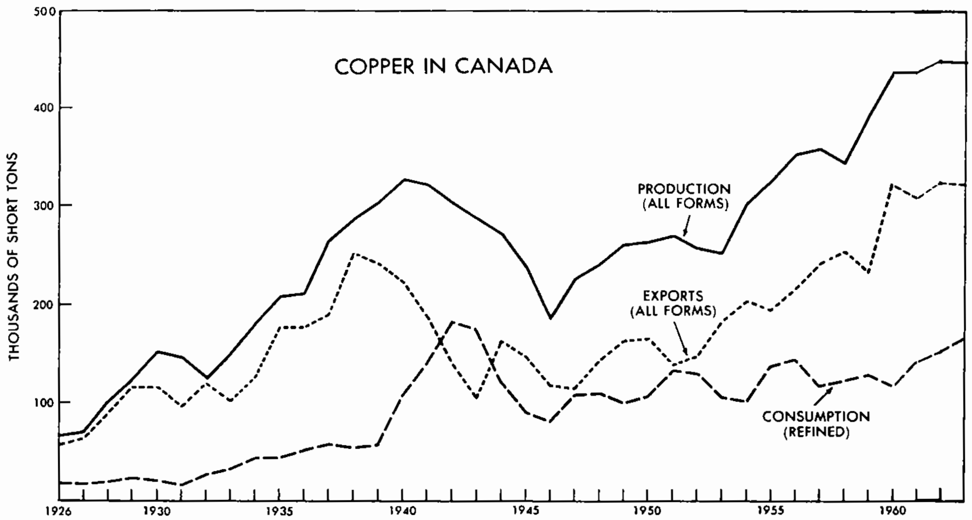
production in March at its No. 12 zinc-lead-copper mine about 10 miles southwest of Bathurst. The mill was originally designed to treat 3,000 tons of ore a day but by July 1 had been expanded to handle 4,500 tons a day. The company will open two new mines and build a new lead-zinc concentrator in the Bathurst area. It is building a lead-zinc smelter at Belledune Point and has announced plans to add a steel mill-fertilizer-acid plant complex. Heath Steele Mines Limited, 33 miles north of Newcastle, continued operation of its 1,500-ton-a-day mill on ore from the Heath Steele mine and from the Wedge mine of The Consolidated Mining and Smelting Company of Canada Limited. Each mine produced about 750 tons of ore a day.

QUEBEC

Quebec's record production of 160,288 tons of copper in 1964 was 18,888 tons more than the 1963 output and 2,818 tons more than in 1960, the previous record year. The increased output was achieved by a return to full production at the Horne mine of Noranda Mines Limited, greater production from the mines in the Chibougamau area and a full year's production from the three mines at Matagami. Production started in August at the mine of Lake Dufault Mines, Limited in the Noranda-Normetal area. The 1,300-ton-a-day concentrator was officially opened in October. Normetal Mining Corporation, Limited completed a program of diamond drilling from the bottom level of its mine. Results were favourable and the company is preparing to deepen the shaft from 6,765 feet below the collar to approximately 8,000 feet. Vauze Mines Limited expects to complete the mining of known reserves by mid-1965 at its copper mine near Waite Amulet.

At Chibougamau, Campbell Chibougamau Mines Ltd. operated four mines. Most of Campbell's ore reserves are in the Henderson orebody, eight miles from the Campbell mill. Extensive development and exploration was carried out on the Henderson A and B zones. Lateral development and some exploration by diamond drilling was done on three deep levels at the Cedar Bay mine on Doré Lake and the Kokko Creek mine was placed on a salvage basis. In 1965, Campbell Chibougamau plans to move its concentrator from the Main mine on Merrill Island to the Henderson mine. Merrill Island Mining Corporation, Ltd. continued exploration of its E zone at depth and started a 2,200-foot drive on the 300-foot level to reach the orebody on the adjoining property of Chib-Kayrand Copper Mines Limited. The orebody will be mined in 1965 by Merrill Island on a profit-sharing basis. The Patino Mining Corporation, Copper Rand Division, continued production, exploration and development at the Machin Point, Bouzan, Portage Island, Jaculet and Quebec Chibougamau mines. At Chapais, Opemiska Copper Mines (Quebec) Limited found several promising new ore zones in both the Perry and Springer mines.

The three mines at Matagami Lake – Mattagami Lake Mines Limited, New Hosco Mines Limited and Orchan Mines Limited – all reached capacity production early in the year. New Hosco was continuing a program of exploration of its



ore at depth and was studying the feasibility of mining zinc ore on its property.

In the Eastern Townships near Stratford Centre, Solbec Copper Mines, Ltd. started open pit mining of its orebody and was preparing the Cupra mine for production in 1965.

Gaspé Copper Mines, Limited continued production at 7,350 tons of ore a day from its Needle Mountain orebodies. The company was preparing to expand the mill to a capacity of 11,000 tons a day and started stripping waste from the Copper Mountain orebody preparatory to mining by open pit. Production from Copper Mountain will be about 4,000 tons of ore a day.

North of Amos, Rio Algom Mines Limited was exploring and preparing a copper-zinc orebody in Poirier Township for production in 1966 at 1,500 tons of ore a day.

ONTARIO

Although not as high as the record output of 211,647 tons in 1961, Ontario's 1964 production of 201,031 tons exceeded that of 1963 by 22,071 tons. The increase was brought about by the reactivation of capacity that had been idled by the curtailments of 1962 and 1963 at the mines and plants of The International Nickel Company of Canada, Limited at Sudbury. International Nickel added production from the Crean Hill mine to that of the six mines it operated in the Sudbury area the previous year. The company is scheduled to start production from three small mines in the same area in 1965. Falconbridge Nickel Mines, Limited continued operations at its five nickel-copper mines in the Sudbury Basin and was preparing the Strathcona orebody for production.

Other copper producers included Rio Algom Mines Limited, Pater Division at Spragge; Kam-Kotia Porcupine Mines, Limited and McIntyre-Porcupine Mines, Limited near Timmins; Copperfields Mining Corporation Limited, formerly Temagami Mining Co. Limited, at Timagami; Noranda Mines Limited, Geco Division, and Willroy Mines Limited at Manitouwadge and North Coldstream Mines Limited near Kashabowie.

A major discovery made by Texas Gulf Sulphur Company started a tremendous prospecting rush that quickly spread over most of Ontario. Texas Gulf plans a 6,000-ton-a-day open pit mine and a mill for production in early 1966. Tribag Mining Co., Limited continued exploration of its property near Batchawana where underground development and surface diamond drilling have indicated over one million tons of copper ore reserves.

MANITOBA–SASKATCHEWAN

Copper output from these provinces totalled 49,880 tons in 1964, an increase of 3,128 tons from 1963. Hudson Bay Mining and Smelting Co., Limited started production from its Stall Lake mine, near Snow Lake, Manitoba, bringing to five the number of mines operated by this company. Hudson Bay was developing two more mines for production in 1966 and had made a promising copper discovery at Anderson Lake in the Snow Lake area. Sherritt Gordon Mines, Limited shipped copper concentrates to Flin Flon and nickel-copper concentrates to its refinery at Fort Saskatchewan, Alberta, from its mine at Lynn Lake, Manitoba. Sherritt Gordon carried out a program of deep diamond drilling from the surface at its Fox Lake property, some 34 miles southwest of Lynn Lake. Preliminary results have indicated 12 million tons of moderate grade copper-zinc ore.

Copper was shipped to Sudbury, Ontario, in the form of smelter reverts from the Thompson, Manitoba, smelter of International Nickel.

BRITISH COLUMBIA

Production of copper declined in 1964 because of the closure of two mines that had operated in 1963; the only new copper mine in the province started production in December. The seven operating mines produced 57,506 tons of copper, 4,712 tons less than in 1963.

The Sunro mine of Cowichan Copper Co. Ltd. at Jordan River on Vancouver Island, remained closed throughout the year. The mine had been flooded in December 1963 by a breakthrough to the surface of a stope under the Jordan River. A strike on August 1 at the Britannia Beach mine of The Anaconda Company (Canada) Ltd. closed the operation and it was inoperative the rest of the year.

Mt. Washington Copper Co. Ltd. started production in December from its open pit mine near Courtenay on Vancouver Island. Production is scheduled at 1,000 tons of ore a day in 1965. Concentrates will be shipped to Japan from the Hatch Point dock of Cowichan Copper Co. Ltd. Normal production continued at the Benson Lake mine of The Consolidated Mining and Smelting Company of Canada Limited, the Highland Valley mine of Bethlehem Copper Corporation Ltd., the mine of Craigmont Mines Limited near Merritt and from the Phoenix mine of The Granby Mining Company Limited near Greenwood.

TABLE 4
Prospective Producing Companies*, 1964

Company and Location	Type of Ore	Mill Capacity (tons ore/day)	Production to Start	Destination of Concentrates
Newfoundland				
British Newfoundland Corporation Limited, Whalesback mine, Springdale	Cu	1,500	1965	Murdochville, Quebec
First Maritime Mining Corporation Limited, Gullbridge mine, Gull Pond	Cu	1,500	1965	..
Quebec				
Cupra Mines Ltd., Stratford Place	Zn,Cu	600 (trucked to Solbec mill)	1965	Overseas market
Rio Algom Mines Limited, Mines de Poirier Inc., Poirier Township	Cu,Zn	1,500	1966	..
Ontario				
Falconbridge Nickel Mines, Limited, Strathcona mine, Sudbury	Ni,Cu	..	1967	Own smelter
Texas Gulf Sulphur Company, Timmins	Zn,Cu,Ag	6,000	1966	..
Manitoba				
Hudson Bay Mining and Smelting Co., Limited, Osborne Lake mine, Snow Lake	Zn,Cu	..	1966	Own smelter
Saskatchewan				
Anglo-Rouyn Mines Limited, Waden Bay	Cu	900	1965	Flin Flon, Manitoba.
British Columbia				
Falconbridge Nickel Mines, Limited, Wesfrob mine, Tasu Harbour, Moresby Island	Fe,Cu	..	1966	Japan
The Granby Mining Company Limited, Granisle mine, Babine Lake	Cu	5,000	1966	Japan

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Table 4 (Concl.)

Company and Location	Type of Ore	Mill Capacity (tons ore/day)	Production to Start	Destination of Concentrates
Granduc Mines, Limited. Unuk River	Cu	7,000	1968	Tacoma, U.S.A.
Western Mines Limited, Buttle Lake, Vancouver Island	Zn,Cu,Pb	900	1965	Overseas markets

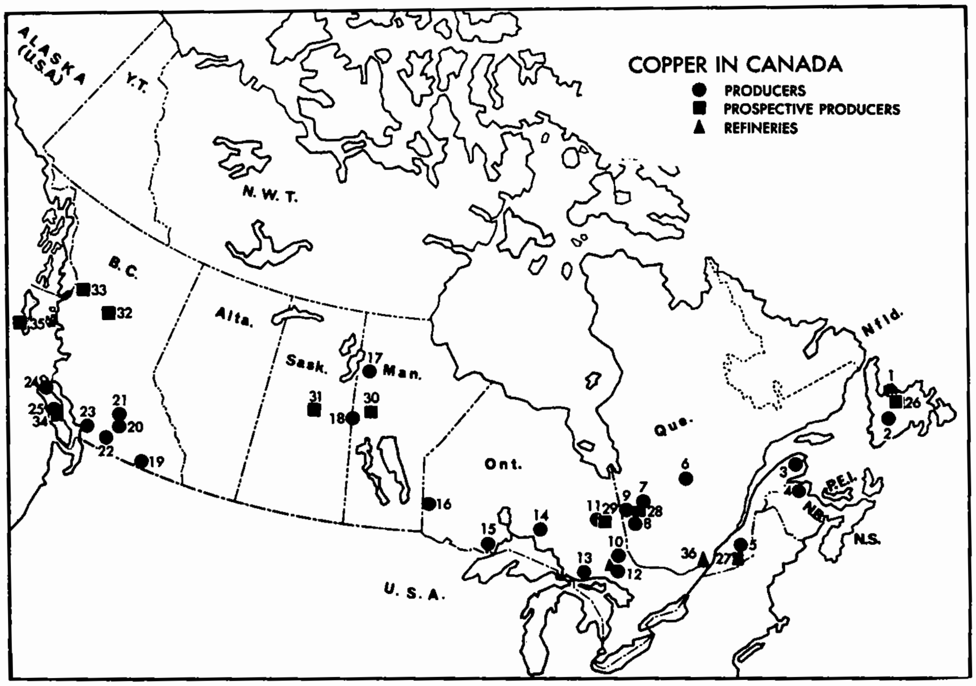
Source: Company reports.
* Includes only companies with announced production plans.
.. Not known.

Three new mines were being developed for production. Granduc Mines, Limited was preparing to drive an 11-mile tunnel from its orebody on the Unuk River to the mill site at Tide Lake, 25 miles north of Stewart. Production at 7,000 tons of ore a day is scheduled for 1968. On an island in Babine Lake, Granby Mining was preparing its Granisle orebody for production in 1966 at 5,000 tons of ore a day. Western Mines Limited at Buttle Lake on Vancouver Island was preparing its Lynx and Paramount copper-zinc orebodies for production in 1966 at the rate of 750 tons of ore a day.

Exploration for new copper deposits continued in most parts of the province. The most promising discoveries were the extensive, low-grade deposits on Galore Creek, a tributary of the Stikine River. These deposits were being explored by Kennco Explorations (Western), Limited and Southwest Potash Corporation.

YUKON TERRITORY

There was no copper production recorded in the Territory in 1964. New Imperial Mines Ltd. was exploring a number of copper occurrences on the Whitehorse copper belt, southwest of Whitehorse. Indicated ore reserves are two million tons.



PRODUCERS

1. Atlantic Coast Copper Corporation Limited
   Consolidated Rambler Mines Limited
   First Maritime Mining Corporation Limited
2. American Smelting and Refining Company (Buchans Unit)
3. Gaspé Copper Mines, Limited (smelter)
4. Brunswick Mining and Smelting Corporation Limited
   The Consolidated Mining and Smelting Company of Canada Limited. (Wedge mine)
   Heath Steele Mines Limited
5. Solbec Copper Mines, Ltd.
6. Campbell Chibougamau Mines Ltd. (4 mines)
   Merrill Island Mining Corporation, Ltd.
   Opemiska Copper Mines (Quebec), Limited
   The Patino Mining Corporation, Copper Rand Mines Division (4 mines)
7. Mattagami Lake Mines Limited
   New Hosco Mines Limited
   Orchan Mines Limited
8. Lake Dufault Mines, Limited
   Manitou-Barvue Mines Limited
   Noranda Mines Limited
   Quemont Mining Corporation, Limited
   Sullico Mines Limited (East Sullivan mine)
   Vauze Mines Limited
9. Normetal Mining Corporation, Limited
10. Copperfields Mining Corporation Limited (Temagami mine)
11. Kam–Kotia Porcupine Mines, Limited
    McIntyre–Porcupine Mines, Limited
12. Falconbridge Nickel Mines, Limited (5 mines, 1 smelter)
    The International Nickel Company of Canada, Limited (7 mines, 2 smelters, 1 refinery)
13. Rio Algom Mines Limited
14. Noranda Mines Limited, Geco Division
    Willroy Mines Limited

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15. North Coldstream Mines Limited
16. Metal Mines Limited
17. Sherritt Gordon Mines, Limited
18. Hudson Bay Mining and Smelting Co., Limited (5 mines, 1 smelter)
19. The Granby Mining Company Limited, Phoenix Division
20. Craigmont Mines Limited
21. Bethlehem Copper Corporation Ltd.
22. Giant Mascot Mines, Limited
23. The Anaconda Company (Canada) Ltd., Britannia Division
24. The Consolidated Mining and Smelting Company of Canada Limited (Coast Copper mine)
25. Mt. Washington Copper Co. Ltd.

PROSPECTIVE PRODUCERS

26. British Newfoundland Corporation Limited (Whalesback mine)
    First Maritime Mining Corporation Limited (Gullbridge mine)
27. Cupra Mines Ltd.
28. Rio Algom Mines Limited (Poirier mine)
29. Texas Gulf Sulphur Company
30. Hudson Bay Mining and Smelting Co., Limited (Osborne Lake and Anderson Lake mines)
31. Anglo-Rouyn Mines Limited
32. The Granby Mining Company Limited (Granisle mine)
33. Granduc Mines, Limited
34. Western Mines Limited
35. Falconbridge Nickel Mines, Limited (Wesfrob mine)

REFINERIES

12. The International Nickel Company of Canada, Limited
36. Canadian Copper Refiners Limited

DOMESTIC CONSUMPTION AND USES

Copper consumption increased sharply throughout the world in 1964. Increased building construction, electrification and a high level of industrial activity combined to bring about the increase. Copper's conventional uses for electric wires and cables, radiators, roofing, brasses and bronzes were supplemented by increased use in the fields of water drainage and vent tubing. Research into the field of tarnish-resistant coatings for copper and brass used in internal and external ornamental work in the building trades, has met with considerable success.

Consumption of refined copper in Canada was 202,101 tons in 1964, 32,351 tons more than in 1963.

The principal copper and brass fabricators in Canada are: British Columbia – Noranda Copper Mills Ltd., Western Division, Vancouver; Ontario – Anaconda American Brass Limited, Toronto, Phillips Cables Limited, Brockville, Ratcliffs (Canada) Limited, Richmond Hill, Wolverine Tube Division of Calumet & Hecla of Canada Limited, London; Quebec – Noranda Copper Mills Ltd., Eastern Division, Montreal East, Pirelli Cables Limited, St. Johns, and Northern Electric Company, Limited, Montreal.

TABLE 5

Consumption of Primary Copper in Manufacture of Semifabricated Products, 1962–63

(short tons)

	1962	1963
Copper mill products – sheet, strip, bars, rolls, pipe, tube, etc.	46,058	52,863
Brass mill products – plate, sheet, strip, rods, bars, rolls, pipe, tube, etc.	12,674	6,665
Wire and rod mill products	95,703	110,031
Miscellaneous	1,384	1,150
Total	155,819	170,709

Source: Consumers' reports to Dominion Bureau of Statistics.

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, semifabricated forms and fully processed products entering the country. Table 6 summarizes the Canadian tariff rates on copper and its products.

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.

TABLE 6

Canadian Tariffs

	British Preferential	Most Favoured Nation	General
Ores and concentrates	free	free	free
Pigs, blocks, ingots and cathodes	¾¢ lb	¾¢ lb	¾¢ lb
Scrap	¾¢ lb	¾¢ lb	1.5¢ lb
Anodes	5%	7.5%	10%
Oxides	free	15%	15%
Bars or rods; tubing not less than 6 feet in length, unmanufactured; copper in sheets, strips or plates, not polished, planished or coated	5%	10%	10%

Table 6 (concl.)

	British Preferential	Most Favoured Nation	General
Bars and rods for the manufacture of wire and cable	free	10%	10%
Tubing not more than ½ inch in dia. and not less than 6 feet long	5%	10%	10%
Alloys of copper consisting 50% or more by weight of copper in sheets, plates, bars, rods and tubes	7.5%	15%	15%

SMELTERS AND REFINERIES

Salient statistics on Canada's six copper smelters and two refineries are given in Tables 7 and 8. The Noranda smelter of Noranda Mines Limited was increased in capacity from 160,000 tons of copper a year to 190,000 tons by the installation of a larger converter and by minor plant modifications. In 1964, the smelters treated 80 per cent of the domestic ores and concentrates, a decrease from the 83 per cent treated in 1963 because of a 12-per-cent increase in the export of copper in ores and concentrates. All of the blister and anode copper produced was refined in Canada and production of refined copper was 408,509 tons, 8 per cent higher than in 1963. Nickel-copper matte from the Falconbridge smelter was shipped to Norway for refining.

WORLD MINE PRODUCTION

The reactivation in January of capacity idled in 1962 and 1963 by production curtailments plus production from new mines raised Free World primary copper production, as reported by the Copper Institute, to 3,783,320 tons* in 1964, 174,084 tons more than was produced in 1963.

PRICES

Prices on all world markets were affected by the copper shortage that was apparent in January. The London Metal Exchange price, that had remained at or near 29.25 cents** throughout most of 1962 and 1963, reacted quickly to the threat of shortage and by April had risen to 39.65 cents a pound. The rise on the LME was checked in May but when the United States mines of Kennecott Copper

*This total excludes production from Russia, Japan, Yugoslavia, Norway, Sweden, Finland, the Messina mine in Transvaal and the production from several small countries from which reports are not available.

**All prices are in U.S. cents a pound unless otherwise noted.

TABLE 7

Canadian Copper and Copper–Nickel Smelters

Operator and Location	Product	Rated Annual Capacity (short tons)	Remarks	Ore and Concentrate Treated, 1964 (short tons)	Blister or Anode Copper Produced, 1964 (short tons)
Falconbridge Nickel Mines, Limited, Falconbridge, Ont.	Copper–nickel matte	650,000 (ores and concentrates)	Copper-nickel ore and prepared concentrate smelted in four blast furnaces and six converters to produce matte for shipment to company's electrolytic refinery in Norway.	372,000	..
Gaspé Copper Mines, Limited, Murdochville, Que.	Copper anodes, metallic bismuth	300,000 (ores and concentrates)	One reverberatory furnace for green- or wet-charge concentrates, two Pierce-Smith converters, one anode furnace and one Walker casting wheel. Also smelts custom concentrates.	246,000 (of which 51,400 were custom concentrates)	43,460
Hudson Bay Mining and Smelting Co., Limited, Flin Flon, Man.	Blister-copper cakes	575,000 (ores and concentrates)	Roasting furnaces, one reverberatory furnace and three converters for treating copper flotation concentrates and zinc-plant residues in conjunction with slag-fuming furnaces. Treats some concentrates on toll.	411,784 (of which 15,488 were custom concentrates)	41,072
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.	..	..

Table 7 (cont.)

Operator and Location	Product	Rated Annual Capacity (short tons)	Remarks	Ore and Concentrate Treated, 1964 (short tons)	Blister or Anode Copper Produced, 1964 (short tons)
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 concentrate; converters for production of blister copper.	332,876	..
			Blast furnaces, roasters, reverberatory furnaces for smelting of copper-nickel ore and concentrate; converters for production of copper-nickel 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	1,900,000 (ores and concentrates and scrap)	Roasting furnaces, two hot-charge reverberatory furnaces, one green-charge reverberatory furnace, and five converters. Also smelts custom material.	1,635,470 (of which 671,046 were custom material)	174,758

Source: Company reports.

.. Not available.

TABLE 8

Canadian Copper Refineries

Canadian Copper Refiners Limited, Montreal East, Que.	The International Nickel Company of Canada, Limited, Copper Refining Division, Copper Cliff, Ont.
CCR brand electrolytic copper wire bars, ingot bars, ingots, cathodes, cakes and billets Rated annual capacity: 284,000 tons Controlled by Noranda Mines Limited. 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.	ORC brand electrolytic copper, cathodes, wire bars, cakes, billets, ingots and ingot bars 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.

Source: Company reports.

Corporation were struck in July the climb in the LME price resumed, with minor checks, until a record high of 66 cents was reached on November 4. At the end of the year the price had declined to 46.25 cents. On January 16 the two large African producers, Rhodesian Selection Trust, Limited and Anglo American Corporation of South Africa Limited, stopped using the LME as the medium for pricing and sales of copper in Europe and announced a producers' price of 29.5 cents for these sales. Other world producers quickly followed and two copper prices were established in Europe, a producers' price and a variable LME price.

Copper in Canada and the United States was sold at producers' prices, which were 31.5 cents (Can.) and 31 cents (U.S.) respectively on January 1. Producers' prices in Canada, United States and Europe have risen in two stages to 35 cents (Can.), 34 cents and 32.5 cents respectively. In October, when the LME price was over 50 cents, the Chilean government announced that all European sales of Chilean copper would be set at a price of 35 cents and in October Anaconda Company Limited raised the United States price of its Chilean copper to 35 cents.

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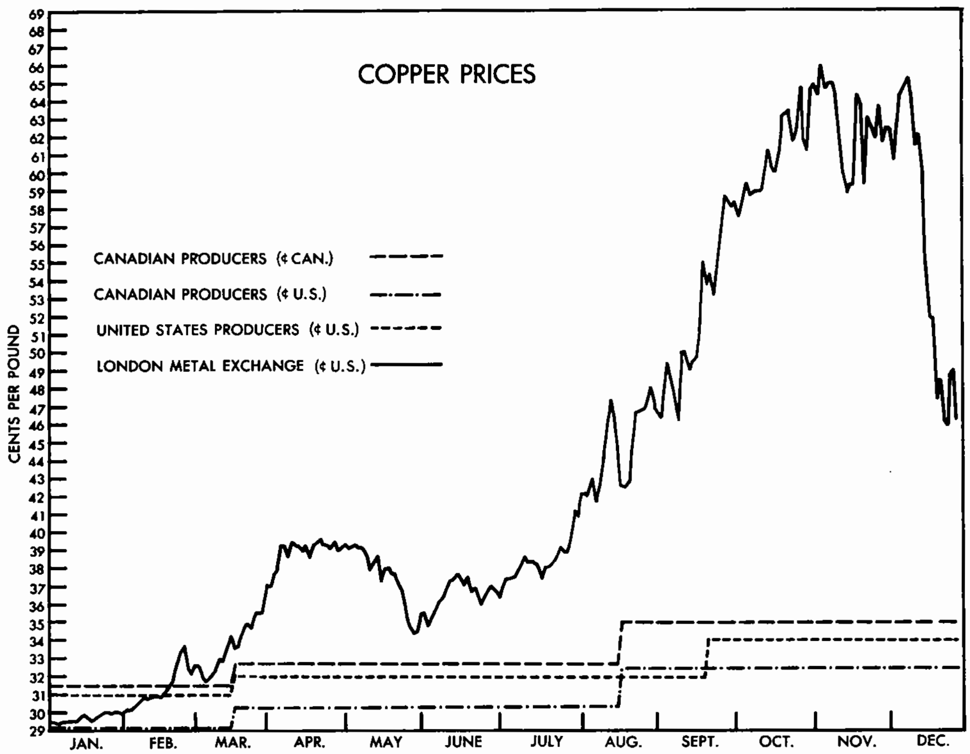


STATISTICAL SOURCE: AMERICAN METAL MARKET

Diatomite

J.S. Ross*

Diatomite, also known as diatomaceous earth and kieselguhr, is a siliceous sediment composed mainly of opaline silica from the fossil remains of diatoms. A diatom is a microscopic fresh- or salt-water plant, a form of algae. Diatomite occurs in bog or dry deposits and when dry it is usually cream coloured, chalk-like and friable. This rock is also characterized by its light weight, having an apparent density in the order of 30 pounds per cubic foot when dried and in lump form.

Canada's diatomite production has been insignificant but practically continuous since 1896. Since 1961 it has amounted to a few hundred tons annually and in 1964 it was 584 tons valued at $24,965 (preliminary). Although diatomite is used widely and for many purposes, world production is relatively small. According to *United States Bureau of Mines Minerals Yearbook*, world production amounted to 1.6 million tons in 1963. The United States, by far the largest producer, accounted for more than one-quarter of the output and was followed in order by Russia, Denmark and France.

No exports of diatomite from Canada have been recorded in the last decade at least, principally because production has been negligible. Practically all Canada's requirements are supplied by imports. These have remained relatively constant since 1957. In 1964 they amounted to 25,089 tons valued at $1,349,330 and, as usual, all came from the United States. The larger imports from 1958 to 1963 were the result of increased demand for filter-grade diatomite used in the recovery of uranium oxide. The lower uranium shipments in 1964 are reflected in decreased imports of diatomite for that year.

Consumption statistics for this commodity are difficult to obtain; those in Table 1 are incomplete and their total is significantly less than the apparent consumption. The actual consumption for 1963 should be similar to the apparent consumption of 27,410 tons. Available data indicate a consumption of 9,245 tons

*Mineral Processing Division, Mines Branch

98115—15½

plus an estimated minimum of 12,000 tons for filtration and an unknown quantity mainly for pozzolanic purposes. Apparent consumption for 1964 was 25,673 tons (preliminary).

TABLE 1

Production, Imports and Consumption

	1963		1964	
	Short Tons	$	Short Tons	$
Production (Shipments)				
British Columbia	798	26,830	584p	20,360p
Imports				
Diatomaceous earth, crude and ground				
United States	26,612	1,406,073	25,089	1,349,330
Consumption (incomplete)				
Filtration	12,000e			
Fertilizer dusting	5,316			
Paper	1,189			
Paint and varnish	688			
Pesticides	328			
Foundry	300			
Asphalt products	89			
Pozzolan	..			
Other products	1,335			
Total	21,245e			

	Production (Short tons)	Imports (Short tons)
1954	4	19,373
1955	16	22,158
1956	2	21,078
1957	120	25,288
1958	27	27,258
1959	5	27,260
1960	44	28,990
1961	214	28,875
1962	211	26,098
1963	798	26,612
1964p	584	24,965

Source: Dominion Bureau of Statistics.

Symbols: p Preliminary; .. Not available; e Estimate.

PRODUCERS

Since 1956, all Canada's diatomite production has come from the Quesnel area of British Columbia. In 1964, Fairey & Company, Limited, of Vancouver recovered diatomite from a leased deposit about 6 miles north of Quesnel. The material was shipped by rail to Vancouver where it was dried, ground and screened and used mainly in the production of special insulating brick.

In the latter part of 1963, Crownite Diatoms Ltd. constructed a pulverizing plant about 2 miles southwest of Quesnel. Since then, the company has processed small quantities of diatomite from a deposit nearby.

Several other companies and individuals periodically have tested and removed samples from the Quesnel deposits. However, only the above-mentioned companies have reported actual production.

OTHER OCCURRENCES

Other deposits have been noted in British Columbia, Ontario, Quebec, Newfoundland and the Maritime Provinces. All have been designated as fresh water in origin.

All occurrences of Tertiary age are in central British Columbia. These are numerous, most are relatively large and some have a thickness of more than 80 feet. Deposits of recent age are in the Kamloops and Ashcroft mining divisions and along the coastal areas of British Columbia. Like the occurrences of recent age in the other provinces, these are usually small and contain considerable organic material.

The Ontario deposits are mainly in the Muskoka district; some of these supported a small mining operation from 1930 to 1939 and in 1953.

Most of Canada's output has come from Nova Scotia, all during the period 1896 to 1955. Much of this was mined and processed at Digby Neck in the southwestern part of the province.

USES AND SPECIFICATIONS

Diatomite may be used in block, lump or pulverized form. The blocks are used for insulation and the lumps mainly as lightweight aggregate. For the pulverized form, which is popular for most uses, the diatomite is crushed, dried, pulverized, sized and then either shipped for sale or calcined and sized before shipment.

About 90 per cent of the diatomite used in Canada is employed because of its physical properties rather than for its chemical content. However, its chemical inertness under normal conditions and its ability to react with alkalis are of importance.

About half Canada's diatomite requirements is estimated to be for filtration purposes. For this application, the commodity's high porosity and surface area and its chemical inertness are of great significance. The former two properties are dependent on the size, shape and purity of the diatomite. Impurities such as clay and iron are particularly detrimental. Under compression, competitive diatomite for filtering can retain up to 90 per cent of its volume as voids and remove solid particles down to 0.1 micron in size. Filter-grade diatomite is used by the dry cleaning, brewing, mining, sugar, food and petroleum industries and in the processing of many chemicals, varnish, oils and fats. Its application in water purification has become widespread in recent years. Canada's previously large uranium industry was a major consumer of diatomite.

The next largest consumer is the fertilizer industry, which uses the commodity to coat ammonium nitrate and occasionally urea prills. Practically all Canadian producers of ammonium nitrate prills use diatomite. However, during the last five years the commodity has met with competition from clays and organic-compound substitutes. Consequently, the consumption of diatomite for fertilizer use has decreased even though nitrate production has increased. For this application, diatomite serves as a coating on the prills where it absorbs excess moisture and prevents prills from sticking so that they can flow freely during application. The lowest commercial grade of diatomite is suitable for this application – uncalcined material, at least 95 per cent of which is minus 325 mesh in particle size.

Diatomite is a widely used filler in such products as paper, paint, varnish, pesticides, asphalt and rubber materials, enamels and plastics. Inertness, particle size and shape, surface area and bulk density are the more critical properties.

This industrial mineral is used as a source of silica in the production of such siliceous products as various types of calcium silicates. In Canada, the most common product of this type is a cellular insulation for application on such objects as pipes, boilers and hot-water tanks. Diatomite for this use must have a high silica content and a low proportion of impurities.

The bulk of Canada's production is used in the manufacture of insulating brick. Blocks of dried or fired diatomite are used occasionally for insulation.

Diatomite is used as a mild abrasive in metal polishes and dentifrices. It is also employed as a pozzolan in concrete and when in lump form it may serve as a lightweight aggregate. Because of its high absorptive properties diatomite serves to control moisture and odours in industry.

PRICES

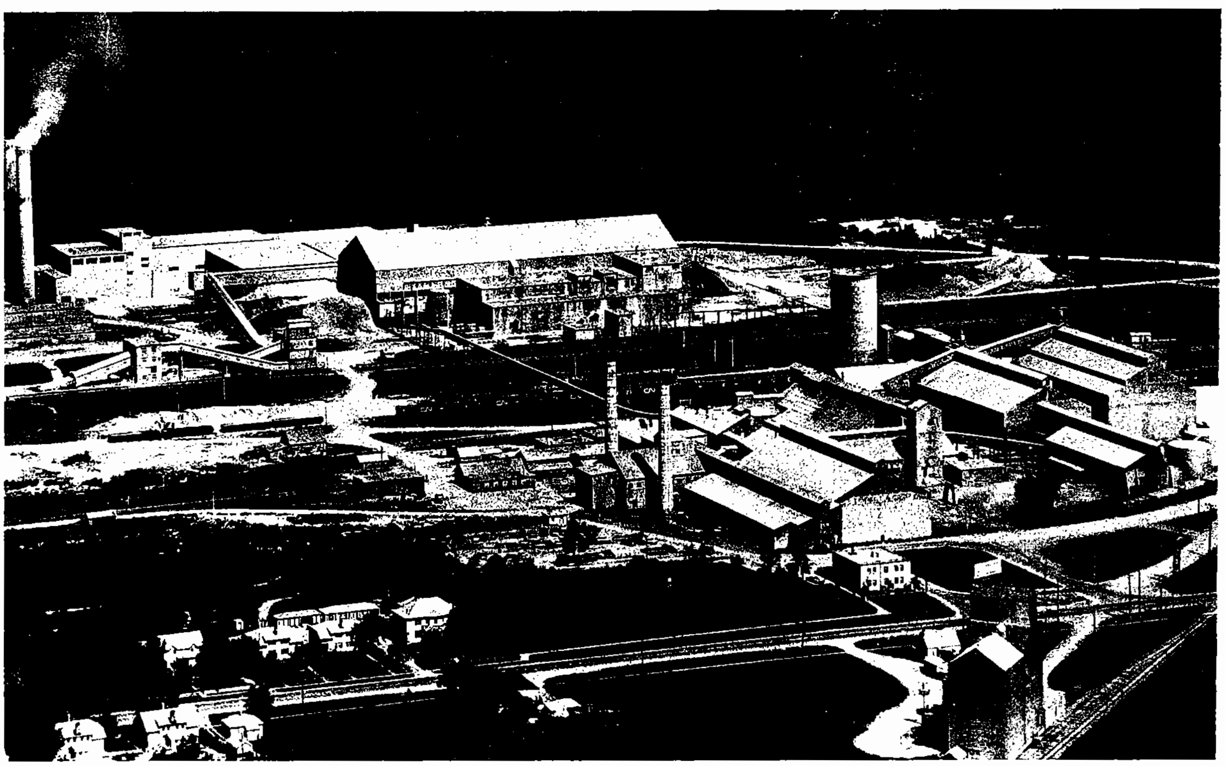
Because of the numerous grades of diatomite and the inherent high transportation cost for such a light material, prices vary considerably according to type, grade, quantity of shipment and distance to the consumer from the producer. Depending on the grade, shipments of 1,000 pounds or more may cost from $100 to $300 per ton, f.o.b. Ontario and Quebec warehouses. The car-lot price for the lowest grade diatomite, f.o.b. California, is about $40 a ton or in the order of $70 a ton in eastern Canada. The average value paid for all imports was $52.84 a ton in 1963 and $53.19 (preliminary) in 1964, not including transportation charges.

TARIFF

There is no tariff on diatomite imported into Canada or the United States.

Canada Cement Co. plant at Hull, Quebec.

Canada Cement Co. plant at Fort Whyte, Manitoba.



Feldspar

J.E. REEVES*

Production of feldspar in Canada in 1964 was about the same as in 1963. The only producer is International Minerals & Chemical Corporation (Canada) Limited, which fine-grinds at Buckingham, Quebec, hand-cobbed feldspar from its own mine in nearby Derry Township.

Exports, mainly to ceramic plants in the northern part of New York State, were little changed from 1963. Statistics on imports of feldspar to western Canada are no longer recorded separately.

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 ceramics industry as a source of alumina (Al_2O_3), potash (K_2O) and soda (Na_2O), and for its relatively low firing temperature; it is of some use to manufacturers of cleaning compounds because of its moderately abrasive properties. 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.

Potash and soda feldspar occur widely in many types of rock but commercially in only a few with a high feldspar content. Very coarse-grained granitic pegmatites, with the feldspar concentrated in zones, have been the most common commercial sources. Hand cobbing was the usual method of further concentration, and grinding and particle-size classification were the only methods of further processing required. Nearly all Canadian feldspar has been mined from such pegmatites, which are relatively common in southeastern Ontario and southwestern Quebec, and processed in this way.

*Mineral Processing Division, Mines Branch

TABLE 1

Production, Trade and Consumption of Feldspar

	1963		1964p	
	Short Tons	$	Short Tons	$
Production, shipments — Quebec...........	8,608	197,031	8,615	205,420
Imports* —				
United States	2,600	59,217	..	..
Exports				
United States	3,282	78,921	3,376	79,525
Other countries.......................	—	—	10	901
Total	3,282	78,921	3,386	80,426
	1962		1963	
Consumption, available data				
Whiteware	5,662		4,800	
Porcelain enamel	260		191	
Cleaning compounds	459		411	
Other	437		607	
Total	6,818		6,009	

Source: Dominion Bureau of Statistics.

* Not available as a separate class commencing 1964.

Symbols: p Preliminary; .. Not available; — Nil.

TABLE 2

Feldspar — Production and Trade, 1955–64

(short tons)

	Production	Imports	Exports
1955	18,152	137	1,426
1956	18,153	196	1,804
1957	20,450	241	4,047
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
1964p	8,615	..	3,386

Source: Dominion Bureau of Statistics.

Symbols: p Preliminary; .. Not available.

Elsewhere, the depletion of many of these deposits and the need for mechanized high-tonnage operations have led to the bulk handling of mixtures composed of feldspar, quartz and small quantities of other minerals from pegmatites or other highly feldspathic rocks in which rich zones of feldspar do not occur. Concentration of the feldspar is accomplished mechanically, usually by flotation.

The acceptance of the feldspathic substitutes for traditional feldspar 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 in Virginia, is also used in some types of glass as a relatively cheap source of alumina; and controlled feldspar-silica mixtures, from previously non-commercial feldspar deposits, have become acceptable.

USES AND SPECIFICATIONS

Feldspar is sold mainly to the ceramics industries. Where it can compete economically with nepheline syenite it is still used extensively as a source of alumina, soda and potash in the manufacture of glass. The size specification requires a relatively coarse particle, generally with an upper limit of 20 mesh. The iron content should be less than 0.1 per cent ferric oxide (Fe_2O_3).

Feldspar is important as a flux in the manufacture of whiteware bodies and glazes. 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. A low iron content (less than 0.1 per cent Fe_2O_3) will generally 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.

Dental spar is a selected high-purity potash feldspar for use in the manufacture of artificial teeth. Freedom from iron-bearing minerals, which would cause specks in the final product, is important.

For cleaning compounds, feldspar should be white and free of quartz.

PRICES

According to *E & M J Metal and Mineral Markets* of December 28, 1964, prices in the United States, f.o.b. point of shipment, North Carolina, in bulk, per short ton, were:

(mesh)	
200	$17.00 to $21.00
325	18.00 to 22.00
40, glass	13.50
20, semigranular	9.00

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	12½¢ per long ton		
Ground	7½% ad valorem		

Fluorspar

C.M. BARTLEY*

Production of fluorspar in Canada during 1964 increased about 13 per cent in volume and 16 per cent in value to more than $2.29 million. The major part of production was from Newfoundland although a small output was reported in British Columbia.

PRODUCTION AND TRADE

The Director mine of Newfoundland Fluorspar Limited at St. Lawrence, Newfoundland, produced 96,000 tons** of fluorspar concentrate which was further processed at Arvida, Quebec, and used in the production of aluminum. A minor amount of metallurgical-grade fluorspar was produced by Pacific Silica Limited as a byproduct of its silica operations in British Columbia.

Exports of Canadian fluorspar were limited to a small quantity directed to Britain for optical use.

Imports of fluorspar, mainly metallurgical grade, increased slightly to 69,984 tons with a value in excess of $2 million. Mexico was the main source with smaller amounts from the United States and Britain.

Consumption of fluorspar in Canada increased in 1963 to a new high of 142,840 tons. The major part of the increase was used in aluminum production, although other demands were higher also. Canadian consumption is believed to be greater than is indicated by available data because in the past 10 years production plus imports minus exports shows a substantial accumulation of fluorspar.

The Nichols Chemical Company, Limited, a subsidiary of Allied Chemical Canada, Ltd., operates a merchant hydrofluoric acid plant at Valleyfield, Quebec, which uses imported acid-grade fluorspar. Using Newfoundland fluorspar, the Aluminum Company of Canada, Limited, produces hydrofluoric acid at Arvida for its own requirements in the manufacture of aluminum.

*Mineral Processing Division, Mines Branch

**Footnote 3, Table 2.

TABLE 1

Fluorspar – Production, Trade and Consumption

	1963		1964p	
	Short Tons	$	Short Tons	$
Production, shipments				
Newfoundland..................	..	1,976,006	..	2,286,887
British Columbia.................	–	–	..	4,739
Total......................		1,976,006		2,291,626
Exports				
Britain........................	4	7,500*	..	5,625*
Imports				
Mexico.........................	48,548	1,385,851	58,485	1,652,000
United States	6,954	250,445	9,912	345,000
Britain.........................	1,713	88,401	1,589	63,000
Republic of South Africa..........	9,583	221,560	–	–
Total	66,798	1,446,257	69,986	2,060,000
Consumption				
Metallurgical flux................	43,663			
Glass..........................	1,999			
Other, including aluminum production..........................	97,178			
Total	142,840			

Source: Dominion Bureau of Statistics.

*Shipments of clear crystal for optical use.

Symbols: p Preliminary; – Nil; .. Not available.

Huntington Fluorspar Mines Limited operates a plant at Northbrook, Ontario, producing a 5-pound fluorspar briquette from imported metallurgical-grade fluorspar. The briquettes are marketed exclusively by Foseco Canada Limited, Guelph, Ontario, for foundry use.

CANADIAN FLUORSPAR RESOURCES

Fluorspar has been produced from deposits in Newfoundland, Nova Scotia, Ontario and British Columbia. The major resources are located in the Burin Peninsula of Newfoundland, currently the only significant source of supply, and at several locations in British Columbia. Deposits in Ontario and Nova Scotia are potential suppliers at higher prices. Known deposits in Newfoundland and at least two large deposits in British Columbia are considered assured future sources although ore dressing problems or their location with respect to markets make them only marginally attractive at present fluorspar prices.

TABLE 2

Fluorspar – Production, Trade and Consumption, 1955-1964
(short tons)

	Production[1]	Exports	Imports	Consumption
1955	128,114	58,390	21,774	87,927
1956	140,071	78,380	28,148	96,126
1957	66,245	23,630	14,547	70,761
1958	62,000[2]	7	30,408	89,933
1959	74,000[2]	3,774	26,588	96,016
1960	77,000[2]r	10,312	59,690	111,835
1961	80,000[2]r	2,048	32,769	111,542
1962	75,000[2]r	4	67,847	123,694
1963	85,000[3]	4	66,797	142,840
1964p	96,000[3]	..	69,986	

Source: Dominion Bureau of Statistics except where otherwise indicated.
[1]Producers' shipments. Tonnage statistics after 1957 are not available for publication.
[2]Estimates reported by the U.S. Bureau of Mines. [3]Shipments reported in Aluminum Limited ANNUAL REPORTS 1963 and 1964

Symbols: p Preliminary; r Revised from previously published figure; .. Not available.

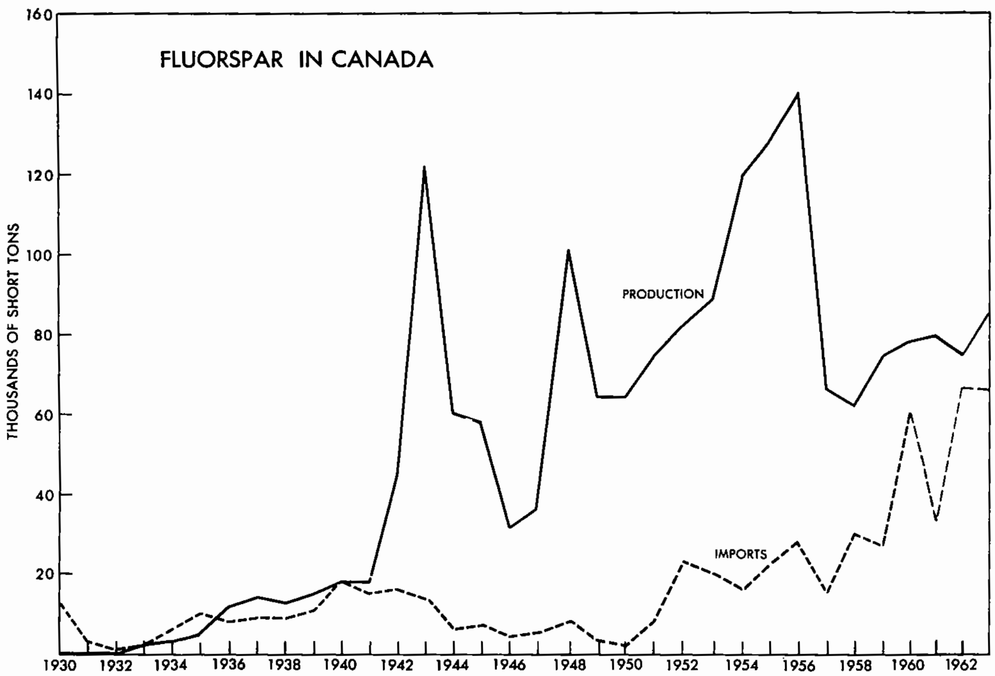


TABLE 3

World Production of Fluorspar

(short tons)

	1963	1964p
Mexico	530,893	686,475
France	248,000	242,000
U.S.S.R.	235,000e	330,000e
China	220,000e	220,000e
United States	199,843	216,680
Spain	168,441	160,796
Italy	137,232	136,436
West Germany	95,942	85,917
Britain	75,121	171,600e
Republic of South Africa	57,761	66,291
Canada	67,000e	95,700e
East Germany	80,000e	82,500e
Other Countries	224,767	277,605
Total	2,340,000	2,772,000

Source: U.S. Bureau of Mines MINERALS YEARBOOK, 1963, and MINERAL TRADE NOTES, Vol. 61, No. 3.

Symbols: e Estimate; .. Not available.

The Newfoundland fluorspar deposits located in the Burin Peninsula near the village of St. Lawrence have been operated by two companies. The occurrences, consisting of veins and stringer zones in a granitic rock, have been the source of some 1.8 million tons of fluorspar to date. Newfoundland Fluorspar Limited has operated at St. Lawrence continuously since 1940. The ore is mined and concentrated by heavy media before being shipped to Arvida. The plant is capable of producing about 100,000 tons per year. St. Lawrence Corporation of Newfoundland Limited holds an adjoining property. It produced metallurgical and acid grades of fluorspar from 1933 to 1957. Although ore reserves are believed to be substantial, the company found difficulty in competing for markets and is not producing at present.

Fluorspar veins near the village of Madoc in eastern Ontario were the source of metallurgical-grade fluorspar from 1910 to 1961. Yearly production varied from nil in 1926-28 to more than 11,000 tons in 1948. Total production is estimated at 120,000 tons. The several small mines in the area operated sporadically on a small scale and mined to shallow depths only, because of water problems and insufficient finances. Considerable amounts of ore probably exist at greater depths in the area.

In the period 1940-44, about 1,400 tons of fluorspar ore for metallurgical use was produced from veins near Lake Ainslie on Cape Breton Island, Nova Scotia. The fluorspar is associated with barite and because of processing problems and small scale operations, marketing in competition with other sources was difficult.

Fluorspar was produced at the Rock Candy mine in British Columbia from 1918 to 1925 and in 1929 and 1942. Substantial reserves are believed to remain at this mine but adequate markets are not currently available to justify its reopening. Shallow flat-lying fluorspar deposits along the Liard River in northern British Columbia have received preliminary investigation and large amounts of ore are indicated. However, the remote location and high cost of transportation make them doubtful sources at present. The Rexspar Minerals & Chemicals Limited fluorspar deposit, located beside the Canadian National Railways at Birch Island, B.C., has been investigated by diamond drilling and surface work. This is a large body of medium-grade ore which is amenable to low-cost open-pit operation. The ore is fine grained and concentration to acceptable grade is difficult. Metallurgical test work has been carried out with encouraging results; improvement in fluorspar prices would quicken development at this property.

The Mount Pleasant Mines Limited tin-base metal deposit in New Brunswick contains some fluorspar which may be recoverable as a byproduct in milling.

WORLD REVIEW

High rates of activity in the world-wide aluminum and steel industries, and the continually rising demand for fluorine chemicals and the products derived from them combined to increase fluorspar consumption during 1964. Fluorine requirements for fluorocarbon aerosols, refrigerants and plastics continued to grow in North America and Europe. This growth is expected to continue both in volume and diversity of applications. As an example, United States fluorspar consumption increased from 736,000 tons in 1963 to an estimated 900,000 tons in 1964.

Although there is no present shortage of fluorspar on a world-wide basis, continually rising demand is supplied by a relatively few large sources and trans-ocean shipments are required to balance demand and supply. For example, the United States imported a total of 645,000 tons in 1964 of which about 128,000 tons were from overseas sources. For these reasons fluorspar prices are expected to rise. A small increase in the price of metallurgical grade during 1964 may indicate the trend. The price of acid-grade material showed little change with supplies available from Mexico, Spain and Italy.

The trend towards pelletized and briquetted fluorspar for metallurgical and foundry use suggests that future fluorspar production may be based on large, lower-grade orebodies with plants to produce various grades, from acid to metallurgical, in accordance with demand.

In several countries new fluorspar-consuming industries under development indicate the wider base of fluorspar demand.

USES AND SPECIFICATIONS

Fluorspar is consumed in two general ways – as a metallurgical and ceramic flux and as the source material for hydrofluoric acid, fluorine gas and the fluorine chemical compounds made from them. For metallurgical purposes, the mineral is used in its natural state, after concentration. When it is a source material for chemicals, preparation of the raw material is more detailed and specifications more strict.

In the steel industry, fluorspar is used as a flux to assist in melting the ore charge and to improve the separation of metal and slag. Other materials have been used but few are comparable to fluorspar in efficiency. Fluorspar for metallurgical purposes must be in coarse sizes, 2 inches to 3/8 inch.

For ceramic purposes, as a flux in glass and in enamel melts, for example, a finer-grained and purer concentrate is used.

Large amounts of fluorspar are consumed in aluminum production and no adequate substitute is known. As previously mentioned, fluorspar is processed to acid-grade purity and made into hydrofluoric acid which is then used to make cryolite. Aluminum metal is produced by the Hall electrolytic process from a molten solution of alumina and cryolite.

Fluosilicic acid and sodium fluoride are used to fluoridate public water supplies. Recently, natural calcium fluoride (fluorspar) has also been used for this purpose.

The amount of fluorspar used by the fluorine chemical industry is increasing each year. The materials consumed are of two general classes – fluorine materials for industrial processes such as uranium processing, the alkylation of gasoline, ore treatment and production of high-energy missile fuels; and fluorine and hydrofluoric acid for the manufacture of refrigerants, aerosol propellant gases, chemicals and the numerous fluorocarbon-plastic intermediates and fluorocarbon-plastic consumer articles.

Three grades of fluorspar are marketed. Standard-fluxing-gravel, or lump grade, is used for metallurgical purposes and is usually sold on a specification of a minimum of 85 per cent CaF_2, a maximum of 5 per cent silica (SiO_2 and 0.3 per cent sulphur). Fines should not exceed 15 per cent.

In ceramic, glass or enamel grade, the requirement is for not less than 94 per cent CaF_2 with a maximum of 3.5 per cent calcium carbonate ($CaCO_3$), 3 per cent SiO_2 and 0.1 per cent ferric oxide (Fe_2O_3). The material must be in mesh sizes ranging from coarse to extra fine.

Acid grade has the most rigid specifications. It must contain more than 97 per cent CaF_2 and not more than 1 per cent SiO_2. Like the ceramic grade it is used in powdered form.

PRICES

Early in 1964 the price in Canada quoted by Aluminum Co. of Canada was as follows:

Per net ton, f.o.b. Arvida, Que., ceramic grade, in bulk, coarse	61.50

Specification were CaF_2 94.0% min., with $CaCo_3$ 4.6% max., SiO_2 2.6% max., and Fe_2o_3 2% max.

According to E & MJ METAL AND MINERAL MARKETS of December 28,1964, United States prices were as follows:

Per short ton, f.o.b. Illinois, Kentucky, CaF_2 content, bulk	
Metallurgical	
72½%	\$37 - \$39
70 %	35 - 37
60 %	32 - 34
Acid, dry basis, 97%	
Carloads	45
Less than carloads	50
Bags, extra	3
Wet filter cake, 8-10% moisture, sold dry content, subtract approx	2.50
Pellets, carload lots	
No. 1	55
No. 2	47
No. 3	44
l.c.l., add	5
Ceramic, calcite and silica variable	
Fe_2O_3 max. 0.14%	41
88-90%	42
93-94%	43
95-96%	43
In 100-lb paper bags, extra	3

TARIFFS

CANADA – free

UNITED STATES

Fluorspar, by weight of calcium cluoride	
Containing over 97%	$2.10 per long ton
Containing not over 97%	8.40

Mattagami Lake Mines Ltd., Mattagami, Quebec. Diamond drill underground at the mine.

Gold

W.J. BEARD*

In 1964 gold production in Canada declined to its lowest level since 1948 as the number of auriferous-quartz mines continued to diminish. Production in 1964 was an estimated 3,829,112 ounces valued at $144,548,979 compared with 4,003,127 ounces worth $151,118,045 in 1963. In 1948, the year the Emergency Gold Mining Assistance Act was introduced, gold production was 3,529,608 ounces valued at $123,536,280. The average Royal Canadian Mint value per fine troy ounce of gold remained at $37.75 in 1964, the same as the previous year.

Ontario remained the principal producer with over 57 per cent of the total. Quebec was second with approximately 24 per cent, followed by the Northwest Territories at 10 per cent and British Columbia at about 3.4 per cent.

Total world gold production in 1963 was estimated by the United States Bureau of Mines to be 51,692,000 ounces compared with 49,800,000 ounces in 1962. The Republic of South Africa was the leader by far with 27,431,573 ounces. Canada ranked second among Free World producers at 4,003,127 ounces followed by the United States (1,468,750 ounces) and Australia (1,023,400 ounces). Production in the U.S.S.R. was an estimated 12,500,000 ounces in 1963.

The Emergency Gold Mining Assistance Act continued to provide cost assistance to most Canadian lode gold mines as 44 of the 48 in production received cost assistance. Assistance payable under the Act for 1963 approximates $14,970,000.

The Act, which came into force in 1948, was extended in December 1963 to the end of the calendar year 1967. The purpose of the Act is to assist marginal gold mines to meet rising costs of operation and thereby help maintain existing gold-mining communities.

* Mineral Resources Division

Many gold mines are having difficulty in continuing operations even with cost assistance. The costs of recovering gold continue to rise due to greater mining depths and the unavoidable mining of lower-grade ore. One lode gold mine closed in 1964 as ore reserves were exhausted; others are scheduled for closure in 1965. Two new, but small, lode gold mines began operations in 1964 and two others operated on a minor, intermittent basis.

TABLE 1

Production of Gold, 1963–64

(troy ounces)

	1963	1964p
Newfoundland		
Base-metal mines	12,318	19,250
New Brunswick		
Base-metal mines	1,128	1,700
Nova Scotia		
Auriferous-quartz mines	–	63
Quebec		
Auriferous-quartz mines		
Bourlamaque-Louvicourt	278,698	273,923
Cadillac-Malartic	234,490	222,254
Chibougamau	–	9,948
Noranda	2,253	12,826
Miscellaneous	17	47
Total	515,458	518,998
Base-metal mines	401,771	425,943
Total, Quebec	917,229	944,941
Ontario		
Auriferous-quartz mines		
Kirkland Lake	259,952	236,396
Larder Lake	333,896	226,970
Porcupine	992,790	975,543
Red Lake and Patricia	507,470	453,334
Sudbury	34,627	32,104
Thunder Bay (Port Arthur)	150,052	130,323
Miscellaneous	105	94
Total	2,278,892	2,094,804
Base-metal mines	59,962	62,080
Total, Ontario	2,338,854	2,156,884

Table 1 (Cont.)

	1963	1964p
Manitoba		
Auriferous-quartz mines	24,017	29,000
Base-metal mines	29,067	36,019
Total	53,084	65,019
Saskatchewan		
Base-metal mines	64,813	47,692
Alberta		
Placer operations	132	55
British Columbia		
Auriferous-quartz mines	105,655	91,318
Base-metal mines	50,229	43,724
Placer operations	3,589	1,670
Total	159,473	136,712
Northwest Territories		
Auriferous-quartz mines	400,885	399,721
Yukon Territory		
Placer operations	54,184	57,075
Base-metal operations	1,027	—
Total	55,211	57,075
Canada, Total		
Auriferous-quartz mines	3,306,268	3,133,904
Base-metal mines	638,954	636,408
Placer operations	57,905	58,800
Total	4,003,127	3,829,112
Total value	$151,118,045	$144,548,979
Average value per ounce	$37.75	$37.75

Source: Dominion Bureau of Statistics.
Preliminary and partially estimated by author.

TABLE 2
World Gold Production, 1962–63
(troy ounces)

	1962	1963
North America		
Canada	4,178,396	4,003,127
United States (including Alaska)	1,556,000	1,468,750
Mexico	236,758	237,948
Nicaragua	221,984	204,769
Other countries	5,140	5,535
Total	6,198,000	5,920,149
South America		
Colombia	396,827	324,514
Brazil	180,000	180,000
Peru	122,985	94,369
Chile	65,009	79,572
Other countries	94,963	214,900
Total	860,000	893,000
Europe		
U.S.S.R.	12,200,000	12,500,000
Sweden	128,667	120,600
Yugoslavia	70,507	74,043
Other countries	501,000	505,300
Total	12,900,000	13,200,000
Asia		
Philippines	423,394	376,036
Japan	286,593	251,868
Korea (including North Korea)	267,880	250,095
India	163,326	138,280
Other countries	103,900	118,700
Total	1,245,000	1,145,000
Africa		
Republic of South Africa	25,491,993	27,431,573
Ghana	888,038	921,255
Southern Rhodesia	554,647	566,277
Republic of the Congo	203,707	213,995
Other countries	211,600	236,900
Total	27,350,000	29,370,000
Oceania		
Australia	1,072,022	1,023,400
Fiji	87,354	107,262
New Guinea	39,007	43,599
Other countries	21,787	14,206
Total	1,220,170	1,188,467
World total (estimate)	49,800,000	51,692,000

Source: U.S. Bureau of Mines, *Minerals Yearbook 1963*
r Revised by author.

TABLE 3

Canadian Gold Production, 1955–64

Year	Auriferous-Quartz Mines (troy ounces)	(%)	Placer Operations (troy ounces)	(%)	From Base-Metal Ores (troy ounces)	(%)	Total Production (troy ounces)	Total Value ($ Can.)	Average Value per Ounce ($ Can.)	Gold as % of All Mineral Production Value
1955	3,866,124	85.2	78,621	1.7	597,217	13.1	4,541,962	156,788,528	34.52	8.7
1956	3,704,870	84.5	74,919	1.7	604,074	13.8	4,383,863	151,024,080	34.45	7.2
1957	3,766,285	85.0	76,303	1.7	591,306	13.3	4,433,894	148,757,143	33.55	6.8
1958	3,928,187	85.9	71,955	1.6	571,205	12.5	4,571,347	155,334,370	33.98	7.4
1959	3,852,074	85.4	72,974	1.6	558,368	12.5	4,483,416	150,508,275	33.57	6.2
1960	3,930,366	84.9	80,804	1.7	617,741	13.4	4,628,911	157,151,527	33.95	6.3
1961	3,774,522	84.4	69,240	1.5	629,937	14.1	4,473,699	158,637,366	35.46	6.1
1962	3,494,821	83.4	57,760	1.3	625,815	15.3	4,178,396	156,313,794	37.41	5.5
1963	3,306,268	82.5	57,905	1.4	638,954	15.9	4,003,127	151,118,045	37.75	5.2
1964p	3,133,904	81.9	58,800	1.5	636,408	16.6	3,829,112	144,548,979	37.75	4.3

Source: Dominion Bureau of Statistics.
p Preliminary.

OPERATIONS AT PRODUCING MINES

ATLANTIC PROVINCES

All gold produced in the four provinces was derived as a byproduct from the mining of base metal ores with the exception of a small amount from Nova Scotia. Gold was recovered from lead-zinc ores of the Buchans Unit of American Smelting and Refining Company with a mine at Buchans in the Red Indian Lake district of Newfoundland and from copper ores of the Tilt Cove mine of First Maritime Mining Corporation Limited and of the Little Bay mine of Atlantic Coast Copper Corporation Limited, both on the northeast coast of Newfoundland. In August 1964, Consolidated Rambler Mines Limited began operations at its copper-zinc-gold mine near Baie Verte, Newfoundland. In New Brunswick, Heath Steele Mines Limited recovered gold from its lead-zinc ores and from copper ore of the Wedge Mine of The Consolidated Mining and Smelting Company of Canada Limited. Both are in the Bathurst-Newcastle area. Gold output in the Atlantic Provinces is expected to increase as more base-metal mines are brought into production.

QUEBEC

Gold production increased by three per cent in 1964. Twelve lode gold mines were in operation, one less than in 1963.

AURIFEROUS-QUARTZ MINES

Bourlamaque-Louvicourt District – Four gold mines were in operation in 1964. Bevcon Mines Limited recorded increased production, Sigma Mines (Quebec) Limited and Lamaque Mining Company Limited produced about the same as in 1963 and Sullivan Consolidated Mines, Limited produced less.

Cadillac-Malartic District – None of the six operating mines in the area recorded increased production except Canadian Malartic Gold Mines Limited, which is scheduled to close in January 1965. Malartic Gold Fields Limited continued to operate its mine on a salvage basis.

Noranda District – Peel-Elder Limited, which resumed shipments to Noranda in December 1963 after closure for shaft sinking, increased production significantly.

Chibougamau District – Norbeau Mines (Quebec) Limited, the only lode gold mine in the Chibougamau copper-gold district, began operations in September 1964; its mill has a capacity of 200 tons a day. Indicated average grade of its ore at 0.46 ounces of gold a ton is the highest in the province.

BASE-METAL MINES

Base-metal mines of the province contribute about 45 per cent of Quebec's gold production. The copper mines of the Noranda and Chibougamau areas provide the largest portion. Copper concentrates are smelted by Noranda Mines Limited at Noranda and the resulting anode copper is refined at Montreal East by Canadian Copper Refiners Limited, a Noranda subsidiary. Copper anodes, which contain some gold, are also refined at Montreal East for Gaspé Copper Mines, Limited, which operates a smelter at Murdochville; Gaspé is a Noranda subsidiary.

ONTARIO

Thirty lode gold mines operated in 1964; two were small, intermittent producers. Gold production was 8.7 per cent lower.

AURIFEROUS-QUARTZ MINES

Porcupine District – Thirteen mines were operated but one of them, Kenilworth Mines Limited, was on a very small scale. Delnite Mines, Limited, a producer since 1937, closed in August when ore reserves were exhausted. Hollinger Consolidated Gold Mines, Limited, the largest producer in the area, is expected to close in 1965. Production of gold at McIntyre-Porcupine Mines, Limited, decreased as a larger percentage of copper ore was milled. Noteworthy production increases were recorded by Broulan Reef Mines Limited, Pamour Porcupine Mines, Limited, and Porcupine Paymaster Limited.

Red Lake and Patricia Mining Division – Six mines were in operation. McKenzie Red Lake Gold Mines Limited and Cochenour Willans Gold Mines, Limited, suffered substantial production declines. The former is expected to close in 1965. Production at Pickle Crow Gold Mines, Limited, declined considerably. Dickenson Mines Limited produced approximately the same amount of gold as in 1963.

Because of increasing costs of production, Dickenson Mines Limited and Cochenour Willans Gold Mines, Limited, rejoined the list of recipients of cost assistance after several years' absence.

Larder Lake District – Kerr Addison Mines Limited continued as one of Canada's largest gold producers although production decreased 15 per cent in 1964.

Kirkland Lake District – Five mines continued operating but total production was about 5.7 per cent lower than in 1963. Wright-Hargreaves Mines, Limited, is expected to close its mine in 1965. Lake Shore Mines, Limited, and Lamaque Mining Company Limited (Teck–Hughes Mining Division) operated under increasing economic difficulties and both are faced with rapidly declining ore reserves.

Port Arthur Mining Division – Production at the three operating mines declined sharply by over 15 per cent. MacLeod-Cockshutt Gold Mines Limited and Leitch Gold Mines Limited operated on a salvage basis.

Sudbury Mining Division – Production at Renabie Mines Limited, was approximately the same as in 1963.

Fort Frances Mining Division – Sapawe Gold Mines Limited operated intermittently with a mill of the capacity of 100 tons per day and recorded a small output. Late in 1964, Shattuck Denn Mining Corporation, a United States company, assumed control and management of Sapawe. Plans are to sink the shaft to 1,000 feet and increase the mill capacity if warranted.

98115—16½

BASE-METAL MINES

Most byproduct gold was recovered from the nickel-copper mines in the Sudbury area and the zinc-copper mines in the Manitouwadge area.

MANITOBA – SASKATCHEWAN

Production at San Antonio Gold Mines Limited at Bissett, Manitoba, improved considerably in 1964. This is the only lode gold producer in the two provinces.

Byproduct gold was recovered from the base-metal mines of Hudson Bay Mining and Smelting Co., Limited, at Flin Flon and Snow Lake, both in Manitoba. Production in Saskatchewan, all from the base-metal operations of Hudson Bay Mining and Smelting Co., Limited, at and near Flin Flon, declined by over 26 per cent.

ALBERTA

Small amounts of byproduct gold are recovered annually from placer gravel of the North Saskatchewan River near Edmonton. The gravel is the main product.

BRITISH COLUMBIA

Two lode gold mines were in continuous operation. Production declined sharply at Bralorne Pioneer Mines Limited but increased slightly at The Cariboo Gold Quartz Mining Company, Limited. Production from the two mines was down over 12 per cent.

Byproduct gold from base-metal mines declined about 24 per cent. The Anaconda Company (Canada) Ltd. ceased mining at its Britannia copper mine in August. Cowichan Copper Co. Ltd. was closed by flood in December 1963 and has not resumed production. The mines of Coast Copper Company Limited at Benson Lake on Vancouver Island and The Granby Mining Company Limited (Phoenix Copper Division) near Greenwood were sizeable producers.

Small amounts of placer gold are recovered in the Wells and Atlin areas each year.

NORTHWEST TERRITORIES

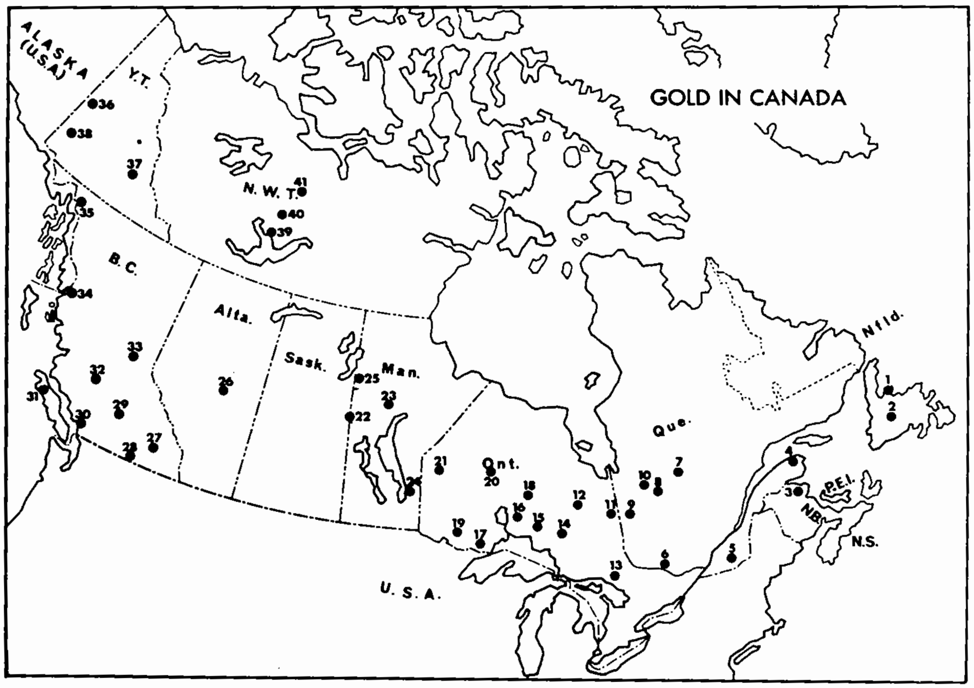
A new lode gold mine, Tundra Gold Mines Limited, began operations in March 1964 and helped to maintain total gold production at about the 1963 level.

Production at The Consolidated Mining and Smelting Company of Canada Limited's Con and Rycon mines was seriously affected by a fire which forced a lengthy closure. Discovery Mines Limited located new, high-grade ore deposits and increased production substantially. Giant Yellowknife Mines Limited also had higher production.

YUKON TERRITORY

Gold production from placer operations remained about the same as in 1963. No gold was recorded from base-metal mining.

The Yukon Consolidated Gold Corporation, Limited, by far the largest placer operation in Canada, operated six dredges in the Dawson City area, the same as in 1963. Despite a late start because of poor weather conditions, the company produced approximately the same as 1963.



PRODUCERS AND PROSPECTIVE PRODUCERS

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. The Consolidated Mining and Smelting Company of Canada Limited (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) (d)

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. *Bachelor Lake District*
   The Coniagas Mines, Limited(a)
   Quebec Sturgeon River Mines Limited (b) (d)

9. *Noranda-Rouyn District*
   Francoeur Mines Limited(b) (d)
   Lake Dufault Mines, Limited(a)
   Noranda Mines Limited(a)
   Peel-Elder Limited(b)
   Quemont Mining Corporation, Limited(a)
   Vauze Mines Limited(a)
   Wasamac Mines Limited(b) (d)

   Cadillac-Malartic District
   Barnat Mines Ltd.(b)
   Camflo Mattagami Mines Limited (b) (d)
   Canadian Malartic Gold Mines Limited(b)
   East Malartic Mines, Limited(b)
   Kiena Gold Mines Limited(b) (d)
   Malartic Gold Fields Limited(b)
   Marban Gold Mines Limited(b)
   Marbridge Mines Limited(a)
   Norlartic Mines Limited(b)

   Bourlamaque-Louvicourt District
   Bevcon Mines Limited(b)
   Chimo Gold Mines Limited(b) (d)
   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)

ONTARIO

11. *Larder Lake District*
   Kerr Addison Mines Limited(b)

   Kirkland Lake District
   Upper Beaver Mines Limited(a) (d)
   Lake Shore Mines, Limited(b)
   Lamaque Mining Company Limited (Teck-Hughes Mining Division) (b)
   Macassa Gold Mines Limited(a)
   Tegren Gold Mines, Limited(b) (d)
   Upper Canada Mines, Limited(b)
   Wright-Hargreaves Mines, Limited (b)

12. *Porcupine District*
   Aunor Gold Mines Limited(b)
   Broulan Reef Mines Limited(b)
   Delnite 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)
   Hugh-Pam Porcupine Mines Limited(b)
   Kenilworth Mines Limited(b)
   McIntyre-Porcupine Mines, Limited(a) (b)
   Pamour Porcupine Mines, Limited(b)
   Porcupine Paymaster Limited (b)
   Preston Mines Limited(b)

Matachewan District
Stairs Exploration & Mining Company Limited(b) (d)
13. *Sudbury Mining Division*
Falconbridge Nickel Mines, Limited(b)
The International Nickel Company of Canada, Limited(a)
14. Renabie Mines Limited
15. *Port Arthur Mining Division*
Geco Mines Limited(a)
Willroy Mines Limited(a)
16. Consolidated Mosher Mines Limited(b)
Leitch Gold Mines Limited(b)
MacLeod-Cockshutt Gold Mines Limited(b)
17. North Coldstream Mines Limited(a)
18. *Kowkash Mining Division*
Louanna Gold Mines Limited (b) (d)
19. *Fort Frances Mining Division*
Sapawe Gold Mines Limited (b) (d)
20. *Patricia Mining Division*
Pickle Crow Gold Mines, Limited
21. *Red Lake Mining Division*
Annco Mines Limited(b) (d)
Campbell Red Lake Mines Limited (b)
Cochenour Willans Gold Mines, Limited(b)
Dickenson Mines Limited(b)
Madsen Red Lake Gold Mines Limited (b)
McKenzie Red Lake Gold Mines Limited(b)
Robin Red Lake Mines Limited(b) (d)
Wilmar Mines Limited(b) (d)

MANITOBA

22. Hudson Bay Mining and Smelting Co., Limited(a)
23. Hudson Bay Mining and Smelting Co., Limited (Snow Lake) (a)
24. San Antonio Gold Mines Limited(b)
25. Sherritt Gordon Mines, Limited(a)

SASKATCHEWAN

22. Hudson Bay Mining and Smelting Co., Limited

ALBERTA

26. Small placer operations on North Saskatchewan River(c)

BRITISH COLUMBIA

27. The Consolidated Mining and Smelting Company of Canada Limited(a)
28. The Granby Mining Company Limited (Phoenix Copper Division) (a)
29. Bethlehem Copper Corporation Ltd.(a)
30. The Anaconda Company (Canada) Ltd. (Britannia Mine) (a)
Texada Mines Ltd. (a)
31. Coast Copper Company Limited(a)
32. Bralorne Pioneer Mines Limited(b)
33. The Cariboo Gold Quartz Mining Company, Limited(b)
Small placer operations(c)
34. Silbak Premier Mines, Limited(a)
35. Small placer operations(c)

YUKON TERRITORY

36. The Yukon Consolidated Gold Corporation, Limited(c)
Small placer operations(c)
37. Discovery Mines Limited (Ormsby Mine) (b) (d)
38. Small placer operations(c)

NORTHWEST TERRITORY

39. The Consolidated Mining and Smelting Company of Canada Limited (Con, Rycon and N'Kana mines) (b)
Giant Yellowknife Mines Limited(b)
40. Discovery Mines Limited(b)
41. Tundra Gold Mines Limited(b)

(a) Base metals. (b) Auriferous quartz. (c) Placer. (d) Prospective producer.

USES

Gold has always been prized for its rarity, beauty, lustre, its ability to resist corrosion and because it can be easily worked into objects of value. Today, however, it is used principally as a monetary reserve of governments and central banks to give stability to paper currencies and to balance international trade.

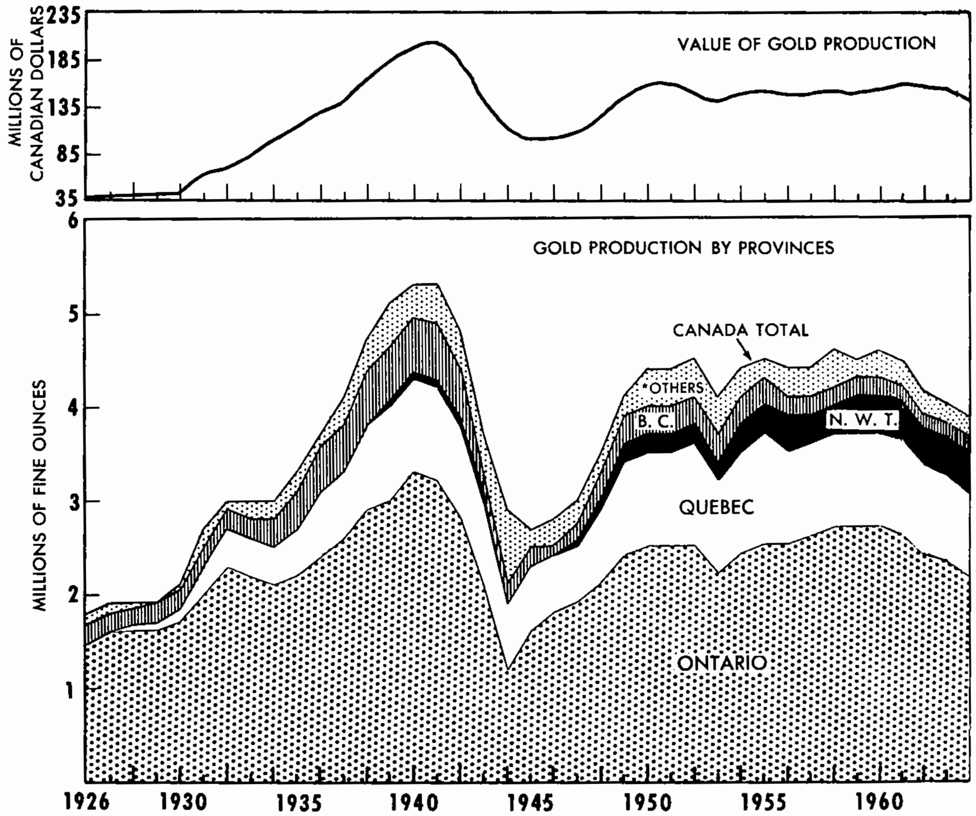
The resistance of gold to corrosion led to its early use for jewelry and decoration. This property has made it useful in recent times for electrical contacts and other devices that must operate reliably in corrosive atmospheres. In jewelry, gold is alloyed with silver, copper, nickel, zinc or palladium to improve its hardness and wearing qualities. It is used in many forms such as plating, gold-ware, foil, leaf, lace, thread, gilding, gold solutions, inserts, inlays and lettering. The colour may vary from natural yellow through various shades of green and even white depending on the alloying elements present.

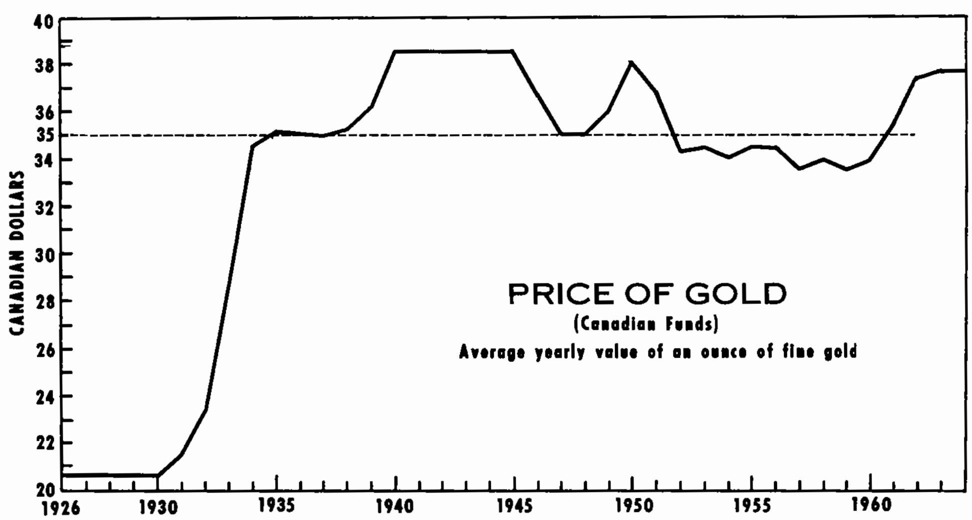
Gold is extremely ductile, highly conductive, has a high reflectivity, high density and low specific heat and vapour pressure. It is used in the chemical industry, in dentistry and in glass-making. Gold in solution is applied like lacquer to decorate pottery. Uses in electronics include radio tubes, gold-plated printed circuits, gold-film thermometers, X-ray tubes, bolometers, transparent windows and semi-conductors. The electrical industry employs it in electrical-contact alloys, resistance alloys, heating elements, condenser plates and thermal fuses. The textile industry uses it in connection with spinnerets and gold thread. It has provided lining for liquid fuel reactors and, because of its optical qualities, has found increasing use in modern aircraft missiles, earth satellites and space vehicles.

PRICES

The average Royal Canadian Mint price per troy ounce of fine gold in Canadian dollars was $37.75 in 1964, the same as in the preceding year.

On May 2, 1962, the Canadian Government fixed the value of the Canadian dollar at $0.925 United States from which level it may be allowed to fluctuate one per cent either way. The Royal Canadian Mint buying price for gold in Canadian funds may vary due to this flexibility from $37.46 to $38.22 per troy ounce. In 1964, the Mint price varied from $37.54 to $37.86 an ounce and closed the


MILLIONS OF CANADIAN DOLLARS
235
185
135
85
35
VALUE OF GOLD PRODUCTION
MILLIONS OF FINE OUNCES
6
5
4
3
2
1
GOLD PRODUCTION BY PROVINCES
CANADA TOTAL
*OTHERS
B. C.
N. W. T.
QUEBEC
ONTARIO
1926
1930
1935
1940
1945
1950
1955
1960


CANADIAN DOLLARS
40
38
36
35
34
32
30
28
26
24
22
20
PRICE OF GOLD
(Canadian Funds)
Average yearly value of an ounce of fine gold
1926
1930
1935
1940
1945
1950
1955
1960

98115—17

year at $37.56. On the international gold market in London, England, the price per ounce of gold varied between $35.06 and $35.12 (weekly averages) in United States funds.

An accompanying graph shows the Royal Canadian Mint price for a fine troy ounce of gold in Canadian funds from 1926 to 1964. The Mint price for gold has been pegged at $35 a fine ounce in United States funds since 1934 and varies because of the relationship between the Canadian and United States dollars. Gold production by provinces and the value of gold production from 1926 to 1964 are shown in two other graphs. The value of gold production declined in 1963 and again in 1964. A further decline will be recorded in 1965 as gold mines which have been operating for some time, exhaust ore reserves and cease operations.

Graphite

J.E. REEVES*

According to preliminary statistics, 13 tons of ground graphite valued at $6,570 were shipped in 1964 to domestic markets. It originated at the plant of O. Clot Graphite Mining Ltd. at Labelle, Quebec, from which many small shipments, mainly for test purposes, have been made in the last four years.

Changes in trade classifications by the Dominion Bureau of Statistics have eliminated all statistics on imports of natural graphite, except that contained in graphite crucibles. In 1964, $244,643 worth of graphite crucibles were imported, indicating little change in the last few years.

Artificial graphite is produced at Welland, Ontario, by Electro Metallurgical Company, division of Union Carbide Canada Limited and at Berthierville, Quebec, by Great Lakes Carbon Corporation (Canada), Ltd.

CANADIAN OCCURRENCES

Graphite occurs commonly in many parts of Canada, although generally in too low or too limited a concentration or too far from markets to be of commercial importance. Particularly well known are the deposits in or associated with the Precambrian limestones and gneisses of southeastern Ontario and southwestern Quebec. These may consist of zones or disseminations of fine- to medium-grained flake or veins and stringers of coarse-grained graphite.

WORLD PRODUCTION

There was a remarkable increase in world production of natural graphite, from 455,000 short tons in 1961 to 780,000 short tons in 1963, and then a decrease to about 600,000 short tons in 1964. This was caused by the rapid growth in production of amorphous graphite in the Republic of Korea, from less than 100,000 short tons in 1961 to more than 374,000 short tons in 1963, and then a decline to an estimated 195,000 short tons in 1964. Austria, also a producer of amorphous graphite, has increased its production steadily to more than 112,000 short tons. Most of North America's traditional sources have shown little change in the level of production in the last few years.

*Mineral Processing Division, Mines Branch

TABLE 1

World Production of Graphite

(short tons)

	1962	1963	1964
Republic of Korea	204,032	374,428	195,000e
Austria.........................	98,416	109,778	112,697
North Korea.....................	72,000e	77,000e	77,000e
U.S.S.R.	60,000e	60,000e	60,000e
China	45,000e	45,000e	45,000e
Mexico..........................	31,992	33,065	33,000e
Malagasy Republic...............	19,274	21,214	17,413
West Germany....................	13,134	13,000e	13,000e
Ceylon..........................	9,665	9,280	11,947
Norway..........................	7,222	8,400	8,400e
Japan...........................	3,812	3,305	2,700
Italy...........................	3,703	1,884	1,443
Brazil..........................	1,775	1,775e	1,775e
Hong Kong.......................	902	891	795
Other countries.................	19,073	20,980	19,830
Total..........................	590,000	780,000	600,000

Source: U.S. Bureau of Mines MINERALS YEARBOOK 1964.
Symbols: p Preliminary; e Estimate.

Mexico is a traditional source of amorphous graphite; the Malagasy Republic supplies flake graphite, including a large tough flake for use in crucibles; West Germany and Norway produce small-flake graphite; and Ceylon is the source of coarse, massive graphite. There is considerable world trade based on the demands in the more highly industrialized countries and the availability of the different commercial varieties elsewhere.

TECHNOLOGY

Graphite is the common form of natural crystalline carbon. It occurs as flakes in zones in or disseminated through various rock types, as coarsely crystalline masses in veins, and in cryptocrystalline, usually bedded, deposits. In general, industry recognizes two kinds of natural graphite: crystalline, which comprises the high-grade products from the first and second types of occurrences, and amorphous, which comprises products from the last type of occurrence and some of the low-grade products from the first two.

To yield marketable flake graphite, a Canadian deposit must have a moderately high content of graphite (a minimum of 15 to 20 per cent) that can be liberated sufficiently during grinding and can be concentrated readily to meet the required specifications. Flotation is generally a suitable method of concentration but electrostatics can also be applied. In Canada, no deposit is of possible value unless it is readily accessible to the rather limited market available.

Graphite is of industrial importance mainly because of its physical properties. It is soft and greasy, a good conductor of heat and electricity, resistant to thermal shock, refractory and chemically inert except for oxidation at high temperature.

The growth in use of natural graphite has not kept pace with industrial growth during the last two decades. In the various metallurgical applications, substitutes such as zirconia mould washes and silicon carbide crucibles have replaced in part similar products made of graphite. When the properties of graphite were required by some technological development, artificial rather than natural graphite was generally adapted for use. Most artificial graphite is made conventionally, by heating petroleum coke to about 1300° C, crushing the resulting dense carbon, and baking the crushed carbon with coal-tar pitch binder to about 2500° C. This process has undergone many refinements and innovations in the last few years in order to provide specialized products with improved properties, such as 'hot-worked' graphite for space applications. In addition, new revolutionary processes have been developed, resulting in entirely new products, such as pyrolytic graphite and graphite fabrics and fibres with improved or special characteristics. Pyrolytic graphite is deposited from a carbonaceous gas on a heated substrate under close temperature and pressure control. Its strongly oriented structure gives it markedly different thermal characteristics in the plane of the structural layers and at right angles to this plane. It also has a marked impermeability, which is important for nuclear applications. In this specialized field of graphite product development, natural graphite has no role to play.

USES AND SPECIFICATIONS

The principal use of natural graphite is in foundry facings, which are mixtures of ground and blended grades of graphite (mostly amorphous), clay and other materials. These mixtures facilitate the separation of the casting from the mould. In the steel industry, low-cost graphite is used for recarburizing. Graphite crucibles, covers, stoppers and nozzles are used in the handling of molten metals. Graphite is also used as a conducting material in dry-cell batteries; as a lubricant, in dry form and in greases and oils; as a means of smoothing out the frictional irregularities in brake linings; in lead pencils; in the manufacture of close tolerance, mechanical and electrical products such as electric brushes and special pistons, rings and bearings; and, in minor amounts, in certain rubber products, such as seals and gaskets, in some polishes and anticorrosion paints, and in packings.

Artificial graphite could be used in much the same way as natural graphite. It is used in large quantity as electrodes in certain metallurgical and chemical plants. It is also used in lubricants and in the manufacture of electric brushes, refractory brick, nuclear reactor components and numerous special shapes.

Specifications for natural graphite are many and varied and subject to change; they relate principally to carbon content, type of graphite and particle size. They are mainly a matter of negotiation between supplier and consumer.

PRICES

Graphite prices in the United States, according to E & MJ METAL AND MINERAL MARKETS of December 28, 1964, were:

	Dollars
Crystalline, f.o.b. source, in bags	
Malagasy Republic, per metric ton (2,205 lb)	90-200
Norway, per short ton (2,000 lb)	85-145
West Germany, per metric ton	124-672
Ceylon, per long ton (2,240 lb)	95-250
Amorphous, f.o.b. source, 80-85% C, in bulk	
Mexico, per short ton	17- 20
Korea, per long ton	15
Hong Kong, per long ton, in bags	23

TARIFFS

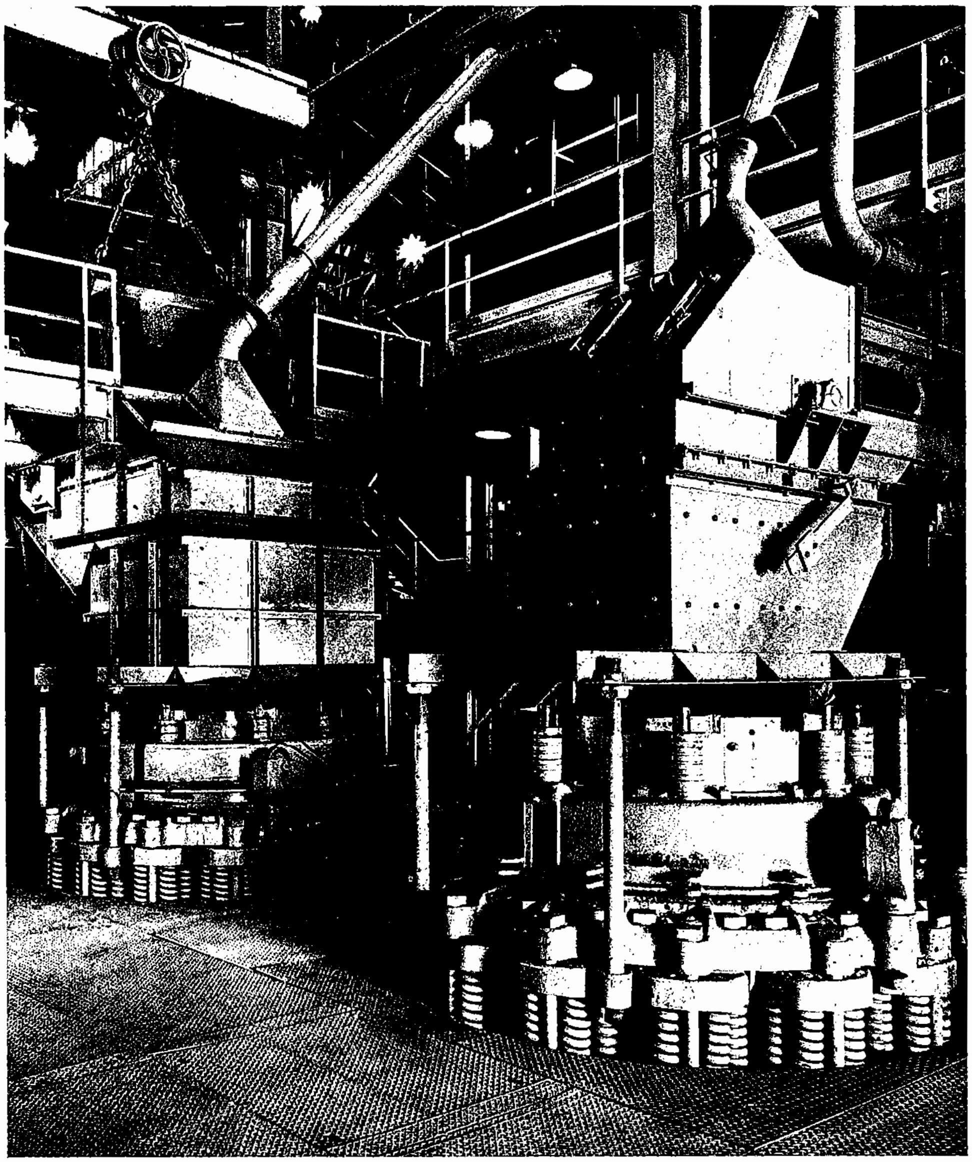
Partial information on tariffs in effect at this date is as follows:

	British Preferential (%)	Most Favoured Nation (%)	General (%)
CANADA			
Graphite, not ground or otherwise manufactured	free	5	10
Graphite, ground and manufactures thereof, not otherwise provided for	15	20	25
Graphite flakes	5	5	25
Foundry facings	15	22½	25

UNITED STATES

Graphite, crude and refined	
Artificial	5%
Natural	
Crystalline flake	
at not more than 5½¢ a pound	15%
at more than 5½¢ a pound	0.825¢ per lb
Crystalline lump or chip	5.5%
Other*	0.5%

*Duty suspended to June 30, 1966, on amorphous graphite valued at $50 or less per long ton.



Crushers at the Mattagami mill.

Gypsum and Anhydrite

R.K. COLLINGS*

Gypsum (hydrous calcium sulphate) is a useful nonmetallic mineral primarily because of its application in the manufacture of plaster and plaster products for the building construction industry. In Canada gypsum is produced in Newfoundland, Nova Scotia, New Brunswick, Ontario, Manitoba and British Columbia. The chief producer, Nova Scotia, annually accounts for about 80 per cent of the total; however, most of the gypsum from this province is exported to plants along the eastern coast of the United States.

The 1964 production, at 6.4 million tons, established a new record and represented an increase of 7 per cent over 1963. Value of production rose 10 per cent to $12.4 million. Nova Scotia and Newfoundland accounted for most of the increased production although gains were recorded in Ontario, British Columbia and New Brunswick as well. Exports, practically all of which were from Nova Scotia to the United States, increased 7.5 per cent to 5 million tons, valued in excess of $9 million. Imports of crude gypsum, mostly from Mexico for consumption in British Columbia, increased moderately in 1964 to 80,986 tons, valued at $715,000.

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 Cape Breton Island; in the St. George's Bay area in southwestern Newfoundland; and in southeastern New Brunswick near Hillsborough.

No natural gypsum occurrences are known in mainland Quebec but extensive deposits outcrop over large areas of the Magdalen Islands in the Gulf of St. Lawrence.

*Mineral Processing Division, Mines Branch

TABLE I

Gypsum – Production and Trade

	1963		1964p	
	Short Tons	$	Short Tons	$
Production, shipments				
Crude gypsum				
Nova Scotia	4,910,536	8,228,893	5,117,205	9,101,074
Ontario	439,206	1,225,301	490,000	1,355,000
Newfoundland	232,259	766,098	349,774	826,900
British Columbia	160,954	482,862	180,500	541,500
Manitoba	131,767	395,301	132,300	396,900
New Brunswick	80,544	139,497	103,986	176,454
Total	5,955,266	11,237,952	6,373,765	12,397,828
Imports				
Crude gypsum				
Mexico	73,300	219,900	70,000	610,000
United States	1,322	24,369	10,974	104,000
Britain	6	262	12	1,000
Total	74,628	244,531	80,986	715,000
Plaster of paris and wall plaster				
United States	7,820	338,884	3,907	183,000
Britain	555	21,270	237	14,000
West Germany	5	292	13	1,000
France	2	425	–	–
Total	8,382	360,871	4,157	198,000
Gypsum lath, wallboard and basic products				
United States	65	11,556	3,761	208,000
West Germany	–	–	4	1,000
Britain	–	–	5	––
Total	65	11,556	3,770	209,000
Total imports	...	616,958	...	1,122,000
Exports				
Crude gypsum				
United States	4,703,118	7,674,340	5,043,469	9,033,140
Bahamas	–	–	13,759	26,968
Bermuda	–	–	25	600
Total	4,703,118	7,674,340	5,057,253	9,060,708

Source: Dominion Bureau of Statistics.
Symbols: p Preliminary; –– Value under $500; – Nil; ...Not applicable.

In Ontario, gypsum occurs in the Moose River area in the far northeast, and in the Grand River area, south and west of Hamilton. The Moose River deposits are 15 to 20 feet thick and usually under 10 to 30 feet of cover; 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 noted in Manitoba are in the southwestern section of the province at Gypsumville, where a 30-foot thickness of gypsum is exposed; at Amaranth, where 40 feet of gypsum occurs at a depth of 100 feet; and at Silver Plains, 30 miles south of Winnipeg, where high-quality gypsum occurs 120 feet below the surface. Gypsum occurs in Alberta in Wood Buffalo Park and is exposed along

TABLE 2

Gypsum Production, Trade and Consumption 1955-64
(short tons)

	Production[1]	Imports[2]	Exports[2]	Apparent Consumption[2,3]
1955	4,667,901	16,104	3,039,192	1,644,813
1956	4,895,811	70,436	3,840,721	1,125,526
1957	4,577,492	92,139	3,410,684	1,258,947
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
1964p	6,373,765	80,986	5,057,253	1,397,498

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
('000 short tons)

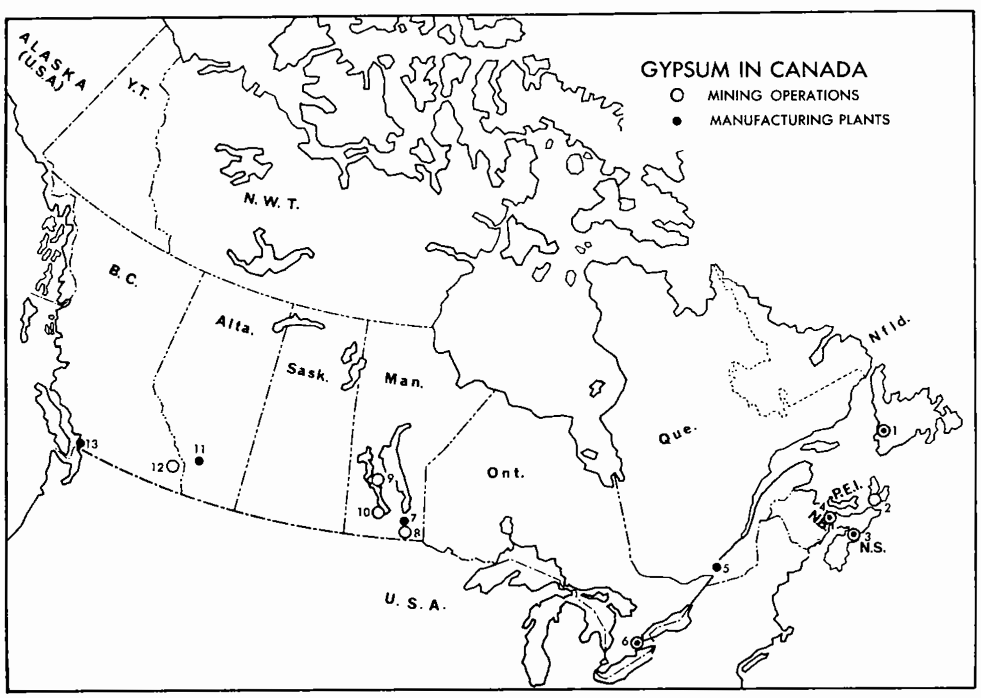
	1963
United States	10,388
U.S.S.R.	8,815
Canada	5,955
Britain	4,614
France	4,519
Italy	3,527
Spain	3,307
India	1,309
West Germany	1,218
Other countries	10,348
Total	54,000

Source: Canada, Dominion Bureau of Statistics; all other countries, U.S. Bureau of Mines, MINERALS YEARBOOK, 1963.

the banks of the Peace River between Peace Point and Little Rapids. It also occurs 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 Territory and, in the Northwest 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.



MINING OPERATIONS*

(Numbers refer to locations on the accompanying map.)

1. The Flintkote Company of Canada Limited, Flat Bay Station
2. Little Narrows Gypsum Company Limited, Little Narrows
   The Bestwall Gypsum Company (Canada) Ltd., 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 Products Limited, Silver Plains (underground)
9. Domtar Construction Materials Ltd., Gypsumville
10. Western Gypsum Products Limited, Amaranth (underground)
12. Western Gypsum Products Limited, Windermere

*Surface operations except where noted otherwise.

MANUFACTURING PLANTS

(Numbers refer to locations on the accompanying map.)

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 Products Limited, Clarkson
7. Domtar Construction Materials Ltd., Winnipeg
   Western Gypsum Products Limited, Winnipeg
11. Domtar Construction Materials Ltd., Calgary
   Western Gypsum Products Limited, Calgary
13. Domtar Construction Materials Ltd., Port Mann
   Western Gypsum Products Limited, Vancouver

CURRENT OPERATIONS

NOVA SCOTIA

There are five companies actively producing gypsum in Nova Scotia. Production totalled 5.1 million tons in 1964, 80 per cent of the Canadian total. Over 90 per cent of the production of this province was exported to the United States in 1964.

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 of the gypsum is for export to company plants in the United States; however, a small amount is shipped to Quebec. 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 Montreal.

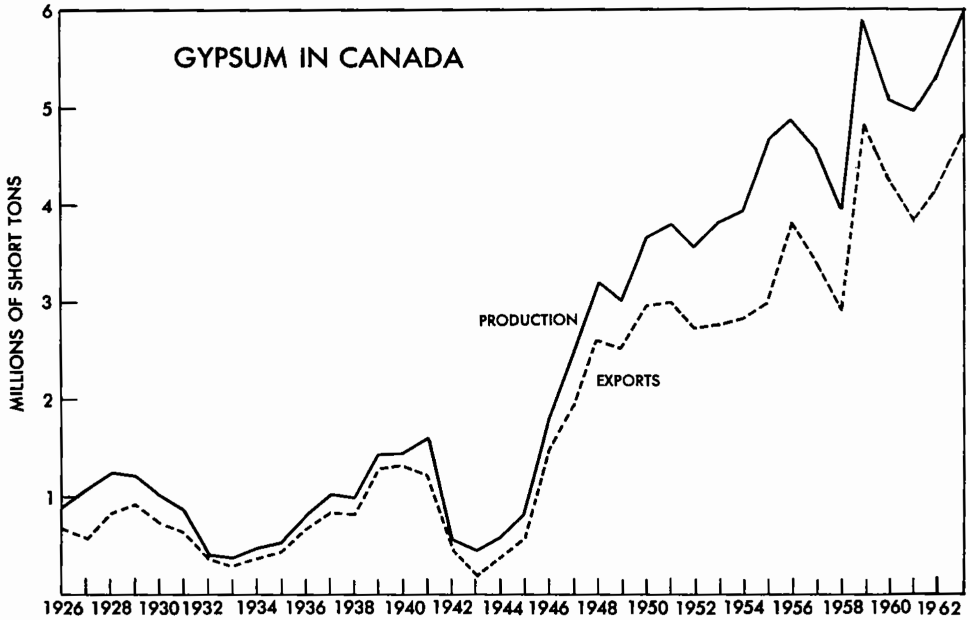
Domtar Construction Materials Ltd., with head offices in Montreal, operates a calcining plant at Windsor, for the production of plaster of paris. Gypsum for this plant is obtained from deposits at McKay Settlement near Windsor. The Nappan gypsum quarry has not been operated for several years. The Bestwall Gypsum Company (Canada) Ltd., quarries gypsum for export near River Denys. The crushed rock is carried by rail to shipping facilities at Point Tupper, 20 miles from the quarry site.

ONTARIO

Gypsum is mined 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 of the mines.

NEWFOUNDLAND

Atlantic Gypsum Limited produces gypsum plaster and wallboard at Humbermouth, on the west coast of the island. This plant, owned by the Government of Newfoundland, is operated by The Flintkote Company of Canada Limited, Toronto, a subsidiary of The Flintkote Company of New York. Crude gypsum for its operation is obtained from Flintkote's deposits at Flat Bay Station, 62 miles by rail southwest of Humbermouth. Most of the production 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 of crude gypsum is shipped to markets in Ontario.



BRITISH COLUMBIA

Western Gypsum Products 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 Products 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 120 feet below the surface. The company's mine at Amaranth, 90 miles northwest of Winnipeg, was closed during the year.

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 Products Limited operates a gypsum-products plant at Clarkson, southwest of Toronto. Crude gypsum for this operation is obtained from southern Ontario and from Newfoundland.

ALBERTA

Domtar Construction Materials Ltd. and Western Gypsum Products Limited produce plaster and wallboard in Calgary. Gypsum for these plants is obtained from British Columbia and Manitoba.

BRITISH COLUMBIA

Domtar Construction Materials Ltd. and Western Gypsum Products Limited also have plants in Vancouver for the production of gypsum plaster and wallboard. The former obtains its crude gypsum from Mexico, the latter is supplied from its Windermere deposit.

USES

Calcined gypsum, or plaster of paris, is the main constituent used in manufacturing gypsum board and lath, gypsum tile and roof slabs, and all types of industrial plasters. Gypsum plaster 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 in the building-construction industry.

Crude uncalcined gypsum is used in the manufacture of portland cement. The gypsum, acting as a retarder, controls the set of the cement. Crude gypsum, reduced to 40 mesh or finer, 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 is used as a soil conditioner to offset the effect of black alkali; as an aid in restoring impervious, dispersed soil; and as a fertilizer for peanuts and other legumes.

TARIFFS

	British Preferential (%)	Most Favoured Nation (%)	General (%)
CANADA			
Gypsum, crude	free	free	free
Gypsum, ground, not calcined	10	12½	15
Gypsum wallboard and lath ..	15	20	35
Plaster of paris and prepared wall plaster per 100 lb	free	11¢	12½¢
UNITED STATES			
Gypsum, crude	free		
Gypsum, ground or calcined, per long ton.............	$1.19		
Gypsum wallboard and lath ..	12½%		

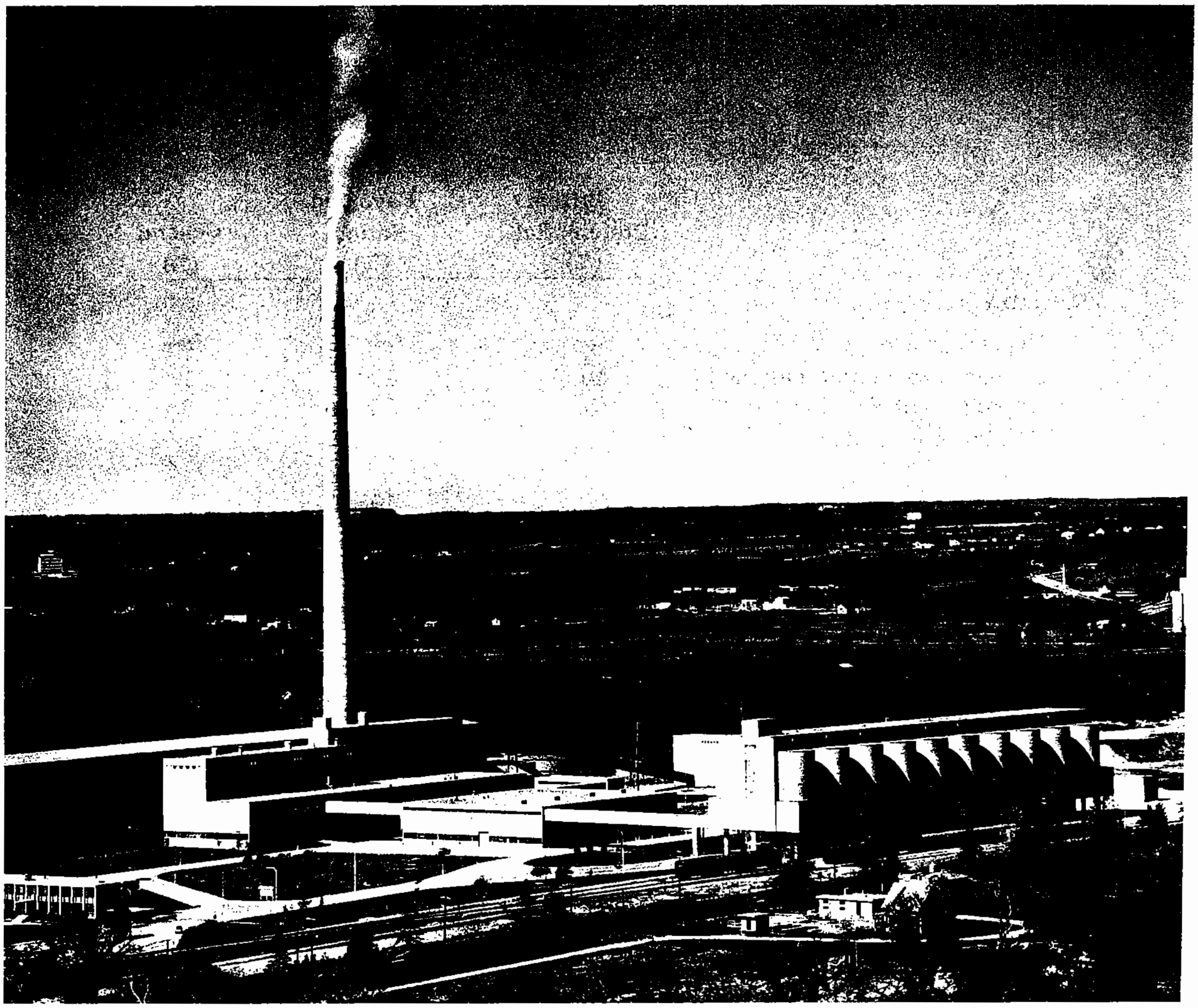
ANHYDRITE*

Anhydrite, an anhydrous calcium sulphate, 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 in 1964 was about 300,000 tons**. Most of this was shipped to the United States for use in the manufacture of portland cement 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 byproduct cement. The gases are then converted into sulphuric acid.

*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.

**Nova Scotia Department of Mines, Halifax.



St. Lawrence Cement Co. plant on shore of
Lake Ontario at Clarkson, Ontario.

Indium

D.B. FRASER*

Indium occurs in minute quantities in certain ores of zinc, lead, tin, tungsten and iron. It is commonly associated with certain occurrences of sphalerite, the common zinc mineral, and becomes concentrated in zinc residues and smelter slags derived from zinc- and lead-smelting operations. Indium is produced at only a few of the world's zinc and lead smelters.

Statistics on production of indium are not available since producers do not publish this information. There is one producer in Canada and one in the United States. The metal is reported to have been recovered also in West Germany, Belgium, Japan, Peru and Russia. The Consolidated Mining and Smelting Company of Canada Limited (COMINCO), which has plants at Trail, B.C., for the reduction of lead and zinc, is one of the world's largest suppliers of indium.

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, B.C., 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 the recovery of contained lead and residual zinc. In the lead blast furnaces, the indium enters the lead bullion and the 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 the 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 the 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 2.5 to 3.0 per cent indium.

*Mineral Resources Division

The dross retreatment slag is reduced electrothermally 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) of 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 silvery-white, very much like tin or platinum in appearance; chemically and physically, it resembles tin more than it does any other metal. Its chief characteristics are its extreme softness, its low melting point and the high melting range. 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 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 for the last 25 years only, 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

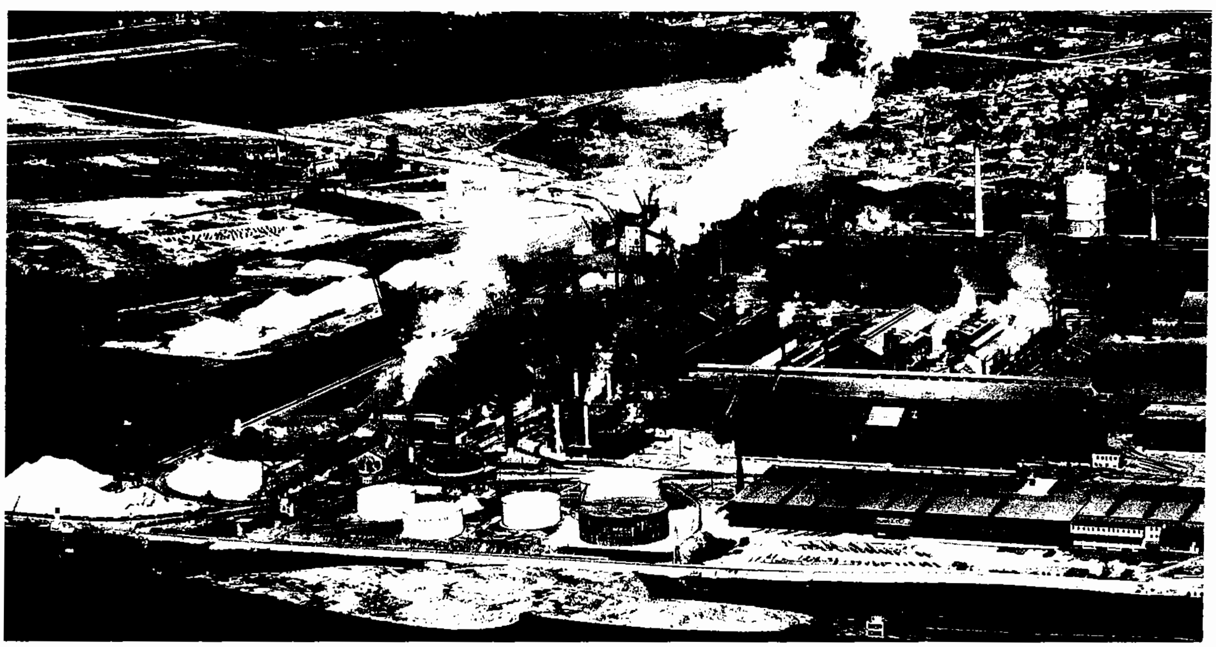
No statistics are available on the export, import or domestic consumption of indium. Much of Canada's output is exported to the U.S. and Britain, and smaller amounts go to a number of countries in Europe.

PRICES

Prices of indium, 99.97 per cent, quoted per troy ounce in E & MJ METAL AND MINERAL MARKETS were as follows:

	(Dollars)
To September 30, 1964	
25-ounce lots	2.25
Ingot, 100-10,000 oz	1.50-1.80
Effective October 1, 1964	
Sticks, 30-90 oz	2.40
Ingot	
100 oz	1.95
10,000+ oz	1.65
Effective May 3, 1965	
Sticks, 30-90 oz	2.55
Ingot	
100 oz	2.10
10,000+ oz	1.80

Algoma's steel mill at Sault Ste. Marie.



Iron Ore

G.E. WITTUR*

Record steel production in the United States was primarily responsible for making 1964 the best year ever for the Canadian iron mining industry. Iron ore shipments of 34.5 million tons** exceeded the previous record set in 1963 by more than 7.6 million tons. Iron ore has become Canada's first-ranking metallic mineral, in terms of value, by displacing nickel from first place in 1964 and copper from second place in 1963. All producing provinces and most producers shared higher 1964 shipments, with those from Labrador and Quebec being particularly strong. Although shipments from British Columbia mines increased, the dollar value fell slightly from 1963 because of the increasing price competition in the Japanese iron ore market that resulted in lower sale prices.

Unlike preceding years, producers of medium-grade ores recorded generally higher shipments in 1964 as sources of high-grade pellets and concentrate were not sufficient to fill the heavy demand. Because sales of medium-grade ores are expected to decline in future years, research on beneficiating them continued. There has been a revival of interest in methods for the direct reduction of iron ore; such investigations received much attention in the mid-1950s. The emphasis has now changed to producing a partially reduced blast furnace feed rather than a fully reduced product that would be a steel scrap substitute. Prompting the renewed interest is the need of steel companies to increase pig iron output without large expenditures for new blast furnaces.

Two companies made final iron ore shipments in 1964 – Nimpkish Iron Mines Ltd. in British Columbia exhausted its ore reserves late in 1963 and Oglebay Norton Company's Canadian Charleson Mine near Atikokan, Ontario, closed in November. Several new iron ore projects were completed, a former producer resumed shipments and several projects were in the construction phase at year's end. The only new producer in 1964 was Coast Copper Company Limited, which recovers magnetite as a byproduct from its copper operations

* Mineral Resources Division

** The long or gross ton (2,240 pounds) is used throughout unless otherwise noted

TABLE 1

Iron Ore – Production and Trade

	1963		1964p	
	Long Tons	$	Long Tons	$
Production (shipments)				
Quebec	10,402,488	122,800,862	13,765,240	155,581,064
Newfoundland	8,645,539	99,601,987	11,691,286	142,524,360
Ontario..........	6,026,444	70,033,690	7,130,103	84,423,975
British Columbia ..	1,839,501	20,746,424	1,935,320	20,363,091
Total.........	26,913,972	313,182,963	34,521,949	402,892,490
Byproduct iron ore* ..	612,285	..	876,656	..
Imports				
United States	4,977,763	63,453,734	4,835,097	63,488,000
Brazil...........	344,930	4,404,834	372,254	3,708,000
Chile	–	–	23,850	91,000
Nigeria...........	3,012	13,255	–	–
West Germany	8	947	–	–
Total.........	5,325,713	67,872,770	5,231,201	67,287,000
Exports				
Iron ore, direct shipping				
United States	6,380,037	65,789,693	8,308,132	85,109,981
Britain	572,823	5,228,460	227,983	1,972,451
Belgium and Luxembourg.....	110,300	853,134	59,100	514,420
West Germany	263,556	2,644,384	58,886	392,759
Japan	–	–	41,734	491,643
Netherlands.......	488,979	4,784,183	–	–
Italy	18,500	115,625	–	–
Total.........	7,834,195	79,415,479	8,695,835	88,481,254
Iron ore, concentrates				
United States	9,226,914	108,805,931	10,744,738	120,471,680
Britain	1,502,141	15,150,950	1,976,471	18,730,120
Japan	1,978,774	20,295,198	1,635,598	17,778,204
Belgium and Luxembourg.....	88,160	825,328	213,505	1,866,628
West Germany	12,350	77,090	198,205	1,387,569
Netherlands.......	26,440	171,860	112,263	1,266,337
Italy	49,580	310,103	30,900	193,125
France	–	–	25,000	286,771
Bahamas	–	–	5,000	54,658
Total.........	12,884,359	145,636,460	14,941,680	162,035,092

Table 1 (cont.)

	1963		1964p	
	Long Tons	$	Long Tons	$
Iron ore, agglomerated				
United States	2,371,376	33,896,710	5,212,898	79,447,054
Britain	388,763	5,887,728	957,513	15,011,226
Netherlands	–	–	76,292	1,176,196
West Germany	–	–	60,489	973,889
Total..........	2,760,139	39,784,438	6,307,192	96,608,365
Iron ore, not elsewhere specified including byproduct iron ore				
United States	350,378	6,039,407	527,494	8,870,978
West Germany	24,042	68,500	–	–
Britain	1,860	4,499	–	–
Trinidad..........	–	–	1,500	11,625
Total..........	376,280	6,112,406	528,994	8,882,603
Total, all classes				
United States	18,328,705	214,531,741	24,793,262	293,899,693
Britain	2,465,587	26,271,637	3,161,967	35,713,797
Japan	1,978,774	20,295,198	1,677,332	18,269,847
West Germany	299,948	2,789,974	317,580	2,754,217
Belgium and Luxembourg.....	198,460	1,678,462	272,605	2,381,048
Netherlands	515,419	4,956,043	188,555	2,442,533
Italy	68,080	425,728	30,900	193,125
France	–	–	25,000	286,771
Bahamas	–	–	5,000	54,658
Trinidad..........	–	–	1,500	11,625
Total..........	23,854,973	270,948,783	30,473,701	356,007,314

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.
Symbols: p Priliminary; – Nil; .. Not available.

on northern Vancouver Island. Two other companies were in the tune-up stage at the end of 1964 – Jones & Laughlin Steel Corporation's Adams Mine near Kirkland Lake, Ontario, and Wabush Mines at Wabush, Labrador. Initial shipments of high-grade pellets left the Adams mine by rail late in December; regular shipments began in February 1965. Concentrate production at Wabush Mines will begin on a regular basis early in 1965. Zeballos Iron Mines Limited on

Vancouver Island resumed production following financial reorganization and an underground development program. The pellet plants of Caland Ore Company Limited at Steep Rock Lake, Ontario, and Arnaud Pellets at Pointe Noire, Quebec, will begin production in 1965. Wesfrob Mines Limited is preparing several magnetite-chalcopyrite orebodies in the Queen Charlotte Islands of British Columbia for production of iron ore and copper concentrates in 1966. Empire Development Company, Limited, is continuing an underground development program at its mine on northern Vancouver Island to exploit an orebody discovered late in 1963. Upon completion of the Caland and Arnaud pellet plants, Canadian iron ore pellet capacity will be 15.4 million tons a year of a total iron ore productive capacity of 47.0 million tons a year. The remaining capacity comprises 13.6 million tons of high-grade concentrate and 18 million tons of medium-grade ore containing between 50 and 58 per cent iron.

A number of companies with undeveloped iron ore properties in eastern Canada, particularly in northwestern Ontario and the Labrador-Quebec Trough area, were negotiating for markets and financing that would enable development of their properties. Prospective consumers, which may also participate financially in development, include steel companies in Canada, United States and western Europe. Early in 1965, it was announced that Dominion Foundries and Steel, Limited, of Hamilton, Ontario, and The Cleveland-Cliffs Iron Company will build a concentrating-pelletizing plant at Temagami, Ontario. Facilities to upgrade and perhaps pelletize their products are being considered by producers of medium-grade ore in eastern Canada. In British Columbia, several companies were engaged in exploration of small iron ore properties, particularly

TABLE 2

Iron Ore – Production, Trade and Consumption, 1955–64

(long tons)

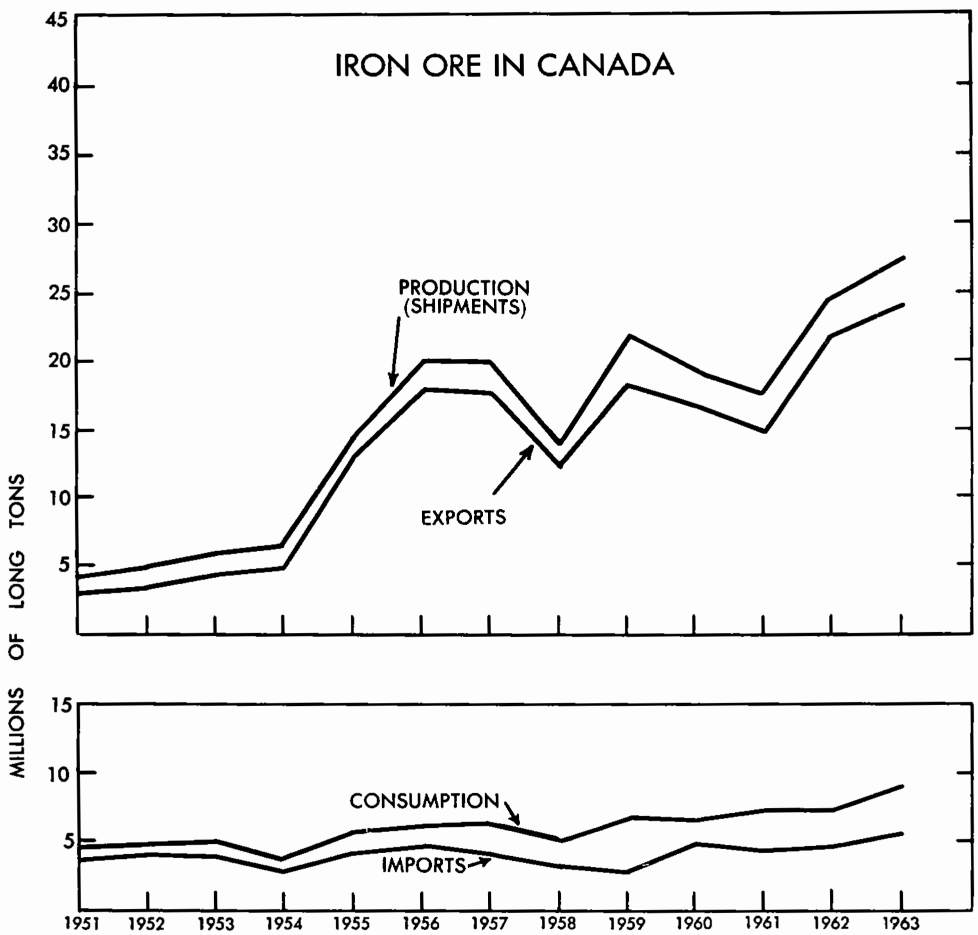
	Production (shipments)	Imports	Exports	Consumption* (indicated)
1955	14,538,551	4,052,490	13,008,000	5,583,041
1956	19,953,820	4,525,768	18,094,080	6,385,508
1957	19,885,870	4,052,704	17,972,769	5,965,805
1958	14,041,360	3,047,301	12,391,314	4,697,347
1959	21,864,576	2,500,894	18,552,488	5,812,982
1960	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
1964p	34,521,949	5,231,201	30,473,701	9,279,449

Source: Dominion Bureau of Statistics.
*Shipments plus imports less exports with no account taken of changes in stocks at consuming plants.
p Preliminary.

on Vancouver Island and the Queen Charlotte Islands. Orecan Mines Ltd. announced plans to bring its iron ore property near Kelsey Bay, Vancouver Island, into production by mid-1965.

MARKETS AND TRADE

Canadian iron ores are consumed by steel industries in five main market areas: Canada, United States, Britain, Japan and western Europe. Shipments to domestic steel plants and to the United States and Britain were significantly higher in 1964 than in 1963; exports to Japan and western Europe were substantially lower. United States, our largest market, took 72 per cent of total shipments in 1964. It is the world's largest iron ore importer and Canada continued to make



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gains there against strong competition. Imports from Canada rose by nearly 6.5 million tons; from all other countries they rose by only 3 million tons. Canada supplied 59 per cent of United States iron ore imports compared with 57 per cent in 1963.

Consumption of iron ore by the Canadian steel industry increased by 5 per cent in 1964 to 8.9 million tons although steel production rose 11.5 per cent. All of the increase in consumption was from domestic sources; imports from the United States and other countries were slightly lower than in 1963. Imports will continue to decline in 1965 when Wabush Mines, 40 per cent owned by two Canadian steel companies, begins production, and should be no more than 10 per cent of consumption by 1968 compared with over 60 per cent in recent years.

Increased shipments to Britain were the result of improved markets for pellets and high-grade concentrates, the shipment of which began in 1963 and accelerated in 1964. Sales of medium-grade ore were up slightly. Exports to western Europe continued to decline in the face of intensive competition from other countries, particularly from those in West Africa and South America. There is some expectation that Canada might experience a resurgence in sales there in the next few years.

Approval was given by voters in Minnesota to amend the state constitution to guarantee no disproportionate tax increases on taconite plants* in the state. Before the end of the year, several companies announced plans for large new concentrating-pelletizing operations in Minnesota. It is not expected that this development will have serious long-term implications on Canadian iron ore production but the industry's rate of growth may be lower in the next few years.

WORLD PRODUCTION

World iron ore production at an estimated 564 million tons was 8 per cent higher than in 1963. The 12 countries listed in Table 3 together produced substantially more with all but West Germany and Brazil sharing in the increase. Among the countries with significantly higher output were Canada and Venezuela, with 28- and 15-per cent increases, respectively, and Liberia with a 228-per-cent increase as a result of production at a large new mine. A three-year record of declining shipments was reversed for Venezuela, whose rank among world producers rose from 11th to 9th; Liberia rose from 22nd place to 10th.

Developments in Australia's iron ore industry during 1964 were particularly noteworthy. By early 1965, four mining firms had received Japanese contracts or commitments for a total of some 187 million tons of high-grade iron ore, valued at U.S. $1.8 billion, to be delivered over periods ranging from 7 to 22 years beginning from April 1966 to 1969. These four contracts will assure

* Plants that process low-grade ore to produce high-grade iron ore pellets.

TABLE 3

Production of Iron Ore, By Country

('000 long tons)

	1961	1962	1963	1964
U.S.S.R	116,137	126,077	136,804	142,710
United States	71,329	71,829	72,310	81,328
France....................	65,525	65,272	57,556	60,501
China.....................	44,300	34,400	49,210	..
Canada	18,177	24,428	26,914	34,522
Sweden	22,766	21,675	22,115	26,116
India (incl. Goa)	18,457	18,326	18,966	19,684
Britain....................	16,518	15,277	14,797	16,324
Venezuela.................	14,335	13,057	11,929	13,680
Liberia	3,200	3,550	3,543	11,614
West Germany..............	18,568	16,380	12,694	11,430
Brazil	9,628	9,842	12,942	11,072
Subtotal..............	418,940	420,113	439,780	..
Other countries	84,839	83,418	83,421	..
World total	503,779	503,531	523,201	564,084

Source: American Iron and Steel Institute, Annual Statistical Report, 1963. Figures for 1964 from *Statistical Quarterly Report for Iron and Steel Industry, West German Iron and Steel Federation,* supplied to the Mineral Resources Division by American Iron and Steel Institute. Figures for Canada from Dominion Bureau of Statistics with totals adjusted accordingly.
.. Not available.

annual exports of more than 10 million tons of direct shipping ore by 1970 and offers have been made by other companies for an additional 6 million annual tons, mostly in the form of high-grade pellets.

DOMESTIC CONSUMPTION

Iron ore is used primarily as a raw material in the making of iron and steel. Small amounts of iron oxides, not properly iron ore, are used in the manufacture of paint and cement, for heavy aggregate in concrete, as heavy media in some beneficiation plants and for agriculture. Most iron ore produced is made into pig iron, some of which is used by iron foundries. Most pig iron, however, along with steel scrap, fluxes, additive agents, etc., goes into the production of crude steel. Some iron ore is also used in steelmaking furnaces. Table 4 summarizes statistics on the consumption of iron ore in Canadian iron and steel plants.

TABLE 4

Consumption of Iron Ore in Canadian Iron and Steel Plants

(long tons)

	1963	1964
In blast furnaces, direct............	6,767,441	7,284,486
In steel furnaces, direct............	435,764	325,366
In sintering plants before ore is charged to blast or steel furnaces..	1,234,895	1,271,686
Miscellaneous....................	322	98
Total.......................	8,438,422	8,881,636

Source: American Iron Ore Association, compiled from company submissions.

TABLE 5

Consumption and Stocks of Iron Ore at Canadian Iron and Steel Plants, 1963 and 1964

(long tons)

	1963	1964
Receipts imported....................................	5,424,636	5,194,724
Receipts from domestic sources.........................	3,281,246	3,532,110
Total receipts at iron and steel plants	8,705,882	8,726,834
Consumption of iron ore..............................	8,438,422	8,881,636
Stocks of ore at iron and steel plants December 31	3,516,561	3,518,381
Change from previous year	+305,157	+1,820

Source: American Iron Ore Association, compiled from company submissions.

TABLE 6

Production and Capacity of Pig Iron and Crude Steel at Canadian Iron and Steel Plants, 1963 and 1964

(short tons)

	1963	1964p
Pig iron		
production.................	5,914,997	6,540,679
capacity at Dec. 31.........	6,905,000	7,288,200
Steel ingots and castings		
production.................	8,190,279	9,130,763
capacity at Dec. 31.........	9,479,240	10,908,836

Source: Dominion Bureau of Statistics.
p Preliminary.

CANADIAN DEVELOPMENTS

NEWFOUNDLAND

Because of sharply increased sales to West Germany and Belgium, shipments from Wabana Mines Division of Dosco Industries Limited rose 6.5 per cent after three successive annual decreases. Shipments of Wabana ore to the parent company's Sydney, Nova Scotia, steel plant fell by one third.

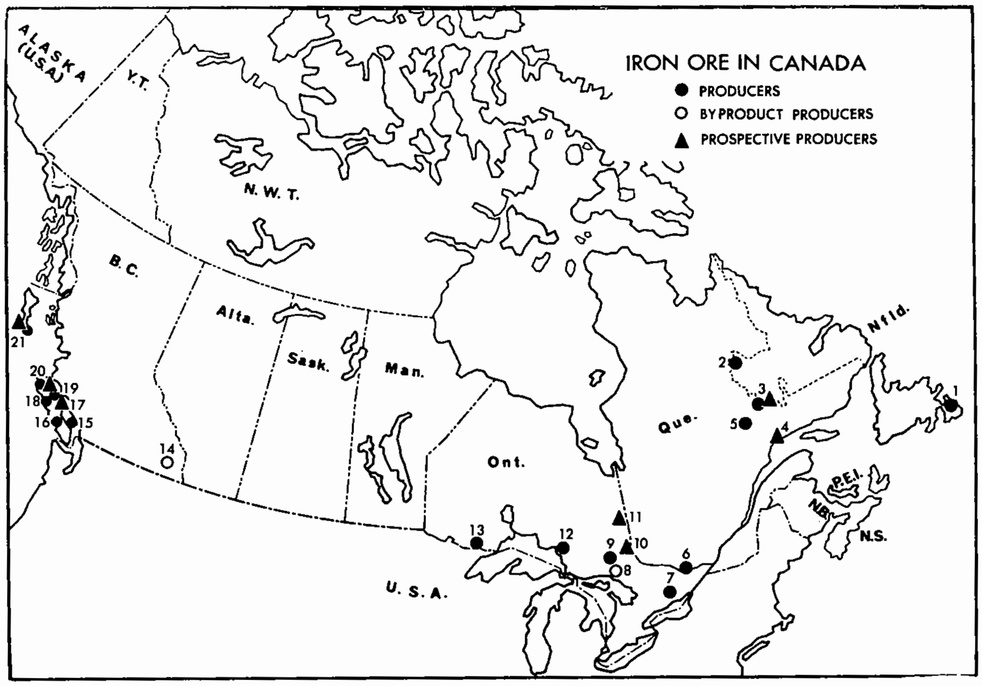
LABRADOR-QUEBEC AREA

Iron Ore Company of Canada's (IOCC) shipments from its two mining operations reached a record 14.16 million tons, comprising 7.67 million tons of direct shipping ore from Schefferville and 4.94 million tons of pellets and 1.55 million tons of concentrates from the Carol operation at Labrador City. Research on the company's ores, particularly the direct shipping type, continued at the Schefferville laboratory.

Shipments of concentrate from Quebec Cartier Mining Company also reached a record of more than 9.1 million tons, which is well above the rated annual capacity of 8 million tons. Production began in 1961 after expenditures of $350 million for an open-pit mine, a concentrator, a 193-mile railway, stockpile and boat-loading facilities, and two towns – Port Cartier and Gagnon.

Construction at the Wabush Mines' project, not far from IOCC's Carol project in Labrador, neared completion; regular production will begin early in 1965. Sections of the concentrator at Wabush, Labrador, designed to produce 5.3 million tons a year of concentrate grading 66 to 67 per cent iron, were turned over in October. At Pointe Noire, Quebec, an associated company, Arnaud Pellets, neared completion of a pelletizing plant that is designed to produce 4.9 million tons of pellets annually from Wabush concentrate. The first of three grate-type pelletizing machines was to be fired in mid-January 1965. The Wabush Mines and Arnaud Pellets projects together are expected to cost nearly $300 million.

Mount Wright Iron Mines Company Limited was negotiating for sales contracts in western Europe and Britain covering 4 million tons of high-grade pellets annually. If contracts are obtained, the company plans an $80-million development program at its iron property in Quebec, some 20 miles west of Labrador City. Canadian Javelin Limited continued negotiations for the sale of large tonnages of pellets on a long-term basis. The company holds concentrating-grade iron ore deposits near Wabush Lake, Labrador, and others to the west in Quebec.



PRODUCERS

1. Dosco Industries Limited, Wabana Mines Division
2. Iron Ore Company of Canada (Schefferville)
3. Iron Ore Company of Canada (Labrador City)
5. Quebec Cartier Mining Company
6. Hilton Mines, Ltd.
7. Marmoraton Mining Company, Ltd.
9. Lowphos Ore, Limited
12. The Algoma Steel Corporation, Limited, Algoma Ore Properties Division
13. Caland Ore Company Limited
    Oglebay Norton Company (Canadian Charleson Mine)
    Steep Rock Iron Mines Limited
15. Texada Mines Ltd.
16. Brynnor Mines Limited
18. Zeballos Iron Mines Limited
19. Nimpkish Iron Mines Ltd.
20. Coast Copper Company Limited
21. Jedway Iron Ore Limited

BYPRODUCT PRODUCERS

8. Falconbridge Nickel Mines, Limited
   The International Nickel Company of Canada, Limited
14. The Consolidated Mining and Smelting Company of Canada Limited

PROSPECTIVE PRODUCERS

3. Wabush Mines (early 1965)
4. Arnaud Pellets (early 1965)
10. Strathagami Mines, Inc. (Sherman Mine) (1967)
11. Jones & Laughlin Steel Corporation (Adams Mine) (early 1965)
17. Orecan Mines Ltd. (1965)
20. Empire Development Company, Limited (1965)
21. Wesfrob Mines Limited (1966)

QUEBEC

Hilton Mines, Ltd., shipped a record 898,150 tons of high-grade pellets compared with 870,716 tons in 1963. The company continued to increase its effective capacity through a program of mill improvement.

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 (TiO_2) and pig iron. Consumption of ilmenite at Sorel was 1,239,520 tons from which 486,258 tons of slag and 335,762 tons of iron were produced. Comparable figures for 1963 were 817,286, 338,679 and 224,949 tons, respectively. Although pig iron is produced from ilmenite, the latter is not classed as iron ore and is not included in iron ore statistics.

ONTARIO

Algoma Ore Properties Division of The Algoma Steel Corporation, Limited, shipped record tonnages of sinter. The parent company's plants took 1,539,909 tons, and exports to the United States were 239,622 tons, down slightly from 1963. Three of the company's smaller sintering strands are being replaced by a single large unit that will be completed early in 1966. The company continued to investigate potential sources of iron ore pellets.

Caland Ore Company Limited shipped approximately the same amount of direct-shipping ore as in 1963. Construction began on the company's $15-million screening-pelletizing plant. The company plans to screen the ore, pelletize the fine fraction and ship the coarse fraction as lump ore. The plant will screen 2.5 million tons of ore annually to produce 1 million tons of pellets and about 1.4 million tons of lump ore. Screening will begin in May 1965 and the pelletizing plant is expected to begin production in the fall.

The Canadian Charleson Mine of Oglebay Norton Company shipped 182,000 tons of concentrate to exhaust the economically-minable crude ore. The company began production in 1958 but did not operate in 1961 and 1963. Total shipments were 652,324 tons. Dismantling and sale of the mill began late in 1964.

Lowphos Ore, Limited shipped a record tonnage of pellets in 1964. The company's pelletizing plant began production in the fall of 1963. Concentrates have been produced since 1959.

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Shipments by Marmoraton Mining Company, Ltd., increased substantially, after two successive annual declines. The west wall of the open pit is being cut back to permit deepening of the pit so that the production period can be extended by about ten years.

Steep Rock Iron Mines Limited sold about 36 per cent more ore than in 1963 with production from the Errington underground mine being slightly higher. The company hopes to build a pelletizing plant and was negotiating with potential customers to obtain the guaranteed markets that are necessary before the plant can be built.

The iron ore recovery plant of The International Nickel Company of Canada, Limited, operated at capacity throughout 1964. Rebuilding of the second of the two original roasting units was completed during the year. Shipments of by-product iron oxide (hematite) calcine by Falconbridge Nickel Mines, Limited, rose by about 11 per cent.

An initial 140-ton shipment of iron ore pellets left the Adams Mine of Jones & Laughlin Steel Corporation, near Kirkland Lake, late in December. The new project, which cost $30 million, has a designed annual capacity of 1.25 million tons of high-grade pellets from magnetite iron formation grading 22 to 23 per cent iron. Regular shipments began in February 1965.

In January 1965, plans were announced for a new mining-concentrating-pelletizing project at Temagami, some 60 miles north of North Bay, Ontario. The operating company, Strathagami Mines, Inc., will be owned 90 per cent by Dominion Foundries and Steel, Limited, of Hamilton, Ontario, and 10 per cent by The Cleveland-Cliffs Iron Company of Cleveland, Ohio, through its subsidiary, Cliffs of Canada Limited. The project will cost over $40 million and is expected to have a minimum annual capacity of 1 million tons of pellets. The operation will be very similar to the Adams Mine near Kirkland Lake.

PRAIRIE PROVINCES

For several years, Peace River Mining & Smelting Ltd., in association with the Alberta Research Council, has carried out research on oolitic iron ore from a large deposit in the Peace River area of Alberta, some 400 miles north of Edmonton. The Research Council is constructing a $1.5-million multi-purpose pilot plant facility near Edmonton in which Peace River will lease space to test a chemical process designed to produce iron powder.

BRITISH COLUMBIA

Brynnor Mines Limited, Jedway Iron Ore Limited, and Texada Mines Ltd. all shipped greater tonnages of magnetite concentrate than in 1963. Texada completed its change from open pit to underground mining in October, Brynnor continued preliminary underground development although its open pit will be operated for some time yet, and Jedway conducted engineering studies to investigate the feasibility of underground mining of its deeper ore.

TABLE 7

Canadian Producers of Iron Ore During 1964

Company and Property Location	Participating Companies	Product Mined (average natural grade)	Product Shipped (average natural grade)	Shipments[1] ('000 long tons) 1963	1964
The Algoma Steel Corp., Ltd., Algoma Ore Properties Division; mines and sinter plant near Wawa, Ont.	Wholly owned	Siderite from open pit and underground mines (32.92% Fe)	Ore beneficiated by sink-float and sintered (50.38% Fe, 2.9% Mn)	1,618	1,783
Brynnor Mines Ltd.; near Ucluelet, Vancouver Island, B.C.	Noranda Mines Ltd.	Magnetite from open pit mine (54.0% Fe)	Magnetite concentrate (60.8% Fe)	671	673
Caland Ore Co. Ltd.; E. arm of Steep Rock Lake, N. of Atikokan, Ont.	Inland Steel Co.	Hematite and goethite from open pit mines (53.59% Fe)	Direct shipping ore (53.59% Fe) (pellets in 1965)	2,003	2,001
Canadian Charleson Mine; S. of Steep Rock Lake, near Atikokan, Ont.	Oglebay Norton Co.	Hematite-bearing gravels (12—20% Fe)	Jig and spiral concentrate (55.3% Fe)	19	182
Carol Pellet Company; adjacent to IOCC's concentrator, Labrador City, Labrador	United States participants of IOCC	Company's plant operated by IOCC to process IOCC concentrate into pellets	Pellets (63.94% Fe)	1,835	4,942
Coast Copper Co. Ltd.; Benson L., northern Vancouver Is., B.C.	COMINCO	Copper ore from underground mine containing 30% Fe as magnetite	Magnetite concentrate (58.5% Fe)	—	52
Empire Development Co., Ltd.; Benson R., 25 miles SW. of Port McNeill, Vancouver Is., B.C.	Loram Ltd.; Quatsino Copper-Gold Mines, Ltd.	Magnetite from underground mine (35.5% Fe)	Magnetite concentrate (54.1% Fe)	86	16[5]
Hilton Mines, Ltd.; near Bristol Que., 40 miles NW. of Ottawa	The Steel Co. of Canada, Ltd.; Jones & Laughlin Steel Corp.; Pickands Mather & Co.	Magnetite from open pit mine (approximately 20% Fe)	Iron oxide pellets (66.3% Fe)	871	898

Table 7 (cont.)

Company and Property Location	Participating Companies	Product Mined (average natural grade)	Product Shipped (average natural grade)	Shipments[1] ('000 long tons) 1963	1964
Iron Ore Company of Canada; Schefferville, Que.	The M.A. Hanna Co.; The Hanna Mining Co.; Hollinger Consolidated Gold Mines, Ltd.; Armco Steel Corp.; Bethlehem Steel Corp.; National Steel Corp.; Republic Steel Corp.; Wheeling Steel Corp.; The Youngstown Sheet and Tube Co.	Hematite-goethite from open pit mines (54.2% Fe)	Direct shipping ore (54.2% Fe)	6,753[2]	7,670
Labrador City, Nfld.	Same as above	Specular hematite from open pit mine (38.1% Fe)	Specular hematite concentrate (62.53% Fe)	2,217[3]	1,550[3]
Jedway Iron Ore Ltd.; Moresby Island, Queen Charlotte Is., B.C.	The Granby Mining Co. Ltd.	Magnetite from open pit mine (35% Fe)	Magnetite concentrate (62.1% Fe)	303	408
Lowphos Ore, Ltd.; Sudbury area, 20 miles N. of Capreol, Ont.	National Steel Corp.; The Hanna Mining Co.	Magnetite from open pit mine (30.9% Fe)	Magnetite concentrate (60.15% Fe) and pellets (63.38% Fe)	315 175	– 623
Marmoraton Mining Co., Ltd.; near Marmora, in southern Ont.	Bethlehem Steel Corp.	Magnetite from open pit mine (about 40% Fe)	Pellets (65.7% Fe)	387	555
Nimpkish Iron Mines Ltd.; 26 miles W. of Beaver Cove, Vancouver Is., B.C.	International Iron Mines Ltd.; Standard Slag Co.	Magnetite from open pit mine (37.3% Fe)	Magnetite concentrate (58.1% Fe)	275	25[5]
Quebec Cartier Mining Co.; Gagnon, Que.	United States Steel Corp.	Specular hematite from open pit mine (32.8% Fe)	Specular hematite concentrate (64.5% Fe)	6,353	9,142
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 from open pit and underground mines (54.3% Fe)	Direct shipping ores and gravity concentrates (55.5% Fe)	963	1,312
Texada Mines Ltd.; Texada Island, B.C.	Private company	Magnetite from open pit and underground mines (44.9% Fe)	Magnetite concentrate (61.8 Fe)	451	515

Table 7 (concl.)

Company and Property Location	Participating Companies	Product Mined (average natural grade)	Product Shipped (average natural grade)	Shipments[1] ('000 long tons) 1963	1964
Dosco Industries Limited, Wabana Mines Division; Bell Island, Conception Bay, E. coast of Nfld.	Wholly owned	Hematite-chamosite from underground and open pit mines (48.04% Fe)	Heavy-media concentrate (50.82% Fe)	1,168	1,243
Zeballos Iron Mines Ltd., near Zeballos, Vancouver Is., B.C.	Falconbridge Nickel Mines, Ltd.	Magnetite from underground mine (40—45% Fe)	Magnetite concentrate (62.6% Fe)	—	82
Byproduct Producers					
The Consolidated Mining and Smelting Co. of Canada Ltd.; Kimberley, B.C.	Wholly owned	Pyrrhotite flotation concentrates are roasted for acid production. Calcine is sintered	Iron oxide sinter (about 65% Fe) is further processed into pig iron at the plant	56[4]	66[4]
Falconbridge Nickel Mines, Ltd., Falconbridge, Ont.	Wholly owned	Pyrrhotite flotation concentrates treated	Iron oxide calcine (about 67% Fe)	64	71
The International Nickel Co. of Canada, Ltd.; Copper Cliff, Ont.	Wholly owned	Pyrrhotite flotation concentrates treated	Iron oxide pellets (67.8% Fe)	458	734
Noranda Mines Ltd.; plant formerly at Cutler, Ont.	Plant purchased in 1962 by CIL and moved to Copper Cliff, Ont.	Plant formerly treated iron sulphide concentrates	Iron oxide calcine (about 66% Fe)	42[5]	6[5]
Quebec Iron and Titanium Corp.; mine at Lac Tio, Que., electric smelter at Sorel, Que.	The Kennecott Copper Corp., the New Jersey Zinc Co.	Ilmenite-hematite from open pit mine (40% Fe, 35% TiO_2)	TiO_2 slag and various grades of desulphurized pig iron or remelt iron.	817[4]	1,240[4]

Source: Company reports, personal communications and other sources.

[1] Statistics supplied by the companies to the Mineral Resources Division. [2] Under the lease agreement with Hollinger North Shore Exploration Company Limited and Labrador Mining and Exploration Company Limited, IOCC mined ore, included in the total figures, for the account of the two concession companies until 1963. Shipments in 1963 were 854,558 tons and 800,700 tons, respectively. [3] Does not include concentrate pelletized by Carol Pellet Company. [4] Iron oxide sinter or ilmenite consumed. Ilmenite is not included in iron ore statistics. [5] Shipments from stockpile.

— Nil

TABLE 8

Companies Under Development With Announced Plans for Production

Company and Expected Production Date	Property Location	Participating Companies	Product to be Mined	Product to be Shipped	Designed Annual Capacity (long tons)
Arnaud Pellets (early 1965)	Pointe Noire, Que.	All participants of Wabush Mines except Mannesmann and Hoesch	Will pelletize much of the specular hematite concentrate produced by Wabush Mines	Pellets (+65% Fe)	4,900,000
Caland Ore Co. Ltd. (1965)*	E. arm of Steep Rock Lake, N. of Atikokan, Ont.	Inland Steel Co.	Hematite and goethite from open pit mine (54% Fe)	Pellets (62% Fe) Lump ore (54% Fe)	1,000,000 1,400,000
Jones & Laughlin Steel Corp. (Adams Mine) (early 1965)**	Boston Twp., near Kirkland Lake, Ont.	Wholly owned	Magnetite iron formation from open pit mine (23% Fe)	Pellets (62%)Fe)	1,250,000
Orecan Mines Ltd. (1965)	Near Kelsey Bay, Vancouver Is., B.C.	Public stock company	Magnetite from open pit mine (43.5% Fe)	Magnetite concentrate (+62% Fe)	150,000
Strathagami Mines, Inc. (Sherman Mine) (1967)	Near Temagami, Ont.	Dominion Foundries and Steel, Limited (90%) and The Cleveland-Cliffs Iron Co. (10%)	Magnetite iron formation from open pit mine (22–25% Fe)	Pellets (about 65% Fe)	1,000,000
Wabush Mines; Pickands Mather & Co., managing agent (early 1965)	Wabush Lake, near Labrador City, Lab., 190 miles N. of Sept-Iles	The Steel Co. of Canada, Ltd.; Dom. Foundries and Steel, Ltd.; Mannesmann Canadian Iron Ores Ltd.; Hoesch Iron Ores Ltd.; and Wabush Iron Co. Ltd. (The Youngstown Sheet and Tube Co.; Inland Steel Co.; Interlake Steel Corp.; Pittsburgh Steel Co.; Finsider of Italy and Pickands Mather & Co.)	Specular hematite iron formation from open pit mine (37% Fe)	Concentrate (66%67% Fe)	5,312,500
Wesfrob Mines Ltd. (1966)	Tasu Harbour, Moresby Is., Queen Charlotte Is., B.C.	Falconbridge Nickel Mines, Limited	Magnetite and chalcopyrite from open pit mines (37% Fe)	Magnetite concentrate for sintering and pelletizing	850,000 to 1,000,000

Source: Company reports and personal communications.
*Company presently produces 2 million tons of natural ore (54% Fe) a year. **Shipped 140 tons of pellets (61.56% Fe) in December 1964.

Nimpkish Iron Mines Ltd. made final shipments of concentrates from stockpile after having ceased mining operations late in 1963. Zeballos Iron Mines Limited resumed mining operations, by underground methods, in July. Open pit mining operations ceased early in 1963 and control of the property now rests with Falconbridge Nickel Mines, Limited.

Coast Copper Company Limited began the recovery of magnetite concentrates from its underground copper ores early in 1964. The company expects to ship 80,000 tons of iron concentrates annually. Empire Development Company, Limited, continued underground development to exploit a magnetite deposit discovered late in 1963. Empire began mining of its earlier discoveries in 1957. Production from the new orebody will begin in 1965.

The Consolidated Mining and Smelting Company of Canada Limited completed installation of its second electric pig iron furnace at Kimberley, tripling the iron capacity to 110,000 net tons a year. It announced that a steelmaking shop capable of producing 80,000 tons of steel ingots a year will be built at Kimberley.

Wesfrob Mines Limited, a Falconbridge Nickel subsidiary, continued development of its iron-copper orebodies at Tasu Harbour in the Queen Charlotte Islands. The project, to be completed in 1966, will cost $25 million and will produce 900,000 to 1,000,000 tons of high-grade magnetite concentrates a year as well as copper concentrates.

It was announced early in 1965 that Orecan Mines Ltd. is developing a small magnetite orebody near Kelsey Bay on Vancouver Island. Annual capacity will be 150,000 tons of concentrates grading 62 per cent iron. The development is expected to cost about $350,000 and production will begin late in 1965.

Several companies were active in exploration for iron ore in British Columbia, particularly in the Queen Charlotte Islands and on Vancouver Island.

YUKON AND NORTHWEST TERRITORIES

Crest Exploration Limited, a subsidiary of The California Standard Company, continued exploration and feasibility studies on its very large iron ore occurrence on the Snake River in the Yukon Territory, near the Yukon-Northwest Territories border. A new railway feasibility study was made during the year.

Baffinland Iron Mines Limited continued exploration of its Baffin Island iron property, which was discovered in 1962. A drilling program in 1964 indicated well in excess of 100 million tons of high-grade ore with a much greater tonnage potentially available. The company is continuing engineering and feasibility studies with a view to possible production.

PRICES AND TARIFFS

Prices received by most iron ore producers in central and eastern Canada for sales to North American consumers are a reflection of the Lake Erie base price, that is, the price paid per long ton of iron ore delivered to rail of vessel at Lake Erie ports. The Canadian mine price may 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 the price declined 7 per cent as a result of increasing supplies from Canada and overseas and falling prices in international markets. Great Lakes freight rates were reduced 10 cents a ton in mid-1963, thereby lowering the Lake Erie price.

TABLE 9

Lake Erie Base Prices, 1950–65

(Mesabi non-Bessemer grade)

	Per Long Ton* ($ U.S.)	
1950	7.70	0.1495
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
1963–65	10.55	0.2049

*Basis 51.50% Fe, unscreened, delivered to rail of vessel at Lake Erie ports. Premium for coarse ore is 80¢ a ton; penalty for fine ore is 45¢ a ton.

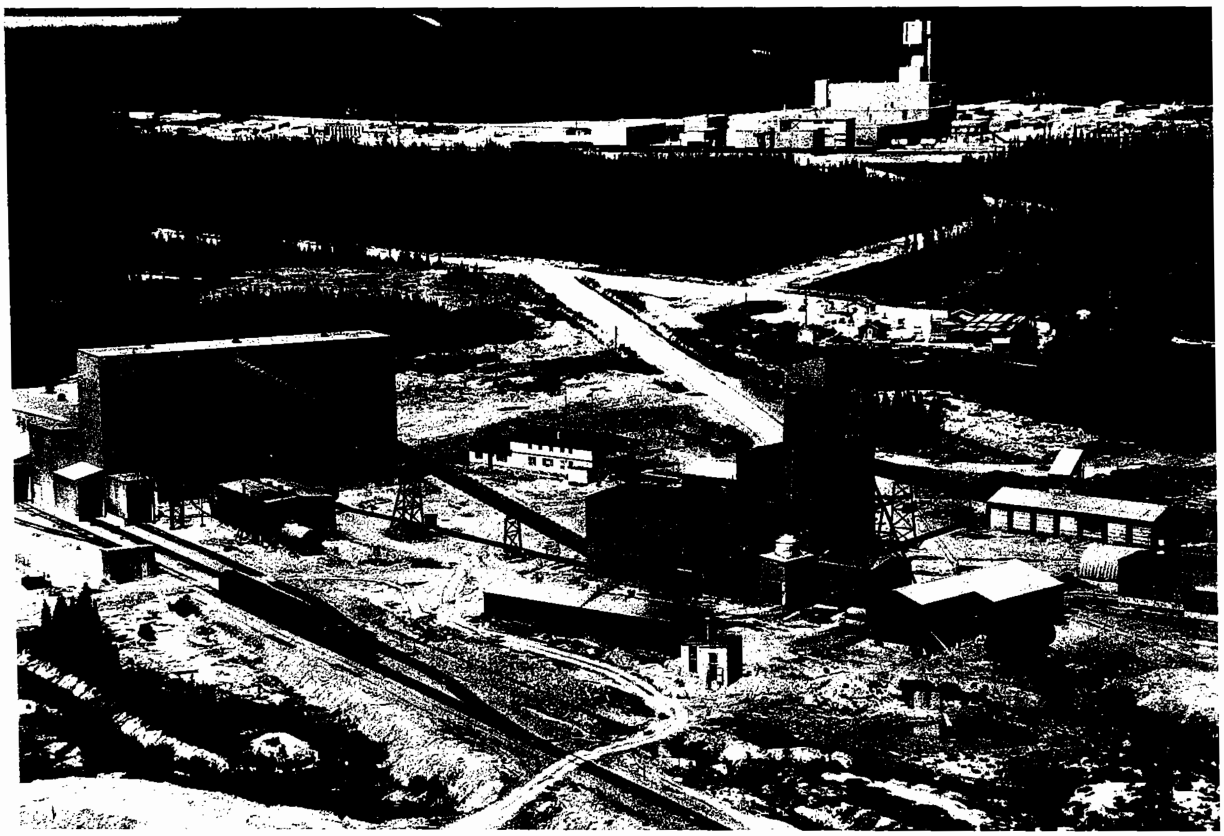
Base prices received by British Columbia mines are individually negotiated but generally range from U.S. $8 to $9.70 a metric ton, f.o.b. loading port, for ore grading 57 to 62 per cent iron.

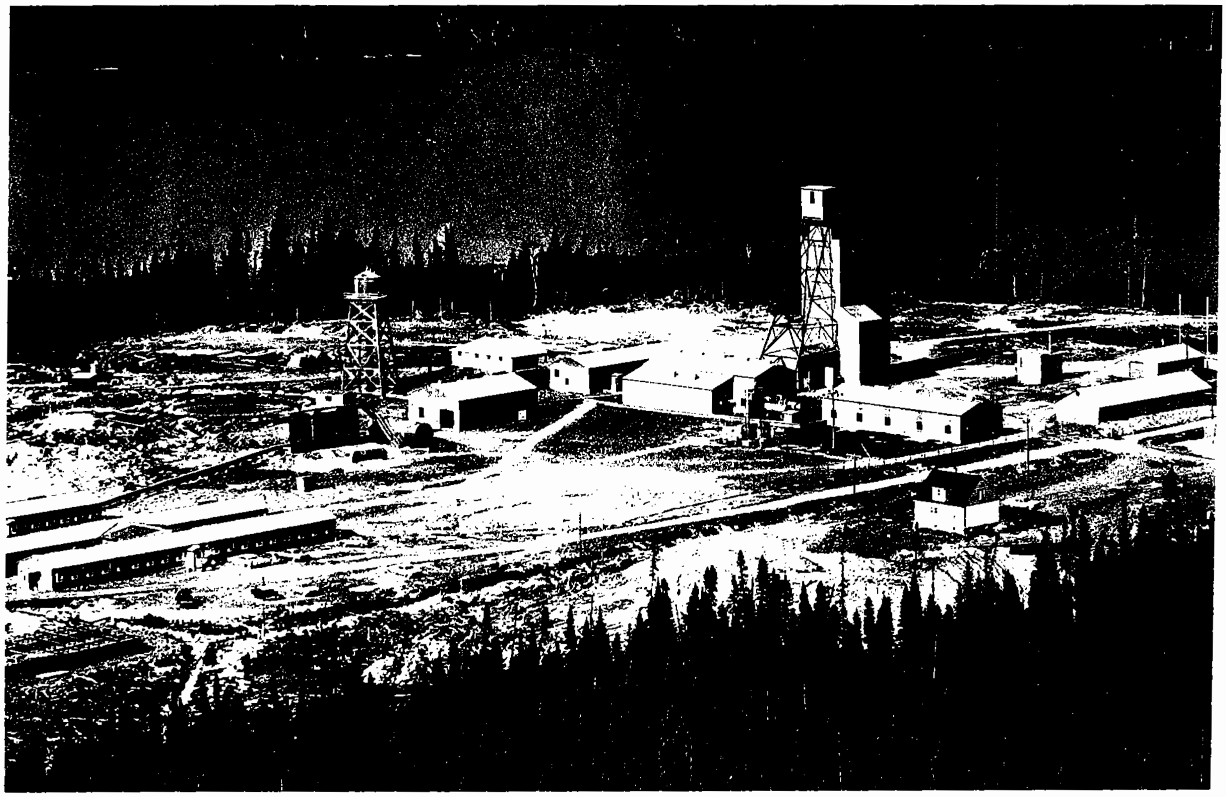
World prices continued to suffer downward pressure during the year with Brazil reducing the price of its very high grade, lump hematite from U.S. $11.20 to $10.40 a ton. Sweden announced that it will not reduce its ore prices for 1965 sales to western Europe, as it did in each of the past several years. Swedish prices often set the pattern for west European ore sales.

Despite accelerated investment in pelletizing plants, pellet prices have held firm. Lake Superior pellets grading 62 to 63 per cent iron are quoted at 25.2 cents a long ton unit (U.S. $15.624 to 15.876 a ton) delivered to rail of vessel at Lower Lake ports. There has been no change in this price for several years.

Neither Canada nor any of its iron ore customers have tariffs on iron ore. There have been requests voiced in the United States Congress and Senate at various times for tariffs or quotas to curb that country's rising imports. Such requests have drawn little support from either the major producers or consumers in the United States.

Mattagami, Quebec aerial view of Orchan mines headframe, mill and mining plant in the foreground, and the Mattagami Lake mines mill and plant in the background. These mills ship zinc concentrates to the Valleyfield zinc reduction plant at Valleyfield, Quebec and copper concentrates to the Noranda, Quebec smelter.





New Hosco's headframe and service buildings.

Iron and Steel

R.B. ELVER*

The Canadian iron and steel industry was again a leading sector in the over-all advance of the economy (Table 1) in 1964 as output reached 9.13 million net tons of crude steel in 1964, to set a fourth consecutive annual record. This compares with 8.19 million in 1963 and 7.17 million tons in 1962. Despite record levels of production, domestic consumption of steel outpaced supply necessitating a sharp increase in imports. Exports increased modestly. Capital expenditures on new plant and equipment were also at record levels. Capital spending for expansion will continue strongly into 1966. The nature of projects under construction or planned suggests that the industry will soon regain net national self-sufficiency. The possibility of over-expansion exists, particularly for certain rolling mill products, but a balance of operations in an integrated steel facility is difficult in an expanding market. The medium- and long-term outlook suggests there will be satisfactory growth in over-all steel consumption to permit some temporary excess capacity in the short-term as new facilities and mills are completed. On an equivalent steel ingot basis steelconsumption, in relation to grossnational product and population forecasts, may be 12.0 to 12.5 million net tons by 1970 and 15.5 to 16.0 million tons by 1975.

WORLD STEEL PRODUCTION

Canada ranked eleventh among the world's steel producers in 1964 as world output continued to increase to an all-time high (Table 2) with all major producing countries sharing the increase. United States continued the 1963 upward trend in output after five years in which there was no pronounced growth. With the exception of Italy, producers in western Europe set all-time records after the slowdown in 1962 and 1963. Output by Japan continued its unprecedented growth to become the world's third most important producer. Increases in production in the U.S.S.R. and eastern Europe also moved ahead significantly as the U.S.S.R. remained the world's second largest producer.

Note: For details on equipment and capacity, by company, the reader is referred to List 1-1, METALLURGICAL WORKS IN CANADA, PRIMARY IRON AND STEEL.

*Mineral Resources Division

TABLE 1

General Statistics of the Primary Iron and Steel Industry

	1962	1963	1964
Index of Industrial production (1949=100)			
Total industrial production for Canada	186.0	195.9	212.7
Primary iron and steel industry..................	193.0	216.9	244.9
Value of shipments (millions of $)	862.9	957.3	1,100.4
Value of unfilled orders at year-end	106.2	109.8	132.6
Value of inventory owned at year-end................	166.1	179.8	208.2
Value of exports (millions of $)*....................	130.9	166.1	210.1
Value of imports (millions of $)*....................	175.6	207.8	286.0
Employees			
Administrative	6,688	7,023	7,713
Hourly rated	30,574	32,180	35,135
Total	37,262	39,203	42,848
Average hours per week by hourly rated..............	40.3	40.5	40.7
Average earnings per hour by hourly rated	$ 2.60	$ 2.67	$ 2.71
Average wages and salaries per week, all employees	$109.53	$112.29	$114.47
Employment index, all employees (1949=100)	124.0	130.9	142.9
Capital expenditure ($000)			
On construction	20,898	28,309	38,954
On machinery	91,979	83,811	149,721
Total	112,877	112,120	188,675
Repair expenditure ($000)			
On construction	5,126	5,335	5,617
On machinery	80,359	90,288	107,633
Total	85,485	95,623	113,250
Total capital and repair expenditures ($000).............................	198,362	207,743	301,925

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.

CANADIAN PRIMARY IRON AND STEEL INDUSTRY

Four integrated and three non-integrated plants account for nearly 90 per cent of crude steel production and 100 per cent of pig iron production. The integrated plants are at Sydney in Nova Scotia, and at Hamilton (two) and Sault Ste. Marie, both in Ontario. The non-integrated pig iron plants are at Tracy in Quebec, Port Colborne in Ontario and Kimberley in British Columbia. There are

TABLE 2

World Production of Steel
(thousands of short tons)

	1962	1963r	1964p
North America			
Canada	7,173	8,190	9,131
United States	98,328	109,261	127,076
Total, North America	105,501	117,451	136,207
Latin America	6,495	7,731	9,703
Western Europe			
Belgium, Luxembourg	12,504	12,740	14,641
France	19,006	19,350	21,803
West Germany	35,898	34,830	41,158
Italy	10,409	11,196	10,783
Netherlands	2,295	2,582	2,917
Total ECSC countries	80,112	80,698	91,302
Britain	22,950	25,223	29,376
Other	13,793	14,463	16,085
Total	116,855	120,384	136,763
Eastern Europe			
U.S.S.R.	84,106	88,434	93,917
Poland	8,410	8,823	9,449
Czechoslovakia	8,420	8,375	9,234
Other	10,231	10,603	10,612
Total	111,167	116,235	123,212
Africa	2,998	3,260	3,561
Middle East	265	257	292
Far East			
Japan	30,336	34,724	43,860
China	8,800	9,000	11,000
India	5,610	6,587	6,483
Other	1,477	1,391	1,419
Total	46,223	51,702	62,762
Oceania	4,750	5,219	5,722
World Total	394,254	422,239	478,222

Source: Annual statistical report of the American Iron and Steel Institute.
Symbols: p Preliminary; r Revised.

several regionally important electric steel plants in Nova Scotia, Quebec, Ontario and the four western provinces, and a major stainless and alloy steel producer in Ontario that commenced production from a new plant at Tracy, Quebec, in 1964. Besides expansion of iron, steel and rolling mill capacity at the major works, new steel plants of regional importance were completed in Nova Scotia, Ontario and Alberta. In addition, a new integrated plant was under study for construction in Quebec. With an emphasis on marketing, some of the major Canadian companies expanded their corporate links with steel consuming industries such as pipe, structural steel and coated steel product manufacturers.

RAW MATERIALS

Major amounts of iron ore and coal are imported by the steel industry. During 1964 and early 1965, further emphasis was placed on increasing the amount of domestic ore consumption with completion of a new mine and beneficiation plant in the Labrador-Quebec district and completion of plans for a new project in northern Ontario. Other projects in northern Ontario are under consideration by Ontario steel producers. All these projects are for the production of pellets. The steel industry is among the world leaders in the degree of blast furnace charge preparation. Of all iron ores consumed in blast furnaces, the percentage of agglomerates increased from 73.3 in 1963 to 81.3 per cent in 1964 of which pellets accounted for 46.2 per cent, works' sinter 18.4 per cent and mine sinter

TABLE 3

Pig-Iron Production, Shipments, Trade and Consumption
(short tons)

	1962	1963	1964
Furnace capacity, Dec. 31	6,115,200	6,905,000	7,288,000
Production			
Basic iron	4,558,571	5,084,882	5,658,853
Foundry iron	252,052	308,951	435,621
Malleable iron	478,310	521,164	446,205
Total	5,288,933	5,914,997	6,540,679
Shipments			
Basic iron	50,788	66,196	76,510
Foundry iron	352,913	329,237	457,110
Malleable iron	407,934	363,524	303,144
Total	811,635	758,957	836,764
Imports	4,897	4,035	15,891
Exports	459,443	481,936	585,841
Consumption of pig iron			
Steel furnaces	4,559,486	5,084,606	5,655,834
Iron foundries	257,539	299,509	333,851
Consumption of iron and steel scrap			
Steel furnaces	3,520,481	4,064,168	4,629,216
Iron foundries	585,950	667,649	760,451

Sources: Dominion Bureau of Statistics and the Canadian Steel Industry.
Note: Value of trade is shown in Table 8.

16.7 per cent. Prices of iron ore and coke increased slightly in 1964. Of greater impact were the price increases in steel scrap, zinc and tin. Details on raw materials consumed at integrated and non-integrated plants are listed in Table 10.

TABLE 4

Crude Steel Production, Shipments, Trade and Consumption

(short tons)

	1962	1963	1964
Furnace capacity, Dec. 31			
Steel ingot			
Basic open hearth	5,045,000	5,427,000	5,939,000
Basic oxygen converter	2,100,000	2,550,000	3,100,000
Electric	931,000	1,008,500	1,295,000
Total	8,076,000	8,985,500	10,334,000
Steel castings	538,000	493,740	390,000
Total	8,614,000	9,479,240	10,724,000
Production			
Steel ingot			
Basic open hearth	4,237,902	4,983,908	5,333,870
Basic oxygen converter*	2,159,204	2,338,826	2,785,482
Electric	653,736	742,138	849,632
Total	7,050,842	8,064,872	8,968,984
Steel castings			
Basic open hearth	3,913	6,729	1,628
Electric	118,720	118,678	160,151
Total	122,633	125,407	161,779
Total production	7,173,475	8,190,279	9,130,763
Alloy steel in total	347,217	433,195	575,956
Shipments from plant			
Steel ingots	247,704	271,923	193,270
Steel castings	121,415	121,933	137,675
Rolled steel products	5,122,341	5,916,903	6,710,249
Total	5,491,460	6,310,759	7,041,194
Exports in equivalent steel ingots	990,000	1,336,000r	1,465,000
Imports in equivalent steel ingots	1,046,000	1,302,000r	2,110,000
Indicated consumption**	7,229,000	8,156,000r	9,776,000

Source: Dominion Bureau of Statistics; Estimates by Department of Mines and Technical Surveys, Ottawa.

* Contains several thousand tons of electric and open-hearth steel. ** Crude steel production plus imports less exports.

Symbols: e Estimate; r Revised.

ENERGY AND REDUCTANT MATERIALS

Besides raw materials consumed in integrated and non-integrated plants, information has become available for 1964 on consumption of the major energy and reductant materials (Table 11). Although the list is not complete, the use of these materials in various sections of plants is indicated. Of particular importance in recent years is the changing utilization of the materials and increased use of natural gas, fuel oil and oxygen.

PIG IRON

Production, exports and consumption increased in 1964 as did shipments to domestic foundries (Table 3). Capacity also increased as a result of more intense use of new techniques such as supplementary fuel injection, higher top pressures, improved physical and chemical properties of charges, and rebuilding. This trend will continue and it is expected that annual capacity will increase from 7,288,000 tons as of December 31, 1964 to 7,518,000 tons in 1965 and 7,813,000 tons in 1966. In addition, construction of a new blast furnace is to start in 1965, the first since 1960, and others are under consideration.

TABLE 5

Shipments of Rolled Steel Products by Type
(short tons)

	1962	1963	1964
Hot-Rolled Products			
Semis	312,597	307,078	378,386
Rails	230,875	339,113	269,004
Wire rod	352,313	391,616	442,561
Structurals			
Heavy	358,435	378,042	462,292
Light	81,891	90,523	105,582
Bars, concrete reinforcing	393,811	426,623	564,332
Bars, other hot-rolled	465,032	544,071	603,020
Tie plate and track material	76,445	78,669	80,868
Plates	608,505	730,757	865,975
Sheets and strips	821,029	1,017,892	1,058,783
Total	3,700,933	4,304,384	4,830,843
Cold-Rolled and Coated Products			
Bars	47,661	57,737	68,905
Sheets, tin mill black plate and tinplate	1,009,068	1,166,767	1,335,384
Galvanized sheets	364,679	388,015	475,117
Total	1,421,408	1,612,519	1,879,406
Total shipments	5,122,341	5,916,903	6,710,249
Alloy steel in total shipments	162,993	208,540	274,931

Source: Dominion Bureau of Statistics.

TABLE 6

Rolled Steel Products, Shipments to Consuming Industries
(short tons)

	1962	1963	1964
Automotive and aircraft	313,493	414,493	492,139
Agricultural equipment and manufactures	129,551	164,695	185,751
Construction	1,029,324	1,147,887	1,143,610
Containers	377,957	395,656	413,863
Machinery and tools	265,496	286,917	230,726a
Wire, products, fasteners	406,022	473,629	522,548a
Resource and extraction	77,554	77,646	155,177a
Appliances, utensils, stampings, pressings	271,943	307,860	666,922a
Railway operating	225,694	250,764	205,715
Railway cars and locomotives	60,001	35,083	82,677
Shipbuilding	79,175	94,679	108,573
Pipe and tubes	538,973	643,344	751,458
Wholesalers and warehouses	721,395	803,610	947,438
Miscellaneous	16,975	22,028	19,920
Total	4,513,553	5,118,291	5,926,517
Direct exports*	608,788	798,615	783,732
Total	5,122,341	5,916,906	6,710,249

Source: Dominion Bureau of Statistics.
* Does not include exports by nonproducers nor ingots and castings exported.
Note: Effective 1964, the classification of consuming industries was adjusted and comparability of the series from 1963 to 1964 is not possible. For some, the break in the series is not serious. For others, comparisons are very unreliable, particularly those marked with *a*.

CRUDE STEEL

Output of crude steel in 1964 set a new record for the fourth consecutive year with almost all companies, plants and regions sharing in the increase. Production of crude steel in basic oxygen furnaces increased from 28.6 to 30.5 per cent of the total. The portion of total steel produced in electric furnaces reversed a trend and increased from 10.5 to 11.1 per cent. Output in basic open-hearth furnaces decreased from 60.9 to 58.4 per cent (Table 4). Capacity of most major steel furnace plants continues to be effectively increased as a result of fuller utilization of technical advances. Greater utilization of oxygen in basic oxygen and open-hearth furnaces and completion of another basic oxygen furnace were significant. Conversion of one open-hearth to a dual-hearth, another first for the industry, indicated that further increases in productivity can be expected. Total steel capacity as of December 31, 1964 was 10.7 million tons; it is expected to increase to 11.1 million tons in 1965 and 11.9 million tons by the end of 1966.

TABLE 7

Trade in Steel Castings, Ingots and Rolled Products

(thousands of short tons)

	Imports			Exports		
	1962	1963	1964	1962	1963	1964
Steel castings	4.9	4.0	5.7	10.8	11.6	19.3
Steel forgings	..	..	4.8	..	..	13.1
Steel ingots	2.3	1.7	2.7	163.4	175.3	103.4
Rolled products, hot						
Semis	4.0	1.3	4.1	101.2	202.0	338.8
Rails	3.4	6.9	5.2	85.0	135.2	126.2
Wire rod	69.9	75.7	117.4	2.9	6.1	7.0
Structurals	212.2	233.0	392.9	17.4	28.9	21.8
Bars	143.6	150.0	253.4	26.5	38.3	27.6
Track material	1.7	3.5	2.7	21.6	15.5	35.2
Plates	56.9	98.0	252.1	26.2	23.5	25.7
Sheet and strip	38.6	111.0	193.9	134.0	205.8	127.9
Total, hot	530.3	679.4	1,221.7	414.8	655.3	710.2
Rolled products, cold						
Bars	7.4	4.8	8.9	1.7	1.4	8.2
Sheet and strip						
Cold	24.0	22.0	19.7	28.0	69.9	115.7
Galvanized	6.8	5.2	6.3	53.0	42.3	66.8
Other	61.2	72.2	88.9	112.0	114.4	131.2
Pipes	126.0	121.5	154.6	47.5	21.0	36.2
Wire	61.8	66.4	70.8	4.5	5.4	5.2
Total, cold	287.2	292.1	349.2	246.7	254.4	363.3
Total rolled products	817.5	971.5	1,570.9	661.5	909.7	1,073.5
Total steel	824.7	977.2	1,584.1	835.7	1,096.6	1,209.3

Source: Dominion Bureau of Statistics.
.. Not available separately.
Note: Related values are contained in Table 8.

CONTINUOUS CASTING

North America's first steel continuous casting machine was installed at Welland, Ontario, in 1954 and had an annual capacity of 93,500 tons. A second machine was installed in 1962 at Edmonton, Alberta. By early 1965, there were six machines in operation with an annual capacity of about 750,000 tons to account for about seven per cent of Canada's steelmaking capacity. By 1966, there will be eight machines with an annual capacity of 1.26 million tons, or over 11 per cent of steelmaking capacity. Two additional machines are in the advanced design stage and installation of others is foreseen.

STEEL SHIPMENTS

The value of all shipments by the primary iron and steel industry increased by 14.9 per cent in 1964 to $1,100 million from $957 million in 1963 (Table 2). The large increase in unfilled orders at the end of 1964 compared with shipments, inventories and the level of unfilled orders in December 1963 was indicative of a tight supply situation in a buoyant market, a condition that continued into early 1965 and was expected to prevail for most of the year. With the exception of rails, shipments of all major steel products increased in 1964. Those of wire rod, heavy structurals, bars, plates, and cold-rolled and coated sheet products were particularly strong. Shipments to most consuming sectors increased strongly. Those for railway operating declined, however, and shipments to the construction industry remained constant but at a high level. Capacity to produce a larger tonnage and greater variety of steel rolling mill products increased in 1964. As indicated in a following section on corporate developments, additional facilities were under construction, particularly for flat products and bar mill products.

TRADE

Exports of pig iron totalled 585,841 tons, up 21.5 per cent from 481,936 tons in 1963. Imports amounted to 15,891 tons, an increase from 4,035 tons. Similarly, exports of steel ingots and semis increased from 377,000 tons to 442,200 tons. As in 1963, exports of semis for conversion and reimport for further rolling, however, inflated the commercial significance of trade returns. Imports of steel ingots and semis increased from 3,000 to 6,800 tons in 1964.

Trade in all steel rolling mill products reflects the high level of consumption in Canada that exceeded even the industry's increased production capacity. Imports were up 61 per cent from 971,500 to 1,570,900 tons and most major exporting countries shared in the increase. Allowing for reimports of converted steel shapes for further processing, the increase was about 30 per cent. Exports of steel rolling mill products increased modestly.

TABLE 8

Value of Trade in Pig Iron, Steel Castings, Ingots and Rolled Products

(thousands of dollars)

	Imports			Exports		
	1962	1963	1964	1962	1963	1964
Steel castings	2,828	2,492	3,570	3,152	2,904	5,938
Steel forgings	..	..	4,395	..	..	7,935
Steel ingots	655	563	1,049	11,552	14,859	12,557
Rolled products						
Hot	73,385	91,363	158,562	45,639	75,130	92,791
Cold	98,225	105,632	117,733	45,563	48,840	61,438
Total	171,610	196,995	276,295	91,202	123,970	154,229
Total steel	175,093	200,050	285,309	105,906	141,733	180,659
Pig iron	502	787	727	24,969	24,321	29,391
Total iron and steel	175,595	207,837	286,036	130,875	166,054	210,050

Source: Dominion Bureau of Statistics.

Note: The values in this table relate to the tonnages shown in Tables 3 and 7. For some items, tonnage data are not available and the corresponding values are not included in the above. These omissions do not distort the pattern significantly.

.. Not available.

MANPOWER

The index of employment (1949 = 100) increased sharply from 130.9 in 1963 to 142.9 in 1964 and brought total employment in the steel industry to 42,848. With several new plants and expansion at others, there are problems in obtaining labour with the necessary skills.

The average monthly hours worked by hourly-rated employees increased from 175.5 in 1963 to 176.4 and average hourly earnings increased from $2.67 to $2.71. Labour contracts that expired in 1964 were renegotiated and provided for increased wages and benefits to mid-1966.

PRICES AND TARIFFS

The base prices for several steel products such as bars and galvanized sheet were increased in February 1965; increases in other products are expected in 1965 (Table 12). This was the first price increase since 1957 and reflected, it is claimed, higher raw material, labour and capital costs in excess of gains in productivity. This is indicated by a decrease in net profit as a per cent of sales. As a result of a reaction by some groups, the federal government instructed the Economic Council of Canada to study the relationship of prices, costs and income to economic growth.

There were no changes in the Canadian tariff schedule for primary steel products in 1964 (Table 13). Meetings in Geneva, Switzerland, of the General Agreement on Tariffs and Trade (GATT) started in 1964 are expected to continue for two years or more.

INVESTMENTS AND CORPORATE DEVELOPMENTS

Capital expenditures by the steel industry increased from $112 million in both 1962 and 1963 to $188.7 million in 1964, an all-time high. As a result of a Dominion Bureau of Statistics survey late in 1964, expenditures in 1965 for projects underway in 1964, or planned as of December 1964, are expected to total $167 million. Subsequent announcements early in 1965 indicate that investments in 1965 will be higher and that this high level will carry into 1966. In the following sections brief mention is made of developments at various plants in 1964 and early 1965.

THE ALGOMA STEEL CORPORATION, LIMITED, SAULT STE. MARIE, ONTARIO

Capital expenditures in 1964 were $37.5 million, an all-time high, compared with $33.2 million in 1962 and $31.5 million in 1963. Expenditures on mine development in the total were about $1.6 million for each of the three years. Capital projects are expected to require $40 million in 1965.

TABLE 9

Steel, Iron, Coke and Sinter Capacity and Production at Integrated Plants, 1964*

	ALGOMA		COMINCO	DOFASCO	DOSCO	Q.I.T.	STELCO	
	Sault Ste. Marie	Port Colborne	Kimberley	Hamilton	Sydney	Tracy	Hamilton	Total
Crude steel capacity, Dec. 31								
Open hearth	1,150,000	–	–	–	979,000	–	3,750,000	5,879,000
Basic oxygen	1,300,000	–	–	1,800,000	–	–	–	3,100,000
Electric	–	–	–	50,850	30,000	–	–	80,850
Total	2,450,000	–	–	1,850,850	1,009,000	–	3,750,000	9,059,850
Production	2,301,245	–	–	1,584,415	838,226	–	3,478,698	8,202,584
Pig iron capacity, Dec. 31								
Blast furnace	2,075,000	240,000	–	1,550,000	810,000	–	2,100,000	6,775,000
Electric	–	–	110,000	–	–	403,000	–	513,000
Total	2,075,000	240,000	110,000	1,550,000	810,000	403,000	2,100,000	7,288,000
Production	2,020,596	240,538	48,425	1,350,765	574,649	376,053	1,939,811	6,553,837
Coke capacity, Dec. 31	1,458,000	–	–	700,000	612,000	–	1,250,000	4,020,000
Production	1,452,731	–	–	668,473	384,946	–	1,282,682	3,788,832
Sinter capacity, Dec. 31	700,000	–	300,000	–	250,000	–	900,000	2,050,000
Production	738,968	–	78,460	–	233,629	–	850,342	1,901,399
Number of furnaces								
Steel								
Open hearth	6	–	–	–	6	–	14	26
Basic oxygen	3	–	–	3	–	–	–	6
Electric	–	–	–	5	1	–	–	6
Pig iron								
Blast furnace	4	1	–	3	3	–	4	15
Electric	–	–	2	–	–	8	–	10
Coke – ovens	253	–	–	105	114	–	191	663
Sinter – strands	1	–	1	–	1	–	1	4

Source: Company data supplied directly to the Mineral Resources Division.
*These companies accounted for all pig iron, coke, sinter, and 90 per cent of steel production by the industry in 1964.
– Nil.

Projects Completed in 1964. A third basic oxygen steel furnace, an electric steel furnace for the foundry, a calcine plant for burnt lime, an extension to the ingot mould foundry, a fifth grinding ball line, a 100-inch continuous pickle line, relining and enlarging No. 3 blast furnace including equipment for tar injection and higher top pressure, equipment to fabricate wide flange beams in sizes from 24 to 48 inches, and equipment for natural gas injection at the blast furnace of Canadian Furnace Division of the company.

Projects Underway in 1964 or Planned for 1965. The 80-inch wide cold strip mill with an annual capacity of 300,000 tons in widths up to 74 inches at a cost of $30 million for completion in early 1965, relining and enlargement of blast furnaces No. 4 and No. 5 replacement of three sinter machines at Algoma Ore Properties Division and a new one that will be among the largest in the world, and miscellaneous equipment and facilities for steel and slag transportation, maintenance shops, billet storage, ladle lining and blast furnace blast.

New Program. The company has several expansion projects under consideration relating to raw materials and various aspects of metal production and rolling. In April 1965, a decision on one phase was made that includes $9 million for two continuous casting machines. One will cast four blooms up to 10½ by 14 inches and the other will cast two slabs or other shapes up to 30 inches wide.

Of importance to the corporate and market structure was the purchase of additional shares of Dominion Bridge Company, Limited to bring Algoma's total share of that company to 43½ per cent of the shares issued. Dominion Bridge is a major steel fabricator and controls Manitoba Rolling Mills Division referred to elsewhere in this review.

ATLAS STEELS COMPANY, DIVISION OF RIO ALGOM MINES LIMITED, WELLAND, ONTARIO AND TRACY, QUEBEC

Capital expenditures in 1964 totalled $15.8 million, the same as in 1963. A decline to $12.2 million in 1965 is anticipated as all phases of the new Tracy plant are to be completed by mid-year. Since start of construction in November 1961, about $45 million has been spent on the new plant. Not included in the original cost is a second cold-rolling mill to be installed in 1965. Steelmaking, cold-rolling and finishing facilities were brought into production during 1963 and 1964. Installation of the continuous casting machine and hot planetary mill by mid-1965 will complete integration of the plant for the production of up to 48-inch wide stainless sheet.

At the Welland plant, about $1.1 million was spent on various equipment. When the Tracy plant is fully operative the one at Welland will produce, primarily, special alloy steels and shapes other than stainless steel sheet.

TABLE 10

Consumption of Raw Materials at Integrated[1] and Nonintegrated[3] Plants, 1964[1]

	In Sinter Plants	In Pig Iron Plants: Blast Furnace	In Pig Iron Plants: Electric[2]	In Steel Furnaces	In Non-integrated Steel Plants
Iron Ore					
Crude and concentrates	1,273,279	1,839,976	1,388,000	159,519	2,006
Pellets	108,268	4,551,186	–	–	–
Sinter (from mines)	43,336	1,654,138	–	124,974	–
Total	1,424,883	8,045,300	1,388,000	284,493	2,006
Sinter (produced at plant)	–	1,816,699	74,002	–	–
Total iron ore	1,424,883	9,861,999	1,462,002	284,493	2,006
Tons of contained iron	770,352	5,843,534	601,657	189,309	..
Other iron-bearing materials					
Cinder	66,623	–	–	–	..
Flue dust	187,213	–	–	–	..
Scale	360,980	133,114	–	77,493	..
Total other	614,816	133,114	–	77,493	..
Tons of contained iron	323,215	85,169	–	48,444	..
Total ore and other	2,039,699	9,995,113	1,462,002	361,986	2,006
Total contained iron	1,093,567	5,928,703	601,657	237,753	..
Other materials					
Ferromanganese	–	–	324	69,994	3,286
Pig iron	–	14,110	806	5,643,898	10,788
Coal	–	–	210,409	–	–
Coke					
Own make	53,102	3,613,122	–	779	–
Purchased	13,267	108,791	18,321	–	1,682
Total	66,369	3,721,913	18,321	779	1,682
Scrap					
Own make	45,829	61,511	–	2,266,173	159,395
Purchased	–	63,257	–	1,119,375	453,626
Total	45,829	124,768	–	3,385,548	613,021
Stone					
Limestone	88,611	720,675	17,063	152,519	18,733
Dolomitic limestone	–	7,944	–	–	–
Dolomite	92,241	480,446	–	127,185	2,214
Total	180,852	1,209,065	17,063	279,704	20,947
Burnt stone					
Lime	–	–	–	246,904	11,925
Burnt dolomite	–	–	–	62,582	1,385
Total	–	–	–	309,486	13,310
Total other materials	123,419	5,069,856	246,923	9,689,409	663,034
Production	1,901,399	6,129,359	424,478	8,152,658	583,380

Source: Company data supplied directly to the Mineral Resources Division.

[1]Raw materials consumed by plants listed in Table 9. [2]Data for some lines is not available or incomplete. [3]Data for 10 plants.

Symbols: .. Not available; – Nil.

BAYCOAT LIMITED, HAMILTON, ONTARIO

Dominion Foundries and Steel, Limited and The Steel Company of Canada, Limited formed a new company on a 50:50 basis to produce prepainted galvanized steel products. The $2-million plant will start production in the latter part of 1965.

BRUNSWICK MINING AND SMELTING CORPORATION LIMITED, TORONTO, ONTARIO

The company announced a broad plan to build a $117-million complex in New Brunswick that would include two base metal mines and concentrators, a chemical and fertilizer complex, shipping and handling facilities, and a steel mill. According to tentative plans, the $64-million steel mill would use byproduct iron ore from the concentrator-chemical plants and may have an annual capacity of 250,000 tons, commencing in 1968. The company principals formed Bay Steel Corporation early in 1965 for establishing the steel and chemical complex.

BURLINGTON STEEL COMPANY, DIVISION OF SLATER STEEL INDUSTRIES LIMITED, HAMILTON, ONTARIO

The company completed a $2.5-million expansion in 1964 that extended its warehouse capacity, effected general plant rearrangement, and increased its steelmaking capacity by replacing the 28,000-ton-a-year electric furnace for a 64,000-ton-a-year unit.

CANADIAN STEEL FOUNDRIES DIVISION OF HAWKER SIDDELEY CANADA LTD., MONTREAL, QUEBEC

A $1-million expansion program was undertaken in 1964 for completion in mid-1965 that will increase plant capacity for large castings by some 40 per cent. The program includes five new pouring pits up to 20 feet deep and 36 feet long, a new heat treat furnace that will be 25 feet square and 15 feet high, and additional mould-drying and pattern-making facilities. Increased demand for heavy industrial machinery in Canada is seen continuing at a high level in the medium term.

THE CONSOLIDATED MINING AND SMELTING COMPANY OF CANADA LIMITED, (COMINCO), KIMBERLEY, B.C.

The company purchased Western Canada Steel Limited of Vancouver in 1964, thus integrating existing pig iron and steel ingot facilities (starting in 1966) at Kimberley with steel ingot and rolling mill facilities at Vancouver. COMINCO's second electric pig iron furnace was completed early in the year and increased annual capacity from 40,000 to 110,000 tons. Late in 1964, a $2-million plant to produce 80,000 tons of steel ingot a year was announced for completion late in 1965. Ingots produced at Kimberley will augment the supply from furnaces at Vancouver (see also Western Canada Steel Limited).

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DOMINION FOUNDRIES AND STEEL, LIMITED, HAMILTON, ONTARIO

Capital expenditures increased from $18.1 million in 1963 to $37.5 million, a record level. Expenditures authorized at year-end amounted to $78.5 million of which $51.3 million were for mining projects. Expenditures are expected to total $38 million in 1965.

Projects Completed in 1964. A new plant for the production of a full range of silicon electrical steels; a fourth 56-inch cold reduction mill with annealing and shearing equipment; a new office building in which many new steel products are incorporated; and relining of No. 3 blast furnace.

Projects Underway in 1964. Repowering of the roughing mill to increase capacity; six new ingot-soaking pits each with a capacity of 300 tons per 24 hours; three, 4-high finishing stands to the four already in operation; and a new 2-stand cold reduction and temper mill.

Raw Materials in 1964. With a 15-per-cent interest in the Wabush Mines project in Labrador-Quebec, the company will start receiving high-grade iron ore pellets in early 1965. A further step in the company's shift from imported ores to domestic ores was made with its 90-per-cent interest in the Sherman Mine, a new development near Timagami, Ontario, that will be managed by Cliffs of Canada Limited. At a total cost of $45 million, the plant will produce one million tons of high-grade pellets a year starting in 1968.

New Expansion Program. In April 1965, the company announced a $120-million capital plan to the end of 1966. About $30 million of this total is allotted to mining projects and the balance to steel plant facilities including new coke ovens ($20 million), a 5-stand cold rolling mill ($31 million), hot-mill expansion with three new finishing stands and a scarfing machine ($13.5 million), water supply and pollution control equipment ($2 million), and additions to the foundry ($1 million). The remainder will be required for another oxygen gas plant, coke-oven gas cleaning equipment, more floor space for steel pouring, a pickle line, a 2-stand temper mill, and additional annealing facilities.

DOSCO STEEL LIMITED, MONTREAL, QUEBEC

Early in 1964, Dominion Steel and Coal Corporation, Limited (DOSCO), formed two management companies. Dosco Steel Limited is responsible for iron and steel mill operations at Sydney, Montreal, Contrecoeur and Etobicoke. Dosco Industries Limited is responsible for ore and coal mining, shipbuilding, steel fabricating, and shipping.

Capital expenditures by both companies increased substantially from $9.3 million in 1963 to $20.7 million in 1964 of which $19.3 million was spent by Dosco Steel Limited.

TABLE 11

Energy and Reductant Consumption at Integrated[1] and Nonintegrated[2] Steel Plants, 1964

	Coal (net tons)	Coke (net tons)	Coke Oven Gas ('000 of cu. ft. 500 BTU per cu. ft.)	Tar & Pitch ('000 of imp. gal.)	Natural Gas ('000 of cu. ft. 1,000 BTU per cu. ft.)	Fuel Oil ('000 of imp. gal.)	Oxygen ('000 of cu. ft.)	Electricity (millions of kwh)
At Integrated Plants								
In coke ovens	5,325,603	—	5,725,396	—	—	—	—	40.5p
In sinter plants	—	61,350	..	—	—	—	—	25.9
In blast furnaces	—	3,721,913	4,053,072	..	..	25,356	..	132.2[3]
In steel furnaces	—	1,056	3,991,815	..	..	88,108	9,107,023	119.2
For other uses	76,602	8,507	31,750,888	..	..	82,918	688,082	1,417.5
Total consumption	5,402,205	3,792,826	45,521,171	5,474	5,043,031	196,382	9,795,105	1,735.3
Of which injected through blast furnace	—	—	..	..	..	15,536	—	—
At Nonintegrated Plants								
Total	50	1,758	—	2	723,698	11,315	106,652	398.0

Source: Company data supplied directly to the Mineral Resources Division.
[1] Consumed by plants listed in Table 9 with the exception of COMINCO and Q.I.T., operators of electric furnace pig iron plants.
[2] Data for 10 electric furnace steel plants referred to in Table 10. [3]Partial breakout but included in the total.
Symbols: —Nil; .. Not available separately but included in the total or "For other uses".

Projects Completed in 1964. The new $20-million rod and bar mill at Contrecoeur with an annual capacity of 200,000 tons that allows for expansion to 450,000 tons, a $3.4-million program at Sydney that included conversion of two open-hearths for oxygen injection, new heating facilities for the rail mill, and other equipment.

Projects Underway in 1964. A $2.2-million continuous casting machine commenced production of steel billets at the Montreal plant early in 1965. As a result, increased efficiencies are anticipated in steelmaking and rolling mill operations.

New Expansion Program. In March 1965, Dosco Steel Limited announced a $40-million plan for completion in 1966 that includes construction of a $30-million hot- and cold-rolled flat steel mill at Contrecoeur. Annual capacity of it will be about 500,000 tons of flat products up to 48 inches wide that will eliminate the major gap in the primary steel product-mix of both the company and the Province of Quebec. Announced plans do not include tinplate, galvanized sheet or heavy structural facilities. Additional capital expenditures of $10 million will be made at the Montreal and Sydney plants.

HORTON STEEL COMPANY, PENTICTON, B.C.

The company was installing electric furnace facilities of 1,000 tons a year capacity for steel castings. Production is to start in 1965.

IMPERIAL OIL LIMITED, TORONTO, ONTARIO

The company proceeded with construction of a $7-million pilot plant at Dartmouth, Nova Scotia, to evaluate various iron ores in a process to produce metallic iron directly from iron ore. Total capital and operating expenditures from 1964 to 1966 may exceed $13 million. The plant is scheduled for completion in 1965.

THE INDIANA STEEL PRODUCTS COMPANY OF CANADA LIMITED, KITCHENER, ONTARIO

The company, a producer of high-alloy steel castings, spent about $50,000 on new equipment for material handling and mixing to increase throughput, and on air exhaust equipment. In 1965, about $250,000 will be spent on plant (10,000 square feet) and office expansion, and on additional casting, cleaning, grinding, and moulding equipment.

LAKE ONTARIO STEEL COMPANY LIMITED, WHITBY, ONTARIO

The company started production from a new steel plant based on scrap using two electric furnaces, two continuous casting machines, and a steel bar and merchant product mill. Initial annual capacity of 100,000 tons was increased to 200,000 tons with the completion of a second 50-ton furnace in the second half of 1964. Total cost of present plant was about $10 million.

MANITOBA ROLLING MILLS DIVISION OF DOMINION BRIDGE COMPANY, LIMITED, SELKIRK, MANITOBA

The company finalized plans for a $7.5-million expansion program to be completed in the first half of 1966. The program includes replacing existing open-hearth and electric furnaces (annual capacity of 108,000 tons) with two new electric furnaces (annual capacity of 160,000 tons) and installation of a continuous casting machine. Changes in the rolling mills are not included in the program.

PEACE RIVER MINING & SMELTING LTD., EDMONTON, ALBERTA

The company will spend about $1.5 million on a process of the Alberta Research Council to produce high-grade iron powder from iron-bearing deposits owned by the company in the Clear Hills area, about 100 miles north of Peace River, Alberta. The Alberta Research Council is to construct a multipurpose pilot plant near Edmonton for many types of research programs; the company will be one of the first to make use of the facilities.

QUEBEC IRON AND TITANIUM CORPORATION, TRACY, QUEBEC

Construction of a $500,000 research laboratory began in 1964. Its investigations will be directed toward process development for the production of titania products and various grades of pig iron and toward improving and developing uses for its products. At a cost of about $1 million, the world's largest induction furnace was completed in 1964 for increasing and maintaining molten metal temperatures. It can receive cold pig iron for remelting if desirable. The furnace is 26 feet long with an outside diameter of 15 feet, powered by two 900 kw inductors and has a volume capacity of 200,000 tons. The furnace assists in increasing production, improving iron quality and expanding the variety of metal grades.

SHAWINIGAN CHEMICALS LIMITED, SHAWINIGAN, QUEBEC

The company closed its foundry for the production of alloy steel castings in 1964.

SIDBEC, MONTREAL, QUEBEC

Sidbec, the company formed to own and operate a steel mill in Quebec, obtained its letters patent in November 1964. The original board of directors consists of two officials from Quebec's General Investment Corporation (GIC) and three executives from private industry. Other directors will be appointed. Stock in Sidbec consists of 11 million common shares and 4 million deferred dividend shares. The Quebec Government is expected to purchase all deferred dividend shares. About $75 million will be raised by equity financing and $150 million by a bond issue. Announced tentative plans suggest a $225-million complex to be completed in 1968 with construction planned for late in 1965. It will be an integrated plant with an initial capacity of 600,000 tons of steel using Quebec iron ore. Principal equipment is to include a blast furnace, oxygen steel furnaces, continuous casting and two rolling mills, one for merchant products and the other for flat-rolled products. Becancour, near Trois Rivières, is the site selected.

SOREL STEEL FOUNDRIES LIMITED, SOREL, QUEBEC

The company, a producer of various grades of abrasion-resistant steel castings, extended its plant by 7,000 square feet to provide additional pattern storage.

STANLEY STEEL COMPANY, LIMITED, HAMILTON, ONTARIO

The company operates facilities for cold-drawing, turning and finishing steel. A 12-foot square shear and 18-inch slitting line were installed in 1964.

THE STEEL COMPANY OF CANADA, LIMITED (STELCO), HAMILTON, ONTARIO

Capital expenditures totalled $109.3 million in 1964, a record level considerably above the $52.2 million expended in 1963 and the previous record of $67 million in 1962. An additional $104 million will be required to complete projects approved as of December 31, 1964.

Projects Completed in 1964. Blast furnace 'D', the company's largest, was relined and enlarged; one of the large open-hearth furnaces was converted to a dual-hearth furnace, a new technique for increasing steel output that indicates considerable economies; new quality control equipment was added; two soaking

TABLE 12

Posted Base Prices for Canadian Steel, January 1965

(f.o.b. mill)

Semis, for rerolling	$78 per ton
	Cents Per Pound
Wire rods	5.70
Bars and small shapes	5.30 - 5.65*
Bars, reinforcing	5.30
Structurals	5.50
Plates, universal	5.10
Sheets and coils, hot-rolled	4.95
Sheets and coils, cold-rolled	6.35
Sheets and coils, galvanized	6.70 - 6.90*
Skelp	4.70
Rails, heavy	5.55

Source: STEEL, February 1965.

*Increases made in February 1965.

pits and handling facilities were installed at the blooming mills; a fourth slab heating furnace and other equipment were added in the 56-inch hot strip mill; more wire drawing, boltmaking and other types of equipment were added at various finished product plants; and a third electric steel furnace was installed at Premier Steel Mills in Edmonton.

Projects Underway in 1964. A steel continuous casting machine to produce 4-inch square billets for the new rod and bar mills at an annual rate of up to 350,000 tons (production in early 1966); a new 148-inch wide plate mill, that started production in the early months of 1965 and is the largest in Canada; an 80-inch pickle line and temper mill adjacent the 80-inch cold rolling mill will be completed in mid-1965; No. 2 rod mill that will increase the company's annual rod capacity in Hamilton from 367,000 to 650,000 tons starting late in 1965; a new rod and bar mill at Contrecoeur, Quebec, to which some equipment from the existing works in Montreal will be transferred with annual capacity increasing from 110,000 to 175,000 tons starting in mid-1965; and a major research centre at Burlington.

Raw Materials in 1964. STELCO has a 23.5-per-cent interest in the Wabush Mines project in Labrador-Quebec that began shipments of high-grade pellets and concentrates early in 1965. Total production will be 5.5 million long tons a year consisting of 4.9 million long tons of pellets. This will be a major long-term source of ore for STELCO. The company has a 10-per-cent interest in Erie Mining Company in Minnesota with an annual capacity of about 8 million long tons of pellets that is currently being expanded to 10.3 million. Closure of several mines in Minnesota that produce medium-grade ore has been effected. STELCO sold one of its coal mines in Pennsylvania and leased another in Kentucky for improving coke quality as a result of changing blast furnace requirements.

New Expansion Program. In April 1965, the company announced an additional $100-million capital expenditure program for new iron and steelmaking facilities that includes a fifth blast furnace, a new coke-oven battery, additional raw material sources and other unspecified changes.

Page-Hersey Tubes, Limited. As a result of a share-exchange, Page-Hersey became a wholly owned subsidiary of STELCO. The transaction also includes the assets of Welland Tubes Limited and Camrose Tubes Limited which were previously owned jointly by Page-Hersey and STELCO.

VANADIUM-ALLOYS STEEL CANADA LIMITED, LONDON, ONTARIO

This company had facilities for heating, rolling, heat-treating and forging a wide range of specialty steels. In November 1964, the company sold its principal hot working equipment. The company will continue as a light manufacturer and steel warehouse for specialty steels previously handled. This will include machining of forgings and bars, and producing centreless ground products. In addition, some forging work will be continued.

TABLE 13

Canadian Customs Tariff on Selected Iron and Steel Items

	British Preferential	Most Favoured Nation	General	Tariff Item
Iron ore......................	free	free	free	329(a)
Iron and steel scrap	free	free	free	373
Pig iron ($ per ton)............	$1.50	$2.50	$2.50	374
Ingots, not otherwise provided for ($ per ton).................	free	$3.00	$5.00	377
Semis (blooms, billets, slabs)....	free	5%	10%	378
Bars or rods, hot-rolled	5%	10%	20%	379
Bars or rods, cold-rolled	5%	15%	25%	379(a)
Rods for wire manufacture.......	free	$4.00	$5.00	379(c)
Shapes and sections either hot- or cold-rolled				
1. made in Canada	5%	10%	20%	380(1)
2. not made in Canada......	free	less	less	380(2)(3)(4)
Plate, hot- or cold-rolled........	5%	10%	20%	381
Sheet and strip				
1. hot-rolled...............	5%	10%	20%	382(1)
2. cold-rolled..............	5%	15%	25%	382(2)
3. coated with tin or enamel.	10%	15%	25%	382(3)
4. galvanized.............	7.5%	15%	25%	382(4)
Skelp (plate and sheet for pipe) ..	free	7.5%	15%	384
Rails........................	5%	10%	20%	385
Castings, not otherwise provided for	15%	17.5%	27.5%	390
Forgings.....................	17.5%	22.5%	30%	392
Pipe, large diameter............	10%	15%	30%	399
Wire, not otherwise provided for	15%	15%	20%	401(g)

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.

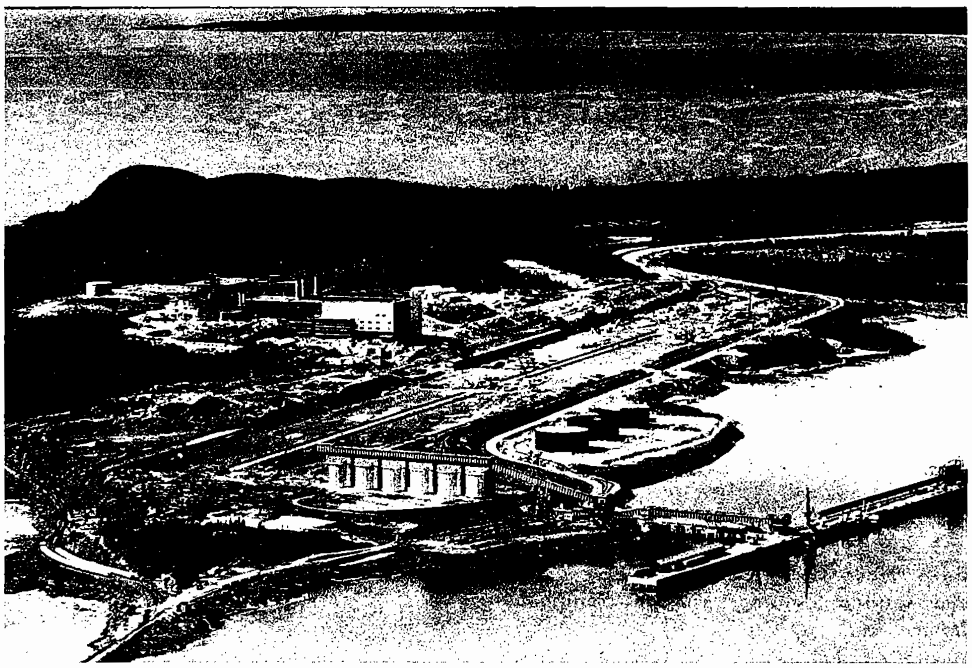
WESTERN CANADA STEEL LIMITED, VANCOUVER, B.C.

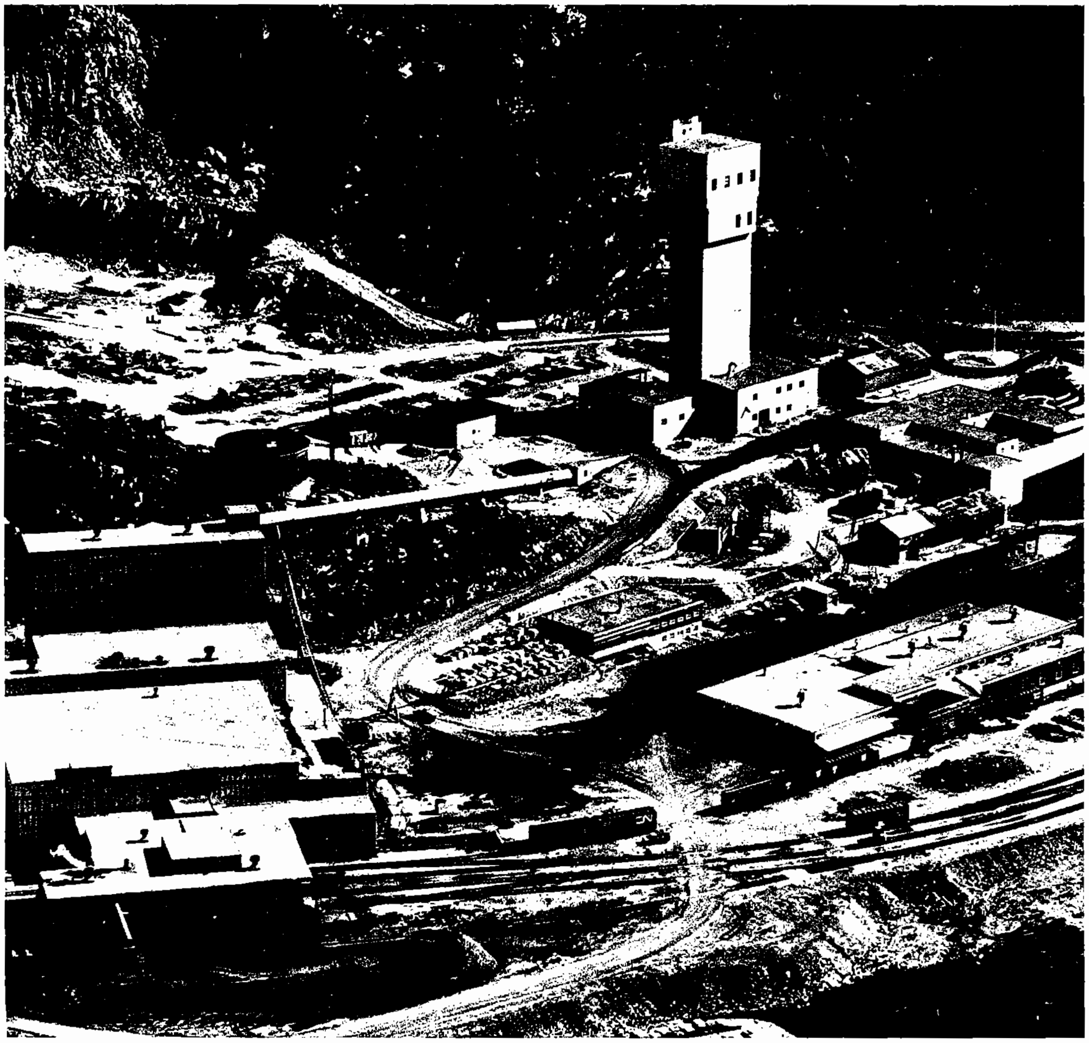
The company became a wholly owned subsidiary of The Consolidated Mining and Smelting Company of Canada Limited (COMINCO) in 1964 as the result of a purchase agreement. This facilitates integration of existing pig iron production and steel ingot production (starting in 1966) at COMINCO's Kimberley plant with Western Canada Steel's steel furnace and rolling mills at Vancouver. At Vancouver, the company began installation of a new 40-ton-per-hour reheat furnace feeding a 3-strand tandem, 2-high, 16-inch mill train that delivers to the existing mills. Additional shear equipment and equipment for increasing the speed of the mills will be installed by the second quarter of 1965. Rolling mill capacity is rated at 120,000 tons a year, an increase of 40,000 tons. The company is also considering installation of a new rod and wire mill (see COMINCO).

WESTERN ROLLING MILLS LTD., CALGARY, ALBERTA

The company started production from its new nonintegrated steel plant that includes an electric furnace (35,000 tons a year) operation based on scrap, a bar and merchant mill, and rail rerolling facilities. Rolled product capacity is rated at 75,000 tons a year.

Aerial view of Pointe Noire harbour, storage silos and plant under construction.





Geco Mines Ltd., Manitouwadge area. Mill and service buildings and principal head-frame.

Lead

J.G. GEORGE*

In 1964, Canada's production of lead, based on lead recovered from domestic ores and concentrates and the recoverable lead content of ores and concentrates exported, was 200,400 short tons compared with 201,200 in 1963. A substantial drop of 23,300 tons in production in British Columbia was offset by an increase of 20,600 tons in New Brunswick, which resulted mainly from tune-up operations begun in March 1964 at the property of Brunswick Mining and Smelting Corporation Limited near Bathurst. Little change took place in the production from other provinces and Yukon Territory. Test shipments of zinc-lead ore were made from Pine Point, Northwest Territories, preliminary to regular production in 1965. Output of refined lead at Canada's only lead smelter and electrolytic refinery, operated by The Consolidated Mining and Smelting Company of Canada Limited (COMINCO) at Trail, British Columbia, was 151,400 tons compared with 155,000 tons in 1963.

Total Canadian production based on the lead content of ores and concentrates produced, rather than the recoverable content of ores and concentrates exported and the lead content of bullion produced, was 209,700 tons. In 1963 and 1962 it was 199,000 and 211,300 tons, respectively.

COMINCO treated most of the lead concentrates from British Columbia and Yukon Territory at its Trail plant; the remainder was treated by The Bunker Hill Company and American Smelting and Refining Company in the United States at plants in Idaho and Montana. Producers in other parts of Canada shipped most of their lead concentrates to smelters in Europe and the United States.

Exports of ores and concentrates were almost 50 per cent higher than in 1963. The increase, 26,600 tons of contained lead, was largely accounted for by increased shipments to Canada's main customers, the United States and Belgium, and by significant shipments to France. Exports of metal at 95,900 tons were down slightly from 1963 exports of 97,100 tons. Britain and the United States together absorbed over 75 per cent of total metal exports and almost 20 per cent of total metal exports went to Japan and India.

*Mineral Resources Division

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TABLE 1

Lead – Production, Trade and Consumption

	1963		1964 p	
	Short Tons	$	Short Tons	$
Production, all forms[1]				
British Columbia	157,487	34,647,144	134,160	36,062,150
Newfoundland	23,392	5,146,264	24,368	6,550,105
New Brunswick	1,783	392,277	22,377	6,014,989
Yukon Territory	8,490	1,867,647	9,463	2,543,803
Quebec	4,337	954,051	3,279	881,376
Ontario	1,539	338,560	1,988	534,437
Northwest Territories	–	–	1,845	495,936
Nova Scotia	1,400	308,053	1,576	423,568
Manitoba	2,737	602,203	1,329	357,182
Total	201,165	44,256,199	200,385	53,863,546
Mine output[2]	198,988		209,673	
Refined[3]	155,000		151,372	
Exports				
In ores and concentrates				
Belgium and Luxembourg	12,960	1,596,011	31,106	6,096,935
United States	27,103	3,853,694	30,471	4,848,199
Britain	9,389	1,121,557	7,434	1,436,754
West Germany	4,304	635,479	4,605	685,087
France	–	–	4,265	834,712
Japan	–	–	1,414	226,043
Mexico	–	–	1,062	135,009
Total	53,756	7,206,741	80,357	14,262,739
In pigs, blocks and shot				
Britain	44,080	6,367,626	42,014	9,243,987
United States	31,690	6,178,916	30,487	7,340,417
Japan	9,031	1,338,092	9,808	2,163,378
India	6,103	768,777	8,473	1,940,790
Netherlands	3,617	526,430	3,305	683,747
West Germany	–	–	1,690	466,228
Other countries	2,623	366,429	90	19,492
Total	97,144	15,546,270	95,867	21,858,039
Lead and lead-alloy scrap				
United States	3,355	430,517	2,905	534,481
Netherlands	–	–	753	249,486
Belgium and Luxembourg	62	8,100	573	110,145
Britain	12	4,500	387	74,861
West Germany	26	2,774	381	72,791
Japan	–	–	225	22,720
Italy	534	33,428	54	14,051
Total	3,989	479,319	5,278	1,078,535

Table 1 (cont.)

	1963		1964p	
	Short Tons	$	Short Tons	$
Lead-fabricated materials not elsewhere specified				
United States	825	240,583	1,520	510,833
Philippines	–	–	174	58,859
Jamaica	–	–	92	31,367
Venezuela	5	2,000	27	12,196
Netherlands	–	–	20	8,059
Other countries	24	9,368	36	16,181
Total	854	251,951	1,869	637,495
Imports[4]				
Lead pigs, blocks and shot	1,741	289,734	73	26,000
Lead oxide: litharge, red lead, mineral orange	1,193	331,472	1,528	470,000
Lead-fabricated materials, n.e.s.	..	351,296	347	284,000
Total		972,502	1,948	780,000
Consumption				
Primary lead				
Antimonial lead	1,488		867	
Batteries and battery oxides	15,961		17,094	
Cable covering	4,612		4,559	
Chemical uses: white lead, red lead, litharge, tetraethyl lead, etc.	15,106		16,251	
Copper alloys: brass, bronze, etc.	227		419	
Lead alloys				
Solders	1,574		1,717	
Other, including babbitts, type metal, etc.	604		198	
Semifinished products: pipe, sheet, traps, bends, block for caulking, ammunition, foil, collapsible tubes, etc.	6,276		9,485	
Other	924		1,051	
Total	46,772		51,641	
Secondary lead				
Antimonial lead	16,561		16,941	
Batteries and battery oxides	619		811	

Table 1 (concl.)

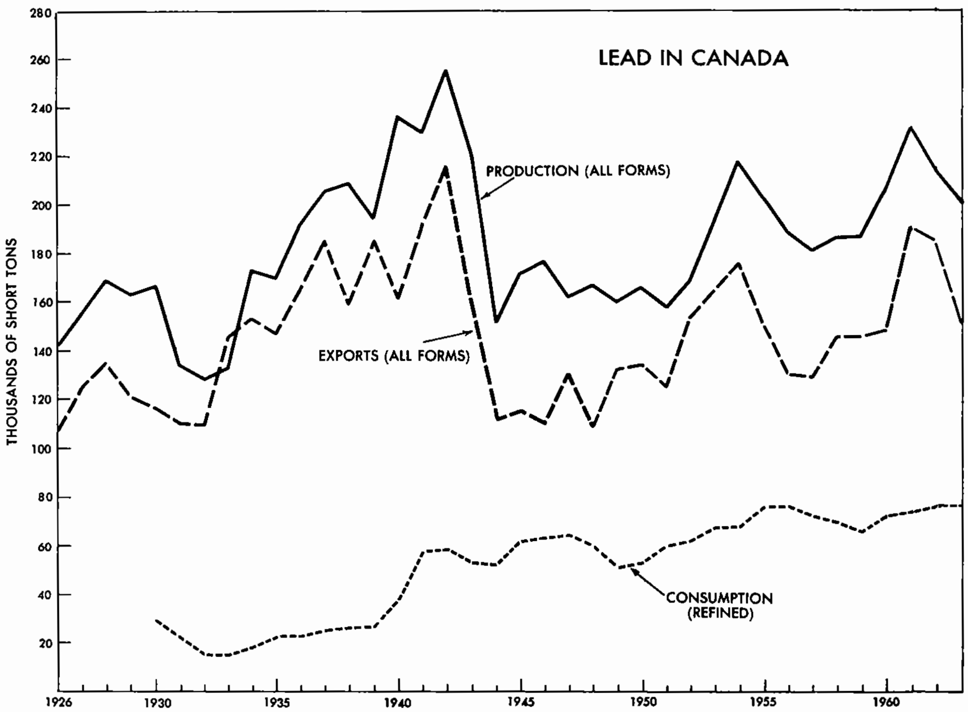
	1963		1964p	
	Short Tons	$	Short Tons	$
Cable covering	1,470		1,582	
Chemical uses: white lead, red lead, litharge, tetraethyl lead, etc.	2,557		1,958	
Copper alloys: brass, bronze, etc.	123		137	
Lead alloys				
Solders	2,717		2,540	
Other, including babbitts, type metal, etc.	1,827		2,070	
Semifinished products: pipe, sheets, traps, bends, block for caulking, ammunition, foil, collapsible tubes, etc.	3,695		3,790	
Other	1,617		1,266	
Total	31,186[5]		31,095[5]	
Consumption Summary				
Primary lead	46,772		51,641	
Secondary lead	31,186[5]		31,095[5]	
Total	77,958		82,736	

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]Due to classification changes in 1964, lead import statistics are not completely comparable with previous years. [5]Includes all remelt scrap lead and scrap lead used to make antimonial lead.

Symbols: p Preliminary; — Nil; .. Not available.

Canada's consumption of primary and secondary lead was 82,736 tons, about 6 per cent higher than in 1963. All of this increase is attributable to the increased use of primary lead, principally in the manufacture of semifinished products, chemicals and batteries.

In the United States, where 35 per cent of Canada's combined exports of lead concentrates and metal were shipped in 1964, consumption rose from 1,163,000 tons in 1963 to 1,187,000 tons in 1964. The increase was caused largely by a substantial rise of about 16 per cent in the amount of lead used as an antiknock additive in gasoline. This increase alone more than offset small declines in consumption of lead for manufacture of storage batteries and for calking.



UNITED STATES IMPORT QUOTAS AND STOCKPILES

On October 1, 1958, the United States imposed annual quotas on imports of unmanufactured lead and zinc for consumption. The quotas are equivalent to 80 per cent of the average annual commercial imports into the United States during the 5-year period from 1953 to 1957. Under these quotas, Canada's quarterly allotments are 7,960 tons of lead metal and 6,720 tons of lead contained in ores and concentrates. In 1964 the allotments for lead metal were filled in all four quarters. The allotments for lead-bearing ores and concentrates were undersubscribed in all four quarters although the shortage was about equal to the amount of duty-free imports of lead in ore from Canada, which were for U.S. government use and not subject to quota limits.

In March 1964 a full-scale investigation was commenced in response to President Johnson's request that the United States Tariff Commission investigate and advise him on the probable economic effects of a reduction or termination of import quota restrictions. One of the suggestions made by U.S. industry spokesmen at public hearings held in June 1964 was that the present absolute quotas be replaced by flexible quotas, which would fluctuate to make up the varying difference between consumption requirements and domestic production. The report by the Tariff Commission was not available at year's end.

TABLE 2

Summary – Lead Production, Trade and Consumption, 1955-64

(short tons)

	Production		Exports			Imports	
	All Forms[1]	Refined[2]	In Ore and Concentrates	Refined	Total	Refined[3]	Consumption[4]
1955	202,763	148,811	58,164	92,704	150,868	98	76,351
1956	188,854	147,865	49,974	79,633	129,607	105	75,882
1957	181,484	142,935	44,167	84,541	128,708	1,507	71,583
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
1964p	200,385	151,372	80,357	95,867	176,224	73	82,736

Source: Dominion Bureau of Statistics.

[1]Lead content of base bullion produced from primary materials (concentrates, slags, residues, etc.) plus 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

A congressional bill was passed in July authorizing the sale of 50,000 tons of lead from the U.S. government stockpile, without the usual 6-month waiting period. In August the General Services Administration (GSA) released 41,000 tons and the remaining 9,000 tons were released in December. These were the first sales to be made from the U.S. stockpile since it had been accumulated. The sales were made by GSA to domestic producers and representatives of foreign producers, all of whom agreed to distribute the metal for consumption only in the United States. The entire balance of stockpile lead, amounting to 1.3 million tons at the end of 1964, had previously been declared as surplus to conventional war requirements. Because of the continuing shortage, legislation was enacted by the U.S. government early in April 1965 authorizing an additional stockpile release of 200,000 tons of lead metal. Of this amount, 50,000 tons is to be disposed of to U.S. governmental agencies with the balance to be sold to industry.

INTERNATIONAL LEAD AND ZINC STUDY GROUP

The Eighth Session of The International Lead and Zinc Study Group was held in Madrid from October 21 to 30, 1964. In its statistical review the group found that lead mine production had expanded slowly in 1964 and that the steady growth of refined lead production had been achieved by some reduction in concentrate stocks and probably by an increase in scrap intake. Free World lead consumption increased by an estimated 6 per cent to 2.9 million tons in 1964 and, despite the release of U.S. government surplus stocks, supplies of lead fell short of requirements. The outlook was for a continuing deficit in 1965.

PRODUCING MINES

Of the 21 producers of lead in Canada listed in Table 3, COMINCO accounted for 121,525 tons, or approximately 58 per cent of Canada's mine production of lead. Ore production was somewhat higher than in 1963 at all of its three base-metal mines. Its Sullivan, H.B., and Bluebell mines in southeastern British Columbia produced 2,711,000, 478,000, and 258,000 tons of ore, respectively, compared with 2,595,000, 474,000, and 256,000 tons in 1963.

Other major producers were the Buchans unit of American Smelting and Refining Company in Newfoundland; Brunswick Mining and Smelting Corporation Limited, which initiated operations in March 1964 near Bathurst, New Brunswick; United Keno Hill Mines Limited at Elsa, Yukon Territory; Canadian Exporation, Limited, at Salmo, British Columbia; and Heath Steele Mines Limited, about 32 miles northwest of Newcastle, New Brunswick. These five mines, together with COMINCO's three base-metal mines in southeastern British Columbia, produced about 90 per cent of Canada's output.

Smaller producers included Reeves MacDonald Mines Limited in southeastern British Columbia and Solbec Copper Mines, Ltd., in southern Quebec, at both of which production was significantly higher because labour strikes had reduced output in 1963; Sheep Creek Mines Limited and Mastodon-Highland Bell Mines Limited in southeastern British Columbia; Hudson Bay Mining and Smelting Co., Limited, in Manitoba; Noranda Mines Limited (Geco Division) at Manitouwadge, Ontario; The Coniagas Mines, Limited, in Quebec; and Magnet Cove Barium Corporation in Nova Scotia. After an interruption of over two years, production of lead concentrates as a byproduct was resumed in September 1964 by Willroy Mines Limited at Manitouwadge, Ontario, because of the lead content derived from ore in the No. 4 zone and also because test shipments began from the nearby property of Willecho Mines Limited. Willecho is jointly owned by Willroy Mines Limited and Lun-Echo Gold Mines Limited; its ore is custom treated at the Willroy mill.

New Calumet Mines Limited, in southwestern Quebec, continued its normal production of lead concentrates. The company also purchased all the adjoining mining properties of Grand Calumet Mines Limited; these contributed about 139,000 tons of zinc-lead-silver-gold ore to the company's ore reserves. This figure is expected to be more than doubled, down dip and along strike, by development in 1965. Two new small producers, which initiated operations at zinc-lead-silver mines in British Columbia about 10 miles from Kaslo in the latter part of 1964, were Johnsby Mines Limited near Silverton and London Pride Silver Mines Ltd. Because of a labour strike, production was curtailed for two months at the Golden Manitou mine of Manitou-Barvue Mines Limited at Val d'Or, Quebec.

TABLE 3

Principal Lead Producers in Canada, 1964

Company and Location	Mill Capacity (tons ore/ day)	Grade of Ore Milled in 1964 (principal metals) Lead (%)	Zinc (%)	Copper (%)	Silver (oz./ton)	Ore Produced 1964 (1963) (short tons)	Contained Lead Produced 1964 (1963) (short tons)	Remarks
British Columbia								
Canadian Exploration, Limited, Jersey mine, Salmo	1,900	1.53	3.54	–	..	407,062 (368,673)	5,700 (5,060)	Plans mine development and diamond drilling on an accelerated scale in untested areas.
The Consolidated Mining and Smelting Company of Canada Limited								
Sullivan mine, Kimberley	10,000	..	..	–	..	2,711,000 (2,595,000)	106,124 (121,653)	A small tonnage of open-pit ore was mined in 1964.
Bluebell mine, Riondel	700	..	..	–	..	258,000 (256,000)	11,266 (12,426)	Exploration continued on 5 level north.
H.B. mine, Salmo	1,200	..	..	–	..	478,000 (474,000)	4,135 (3,300)	Development of lower-grade ore zone was initiated during 1964.
Johnsby Mines Limited, Silverton	250	3.23	4.59	–	16.03	2,988 (–)	94 (–)	Further diamond drilling, raising, and surface and underground exploration planned. Company also custom mills for local ores.

Table 3 (cont.)

Company and Location	Mill Capacity (tons ore/day)	Grade of Ore Milled in 1964 (principal metals) Lead (%)	Zinc (%)	Copper (%)	Silver (oz./ton)	Ore Produced 1964 (1963) (short tons)	Contained Lead Produced 1964 (1963) (short tons)	Remarks
London Pride Silver Mines Ltd. Cork Province mine, Kaslo	100	2.33	5.42	–	..	6,742 (–)	148 (–)	Working Cork Province mine.
Mastodon-Highland Bell Mines Limited, Beaverdell	90	1.3	1.8	–	34	25,090 (21,689)	303 (403)	Plans routine exploration and development.
Reeves MacDonald Mines Limited, Remac	1,200	1.20	3.56	–	..	379,269 (145,966)[1]	3,972 (1,560)[1]	Plans increased exploration in interesting areas of property.
Sheep Creek Mines Limited Mineral King mine, Toby Creek ...	500	1.49	4.13	–	0.59	182,958 (203,942)	2,479 (4,011)	Preparing to sink an 800-foot internal inclined shaft at –45°.
Yukon Territory								
United Keno Hill Mines Limited, Hector-Calumet, Elsa, Keno, and Silver King mines, Mayo District	500	6.38	4.92	–	33.37	181,849 (186,721)[2]	10,876 (8,376)[2]	Continuing extensive exploration program.

Table 3 (cont.)

Company and Location	Mill Capacity (tons ore/ day)	Grade of Ore Milled in 1964 (principal metals) Lead (%)	Zinc (%)	Copper (%)	Silver (oz./ton)	Ore Produced 1964 (1963) (short tons)	Contained Lead Produced 1964 (1963) (short tons)	Remarks
Manitoba-Saskatchewan								
Hudson Bay Mining and Smelting Co., Limited								
Flin Flon mine, Flin Flon	6,000 treated at central mill at Flin Flon	0.2	3.2	2.27	0.96	789,918 (924,616)	1,329 (2,857)	Extensive field exploration will be continued. Mine development will proceed at company's Osborne Lake and Anderson Lake mines.
Chisel Lake mine, Snow Lake		0.9	11.1	0.61	1.73	267,630 (300,065)		
Ontario								
Noranda Mines Limited								
Geco Division, Manitouwadge	3,300	..	5.52	2.09	2.48	1,299,300 (1,281,165)	1,745 (1,570)	Plans to complete sinking of No. 4 shaft.
Willroy Mines Limited, Manitouwadge	1,500	0.35	3.34	1.10	1.38	530,151 (483,800)	377 (–)	Continuing exploration drive on 1,600-foot horizon for 2,500 feet.
Quebec								
The Coniagas Mines, Limited, Bachelor Lake	350	0.72	9.57	–	3.68	114,459 (111,418)	607 (1,433)	Plans to continue exploration and production.

Note: The contained lead figure 1,329 (2,857) and its remarks are bracketed together for the Flin Flon and Chisel Lake mines.

Table 3 (cont.)

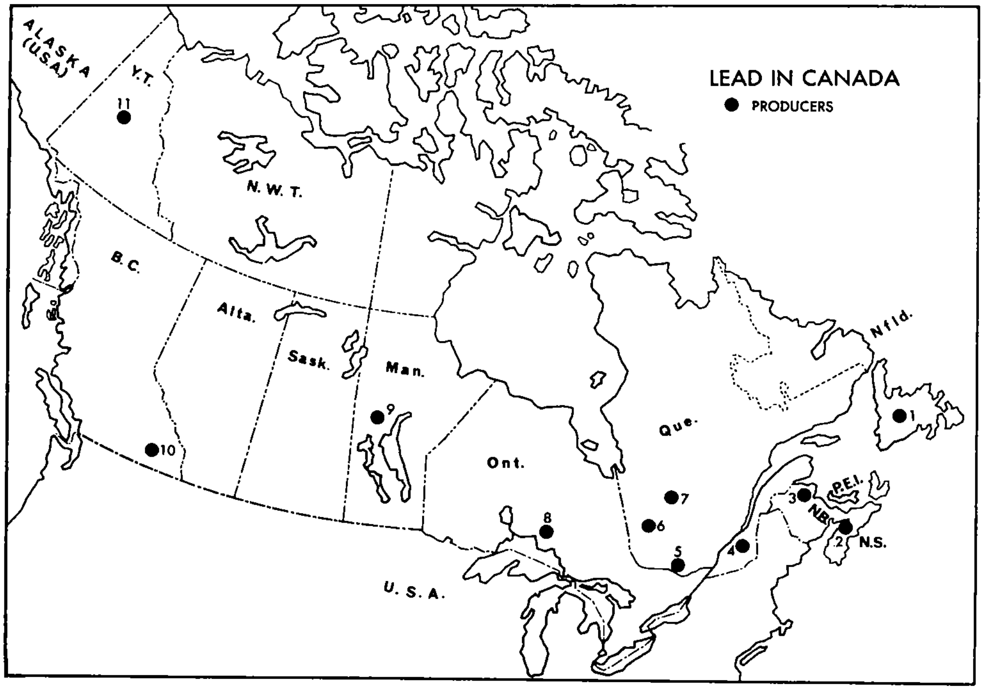
Company and Location	Mill Capacity (tons ore/ day)	Grade of Ore Milled in 1964 (principal metals) Lead (%)	Zinc (%)	Copper (%)	Silver (oz./ton)	Ore Produced 1964 (1963) (short tons)	Contained Lead Produced 1964 (1963) (short tons)	Remarks
Manitou-Barvue Mines Limited, Val d'Or	1,300	0.57	5.12	–	3.68	142,925[3] (174,365)[3]	682 (1,031)	
New Calumet Mines Limited,[2] Calumet Island	750	1.61	6.09	–	3.55	94,823 (93,360)	1,581 (1,711)	Development was continued throughout the year for exploration purposes and to open up new ore zones for mining.
Solbec Copper Mines, Ltd., Stratford Place	1,000	0.57	4.56	1.80	1.28	424,127 (188,493)[4]	1,277 (749)[4]	Open-pit mining will proceed until July 1965 when custom milling of Cupra ore is expected to commence.
New Brunswick								
Brunswick Mining and Smelting Corporation Limited [5] No. 12 mine, Bathurst	4,500	4.07	9.47	0.30	2.60	777,902 (–)	59,238[6] (–)	Routine development and expansion of ore reserves continued in 1964.
Heath Steele Mines Limited[7] Newcastle	1,500	2.7	6.4	0.9	2.6	290,000 (265,939)	5,570 (4,293)	Plan to continue exploration and development of known ore bodies.

Table 3 (concl.)

Company and Location	Mill Capacity (tons ore/ day)	Grade of Ore Milled in 1964 (principal metals) Lead %	Zinc %	Copper %	Silver (oz./ton)	Ore Produced 1964 (1963) (short tons)	Contained Lead Produced 1964 (1963) (short tons)	Remarks
Nova Scotia								
Magnet Cove Barium Corporation, Walton	125	3.69	1.52	0.64	12.7	48,927 (49,058)	1,759 (1,809)	Routine exploration and development.
Newfoundland								
American Smelting and Refining Company Buchans Unit, Buchans	1,250	7.36	13.04	1.09	4.07	383,000 (376,000)	26,064 (28,192)	

[1]The mine closed May 6 to December 20, 1963, due to strike of employees. [2]Production for fiscal years ending September 30. [3]Manitou-Barvue also mills copper ore. In 1964, 244,980 tons grading 0.818 per cent copper were treated. The mine closed February 20 to April 20, 1964, due to labour disagreement. [4]The mine closed for 5 months in 1963 by strike of employees. [5]Tune-up operations March through June 1964; regular operations July to December. [6]Tonnage shown is lead concentrate produced. [7]One half of Heath Steele's mill capacity used to treat copper ore mined by The Consolidated Mining and Smelting Company of Canada Limited at its Wedge mine.

Symbols: — Nil; .. Not available.



PRINCIPAL PRODUCERS

1. American Smelting and Refining Company, Buchans Unit
2. Magnet Cove Barium Corporation
3. Brunswick Mining and Smelting Corporation Limited
   Health Steele Mines Limited
4. Solbec Copper Mines, Ltd.
5. New Calumet Mines Limited
6. Manitou-Barvue Mines Limited
7. The Coniagas Mines, Limited
8. Noranda Mines Limited (Geco Division)
   Willroy Mines Limited
9. Hudson Bay Mining and Smelting Co., Limited (Chisel Lake mine)
10. Canadian Exploration, Limited
    The Consolidated Mining and Smelting Company of Canada Limited (also lead smelter and lead refinery) (Bluebell mine, H.B. mine, Sullivan mine)
    Johnsby Mines Limited
    London Pride Silver Mines Ltd.
    Mastodon-Highland Bell Mines Limited
    Reeves MacDonald Mines Limited
    Sheep Creek Mines Limited
11. United Keno Hill Mines Limited

OTHER DEVELOPMENTS

BRITISH COLUMBIA

The Lynx mine of Western Mines Limited, at Buttle Lake in the Alberni district on Vancouver Island was being prepared for production. Ore reserves at September 30, 1964, after allowing for dilution, were estimated at 1,500,200 tons averaging 10.49 per cent zinc, 1.21 per cent lead, 2.19 per cent copper, 2.91 ounces of silver and 0.063 ounces of gold a ton. Milling at a rate of approximately 750 tons daily was planned. Milling operations at the lead-zinc-silver property of Silbak Premier Mines, Limited, in the Portland Canal district of British Columbia were temporarily suspended late in 1964 after a short period of operation. After modifications were made in the mill circuit, milling operations were expected to resume. In the meantime the company continued to make high-grade ore shipments direct to the smelter. During 1964 intermittent shipments of silver-lead-zinc ores and concentrates were made by many small operators in the Slocan area, Hazelton-Smithers district, and other areas in British Columbia.

ATLANTIC PROVINCES

A significant development in New Brunswick was the commencement of milling operations in March 1964 at the major zinc-lead-copper-silver property of Brunswick Mining and Smelting Corporation Limited near Bathurst. The mill, originally designed to treat 3,000 tons daily, was expanded to a rated capacity of 4,500 tons a day. Ore reserves in the main No. 12 mine have been calculated at over 20 million tons grading 15 per cent combined lead and zinc down to the 1,650-foot level. Plans were announced for bringing the No. 6 orebody, about 5 miles south of the No. 12, into production; ore reserves were estimated at 27 million tons, of which 11.3 million tons are available for open-pit mining. Production from the open-pit mine is expected to start late in 1965. A new 2,250-ton-a-day concentrator was planned to process ore from the mine. Development was resumed at the property of Key Anacon Mines Limited, 10 miles east of the Brunswick No. 12 mine, where ore reserves were 1,463,000 tons grading 2.94 per cent lead, 7.81 per cent zinc, 0.20 per cent copper and 3.28 ounces of silver per ton.

At Belledune Point, New Brunswick, East Coast Smelting and Chemical Company Limited, a subsidiary of Brunswick Mining and Smelting Corporation Limited, continued construction of a lead-zinc smelter complex. When it is completed about mid-1966 it will treat a substantial portion of the lead and zinc concentrates produced by Brunswick. In October 1964 Brunswick announced plans to build at Belledune Point an integrated steel, chemical and fertilizer complex to be in operation by the end of 1968.

The Sullivan group of companies plans to bring into production, late in 1966, the lead-zinc-copper-silver deposit of its subsidiary, Nigadoo River Mines Limited. The property is 15 miles northwest of Bathurst, New Brunswick. Ore reserves have been calculated to a vertical depth of 1,000 feet at 1,390,000 tons averaging 2.97 per cent lead, 2.77 per cent zinc, 0.34 per cent copper and 4.36 ounces of silver a ton together with some recoverable bismuth and cadmium. Construction of a 1,000-ton-a-day concentrator will begin in the spring of 1966.

In Nova Scotia, exploration and development work continued at the lead-silver deposit of Yava Mines Limited on Cape Breton Island about 27 miles southwest of Sydney. Diamond drilling carried out in 1962 indicated the presence of a sandstone bed assaying from 3 to 3½ per cent lead with minor values in silver. At that time, possible ore was estimated at up to 125,000 tons. Yava Mines Limited was incorporated in the fall of 1964 to take over the property which had formerly been developed by Talisman Mines Limited. Participating in Yava Mines are Talisman Mines Limited, Phelps Dodge Corporation of Canada, Limited, Gunnex Limited and Lehman Brothers of New York.

YUKON TERRITORY

Although the total tons of ore milled at United Keno Hill Mines Limited in the year ended September 30, 1964, was about 500 tons less than during the previous year, lead production increased from 8,376 to 10,562 tons because of the substantially higher lead content of mill feed and better recovery. Extensive exploration and development was continued in many areas of mineralization at the company's properties in the Mayo district.

Exploration work continued on the property of Vangorda Mines Limited, controlled by Kerr Addison Mines Limited, that is on the Pelly River about 126 miles northeast of Whitehorse, Y.T. Diamond drilling some years ago indicated a shallow flat-lying mineral deposit containing reserves of 9.4 million tons of which two thirds could be mined by open-pit methods. Grade averages 4.96 per cent zinc, 3.18 per cent lead, 0.27 per cent copper, 1.76 ounces of silver and 0.02 ounces of gold a ton. In 1964, two large-diameter holes were diamond drilled on the deposit to obtain fresh samples for metallurgical testing. The test results will be used for the completion of production feasibility studies.

NORTHWEST TERRITORIES

Preparation for production continued at the major zinc-lead property of Pine Point Mines Limited, a subsidiary of The Consolidated Mining and Smelting Company of Canada Limited, whose property is on the south shore of Great Slave Lake at Pine Point. Ore reserves were reported to be 17.5 million tons averaging 4.8 per cent lead and 7.4 per cent zinc. A large number of houses have been built for employees and by the end of 1964 auxiliary service buildings were nearly completed. Construction proceeded on the 5,000-ton-a-day concentrator and overburden was stripped from the orebodies to prepare them for open-pit mining.

The laying of rails for the 432-mile Great Slave Lake Railway (a line of Canadian National Railways) being constructed from Grimshaw, Alberta, to Hay River and Pine Point, N.W.T., was completed late in the year; further grading work remains. Power for all purposes will be supplied by a 25,000-hp. hydroelectric plant being developed on the Talston River about 35 miles northeast of Fort Smith, N.W.T., and some 150 miles from Pine Point. Power is expected to be available late in 1965 at about the same time that the mill at Pine Point is scheduled to commence operations. Test shipments of ore from the mine, which will be the first lead-zinc producer in the N.W.T., began in November 1964 to the Kimberley and Trail, British Columbia, plants of COMINCO. Test shipments of ore will continue until milling operations are initiated at the Pine Point concentrator. Lead and zinc concentrates from Pine Point will be railed to COMINCO's lead and zinc smelters at Trail, B.C., at an initial total rate of 215,000 tons a year.

USES

The main industrial applications of lead in Canada in 1964 and the tonnages used in each are listed in Table 1.

Lead has many useful chemical and mechanical properties and because of this versatility it has a variety of industrial applications. Often referred to as the imperishable metal, lead is ductile, malleable and easily worked. It alloys readily with other materials, offers excellent corrosion resistance, has a low melting point and a high specific gravity. Because of its high density lead is a good shield against gamma radiation. The metal also has excellent qualities for preventing the transmission of sound.

Currently, the major use for lead is in lead-acid storage batteries, the bulk of which are used for automobile starting and lighting. There are also new and expanding markets for lead in batteries for industrial trucks and certain household appliances. Batteries consume about equal quantities of lead in the metallic grids and posts, and in the oxide paste. Its next two most important uses are in cable sheathing and for making tetraethyl lead, which is used as an additive for gasoline to improve its octane rating and reduce engine knock. Lead is also used extensively in the manufacture of corrosive-liquid containers, different types of lead-base babbitts, solders and type metals, plumbing equipment such as pipes, drains and bends, calking materials, pigments, collapsible tubes and ammunition.

Because of its sound attenuation qualities, lead is being increasingly used in the architectural and building fields for acoustical privacy and the reduction of noise in buildings.

Lead usage in this market – in over-the-ceiling liners, doors, partition panels, removable walls – is increasing substantially. In the allied field of vibration isolation it is almost becoming standard practice to install lead-asbestos antivibration pads in the foundations of skyscrapers and other buildings exposed to severe vibration from nearby trains, subways, or heavy haulage vehicles. Also because of these excellent qualities for preventing the transmission of sound and vibration, lead is used in the mounting of certain types of equipment such as air-conditioning systems, printing presses and commercial laundry machines.

Other uses are as lead-ferrite for permanent magnets in motors for windshield wipers, turning signals, windows, seats, tooth brushes, sewing machines and many other applications requiring small electric motors. Miscellaneous uses include wheel weights, ship ballast, roofing systems, sprayed lead coatings, various alloys and terne steel. A newer use is leaded porcelain-enamelled aluminum. Research is endeavouring to develop new markets for lead additives in lubricating oils and as a wood preservative in marine environment; similar applications include its use in biocides, fungicides, insecticides, antifouling pigments and curing agents for rubber. A relatively new and growing use is for radiation shielding against gamma rays in nuclear power reactors, nuclear-powered merchant ships and submarines, and shipping casks for transporting radioactive materials.

RESEARCH

A program to determine the effect of temperature and composition on the surface tension, viscosity and density of molten lead and lead alloys has begun

TABLE 4

Free World Production of Lead, 1964

(short tons)

	Mine Production	Refined Production
Australia	415,300	245,500
United States	294,600	822,800
Canada	209,700	151,400
Mexico	..	184,600
Peru	..	97,800
Yugoslavia	105,800	111,300
Morocco	..	20,800
Republic of South Africa	..	52,600
Sweden	71,900	59,500
Spain	62,400	63,800
Japan	59,600	119,200
West Germany	57,200	242,800
Italy	36,600	56,200
Argentina	29,100	39,700
Bolivia	22,500	–
Belgium	–	82,600
Britain	–	197,600
France	12,800	134,200
Other countries	..	114,200
Total	..	2,796,600

Source: International Lead and Zinc Study Group.
Symbols: .. Not available; – Nil.

in the Physical Metallurgy Division of the Department of Mines and Technical Surveys. Authoritative values were obtained for the surface tension, viscosity and density of pure lead and it was shown that the temperature coefficient for surface tension is weakly negative. Viscosity and density determinations were made across the lead-tin system at intervals of approximately 10 per cent tin. It was shown that the system displays a high degree of ideality, and no anomalies associated with constitutional features such as have been reported by other workers, were detected. It was concluded that such anomalies are spurious effects associated with incorrect experimental techniques.

WORLD PRODUCTION OF LEAD

The countries listed in Table 4 were the Free World's leading lead producers in 1964. Mine production of lead by countries of the Soviet bloc in 1963 totalled approximately 718,600 tons.

PRICES

Since 1962, Free World lead consumption has exceeded production, thereby causing a shortage which exerted an upward pressure on prices. In the latter part of 1962 the lead price started to rise. This upward trend continued throughout 1964 and became more pronounced during the latter part of the year, after which the price tended to level off.

The year 1964 opened with the Canadian price f.o.b. Toronto and Montreal increasing from 12.5 to 13.0 cents a pound on January 3. There was no further change until September 2 when the price again moved upward to 13.5 cents. This price held until October 19 when it was raised to 14.5 cents and this figure remained in effect until December 14 when a further increase to 15.5 cents occurred.

The United States price for common lead f.o.b. New York was increased from 12.5 to 13.0 cents a pound on January 2, 1964. The price remained at that level until September 1 when it moved to 14.0 cents. Another increase took place on October 16 when the price was raised to 15.0 cents. This price held until December 10 when it rose to 16.0 cents, the highest since 1957.

On January 2, 1964, the London Metal Exchange (LME) price was £79.1 per long ton (10.6 cents a pound Can.). The price trended upward from January onwards and on December 15 reached the high for the year of £154.5 (20.8 cents Can.), the highest level since the peaks caused by the Korean War. In 1964 the LME price was higher than its U.S. counterpart for the first time since 1952. By the end of the year the price had declined to £123.0 (16.5 cents Can.).

TARIFFS

Canadian and United States tariffs in 1964 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	½¢	½¢	1¢
Lead in bars and sheets	10%	10%	25%
Babbit metal and type metal in blocks, bars, plates and sheets	10%	20%	20%

UNITED STATES	(¢ per lb)
Lead in ores and concentrates*	0.75 on lead content
Lead bullion, lead waste and scrap*	1.0625 on 99.6% of lead content
Other forms of unwrought lead*	1.0625

*Subject to quarterly import quotas.

Geco Mines Ltd., Manitouwadge area. Open-pit operations.

Lime

J.S. ROSS*

Lime production again increased in 1964, continuing the general upward trend that had been interrupted from 1958 to 1960 by a high production rate based on unusually large demands for lime by the uranium industry. The technical changes taking place in steel production and the added demand for alkali chemicals provided the main reasons for the increase in lime output in 1964. In particular, the demand by the steel industry should continue to provide substantially increasing outlets. The prospects for renewed additional requirements by the uranium industry are improving. Consequently, although lime production generally will vary with industrial activity, any large fluctuations in output will depend on the demands of the steel, uranium and alkali industries in the near future.

Almost half of Canada's primary lime output is of a captive nature. In 1964 this feature was made more significant by the erection of a new plant in Ontario to provide lime for steel production. Now, two of the four Canadian producers of crude steel have captive lime plants. One other Ontario lime plant ceased operating in 1964.

PRODUCTION AND TRADE

During the year, lime shipments increased 3 per cent over 1963 to 1.49 million tons valued at $19.1 million (preliminary). The industry was at little more than half its rated capacity and, as customary, quicklime made up most of the output – 82 per cent of the total. Practically all the increase came from Ontario whereas production from other provinces remained relatively constant. Ontario supplied 67 per cent of the total.

*Mineral Processing Division, Mines Branch

TABLE 1

Lime — Production and Trade

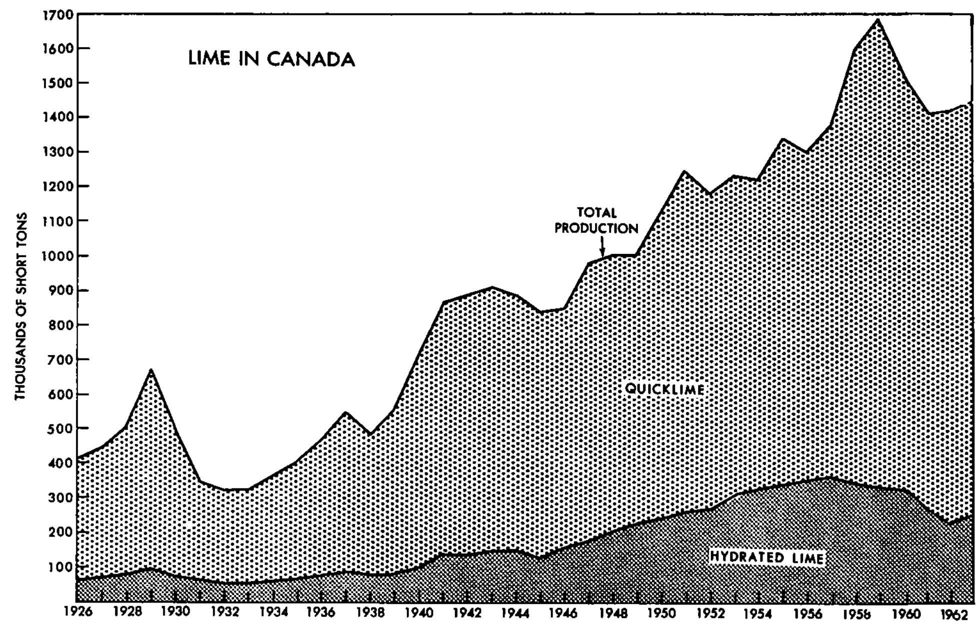
	1963		1964	
	Short Tons	$	Short Tons	$
Production*				
By type				
Quicklime	1,204,824	14,915,096	1,221,065p	..
Hydrated lime	245,907	3,589,124	269,857p	..
Total	1,450,731	18,504,220	1,490,922p	19,122,104p
By province				
Ontario	952,945	11,434,223	1,008,123	12,236,864
Quebec	358,201	4,586,493	349,400	4,616,693
Alberta	54,826	970,673	58,618	1,051,192
Manitoba	54,879	908,952	53,760	911,019
British Columbia	12,961	221,166	15,343	165,848
New Brunswick	16,919	382,713	5,678	140,488
Total	1,450,731	18,504,220	1,490,922	19,122,104
Imports				
Quick and hydrated				
United States	44,110	709,207	20,551	475,750
United Kingdom	163	2,993	152	2,163
France	18	1,357	88	2,316
Total	44,291	713,557	20,791	480,229
Exports				
Quick and hydrated				
United States	95,690	1,114,086	102,725	1,170,707
British Guiana	2,310	23,723	3,500	33,414
Bermuda	80	3,101	70	2,135
Ghana	—	—	43	1,530
Netherlands Antilles	4	250	4	218
Pakistan	—	—	1	214
Total	98,084	1,141,160	106,343	1,208,218

Source: Dominion Bureau of Statistics.

*Producers' shipments of primary lime plus quantities used by producers. In 1963, 887,986 tons of the total were shipped and 562,745 tons were used at the producing plants.

Symbols: p Preliminary; — Nil; .. Not available.

Canada produces mostly high-calcium quicklime in addition to dolomitic and magnesian quicklime and the hydrated forms of each type. High-purity limestone is used as the raw material and in 1963, 2.7 million tons served that purpose. Limestone suitable for lime production is generally available near most of the more populous areas in all provinces except Saskatchewan and Prince Edward Island.



Primary lime was produced in six provinces: Ontario, Quebec, Alberta, Manitoba, British Columbia and New Brunswick. Ontario was by far the leading supplier and, with Quebec, produced 91 per cent of the output in 1964. As indicated in Table 3, all producing provinces supplied high-calcium quicklime, but only plants in Manitoba, Ontario and New Brunswick marketed the dolomitic type. About half the output was used captively either at the producing plant or by parent companies. Although 36 plants with 121 kilns operated during 1964, only 34 plants with 116 kilns (89 vertical, 26 rotary and 1 Calcimatic) were producing at year's end. The industry operated at 56 per cent of rated year-end capacity. This compares with 34 plants and 117 kilns at the end of the previous year. Since 1958 there has been a general decrease in the number of lime plants in operation, a fluctuating but small increase in plant capacity,

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but a significant gain in both average rated plant and kiln capacity (Table 2). In addition, two separate plants hydrated purchased lime.

A large and unknown amount of secondary lime was recovered from chemical plants, particularly from calcium carbonate sludge resulting from the processing of paper pulp. It is estimated that in 1964 at least 20 pulp plants with 21 kilns recovered more than half a million tons of secondary lime. On occasion, a few of these mills produced small amounts of primary lime from limestone. Because of the significant amount of primary lime produced by the Campbell River, British Columbia, plant of Crown Zellerbach Canada Limited, that plant has been added to Table 3 and the necessary adjustments were made to Table 2 starting with 1962.

TABLE 2

Lime – Rated Production Capacity*, 1958–64

	No. of Plants Operating*	No. of Kilns*	Approximate Rated Capacity (tons/day)	Average Rated Capacity Plant (tons/day)	Average Rated Capacity Kiln (tons/day)	Production (tons)	Production as % of Capacity**
1958	38	150	7,400	195	49	1,596,422	63
1959	38	155	7,680	202	50	1,685,725	64
1960	35	145	8,010	229	55	1,529,568	56
1961	35	125	7,825	224	63	1,415,290	53
1962	36	126	8,120	226	64	1,424,459	52
1963	34	117	7,830	230	67	1,450,731	55
1964	34	116	7,845	231	68	1,490,922p	56p

*At year's end and excluding separate hydrating plants. **Assuming 340 operating days a year. p – Preliminary.

TABLE 3

Lime Producers, 1964

Name of Firm	Plant Location	Type of Quicklime
New Brunswick		
Bathurst Power and Paper Company Limited	Bathurst	High-calcium
Snowflake Lime Limited	Saint John	High-calcium and dolomitic*

Table 3 (concl.)

Name of Firm	Plant Location	Type of Quicklime
Quebec		
Aluminum Company of Canada, Limited	Wakefield	Magnesian*
Bousquet, Adrien	St. Dominique	High-calcium
Dominion Lime Ltd..............	Lime Ridge	,, *
Domtar Chemicals Limited	Joliette	,, *
Lamothe, N.	Pont Rouge	,,
Quebec Sugar Refinery	St. Hilaire	,,
Shawinigan Chemicals Limited	Shawinigan	,,
Ontario		
Bonnechère Lime Limited.........	Grattan Tp.	High-calcium
Brunner Mond Canada, Limited	Anderdon Tp.	,,
Canada and Dominion Sugar Company Limited	Chatham	,,
Canadian Gypsum Company, Limited	Guelph Tp.	Dolomitic*
Carleton Lime Products Co........	Carleton Place	High-calcium
Chemical Lime Limited...........	Beachville	,,
Cyanamid of Canada Limited	Niagara Falls	,,
	Ingersoll	,,
Dominion Magnesium Limited......	Haley	Dolomitic
Domtar Chemicals Limited	Hespeler	,, *
	Beachville	High-calcium*
Indusmin Limited	Coboconk	,,
Rockwood Lime Company Limited..	Rockwood	Dolomitic*
The Algoma Steel Corporation, Limited	Sault Ste. Marie	High-calcium
Manitoba		
Building Products and Coal Co. Ltd.	Inwood	Dolomitic*
The Manitoba Sugar Company, Limited	Fort Garry	High-calcium
Selkirk Silica Co. Ltd.**	Spearhill	,,
	Stonewall	Dolomitic
Alberta		
Canadian Sugar Factories Limited .	Raymond	High-calcium
	Picture Butte	,,
	Taber	,,
Loder's Lime (Company) Limited ..	Kananaskis	,, *
Summit Lime Works Limited	Crowsnest	,, *
British Columbia		
Crown Zellerbach Canada Limited .	Ocean Falls	,,
	Campbell River	,,
Domtar Chemicals Limited	Granville Island	,,

*The hydrated varieties are also produced. **Formerly The Winnipeg Supply & Fuel Company Limited.

Trade – mostly with the United States – is relatively small although the value of exports is significant. In 1964 exports were up from 1963 and reached 106,343 tons valued at $1,208,218. Imports were mostly of special types. They were down from 1963 and amounted to 20,791 tons valued at $480,229.

DEVELOPMENTS

The Blubber Bay, British Columbia, and the St. Marc des Carrières, Quebec, plants of Domtar Chemicals Limited were closed in 1963 and were not operated in 1964. The Indusmin Limited lime operation at Coboconk, Ontario was closed during the latter part of 1964.

A significant development was the erection of a new plant containing the first Calcimatic kiln to go into commercial production in Canada. This kiln employs the principle of a circular travelling bed. Operated by The Algoma Steel Corporation, Limited, at Sault Ste. Marie, Ontario, the plant has a rated output of 200 tons of lime a day and will supply lime for use in steel production. This is the second of the four crude steel producers in Canada to have a captive source of lime.

CONSUMPTION AND USE

Lime is relatively inexpensive and is desired as an alkali and a chemical for many purposes. Consequently it finds use in many industries. Consumers of lime can be divided into four categories: chemical and metallurgical, construction, agriculture, and other industries as indicated in Table 4.

The chemical and metallurgical industries are by far the largest users of lime and consumed 87 per cent of the output in 1963. Most of this was used captively, including most of the 605,312 tons under 'other' that went mainly for the production of calcium carbide, sodium carbonate and calcium chloride at three plants in Ontario and Quebec. In addition, some of the lime used by steel plants and pulp mills was produced captively. Lime is used by the iron and steel industry as a flux in smelting and for neutralizing waste liquors. In paper-pulp production, it is employed in the preparation of dissolving fluids for the soda and sulphite processes. In the recovery of uranium, lime controls the hydrogen-ion concentration and neutralizes waste sludges. Lime is used as a flux in nonferrous smelting and regulates alkalinity in the flotation and cyanidation of minerals. It precipitates impurities from the sucrate during beet-sugar production and is employed in the manufacture of glass as a flux and source of calcium. It is also used in the production of, and as an ingredient in, some fertilizers, in the tanning of leather and in the manufacture of many materials such as insecticides, fungicides, pigments, glues, acetylene, calcium carbonate, calcium hydroxide, calcium sulphate, magnesia and magensium metal.

TABLE 4

Consumption of Lime
(producers' shipments and consumption, by use)

	1962		1963	
	Short Tons	$	Short Tons	$
Chemical and Metallurgical				
Iron and steel plants.......	187,344	2,205,413	221,360	2,611,775
Pulp mills	206,857	2,602,043	201,156	2,502,224
Uranium mills	98,304	1,225,405	98,862	1,155,871
Nonferrous smelters	57,911	470,069	61,126	488,640
Sugar refineries...........	33,120	463,843	35,255	518,155
Cyanide and flotation mills.	42,042	430,549	25,523	321,500
Glass works..............	11,510	141,073	3,209	28,604
Fertilizer plants	6,564	57,253	3,430	37,004
Tanneries................	4,967	67,184	5,012	69,928
Insecticides, fungicides ...	1,077	20,889	1,097	21,450
Other....................	576,790	6,560,994	605,312	7,416,781
Construction				
Finishing lime............	78,372	1,713,431	78,255	1,807,233
Mason's lime	51,269	820,553	37,742	596,156
Sand-lime brick...........	17,990	189,897	26,749	313,002
Agricultural	2,682	39,361	8,495	103,057
Other......................	47,660	638,631	38,148	512,840
Total.................	1,424,459	17,646,588	1,450,731	18,504,220

Source: Dominion Bureau of Statistics.

About 10 per cent of Canada's lime output was used by the construction industry in 1963. It serves as an ingredient in plaster, mortar, artificial stone, brick and concrete. Small amounts, included under 'other' in Table 4, are used in soil stabilization, ready-mixed mortar and asphalt paving. An insignificant amount of lime is used as a soil conditioner in agriculture. The fourth major consuming group of industries is designated by 'other' in Table 4 and includes the use of lime in water treatment.

PRICES

Quicklime is marketed in lump, pebble, crushed and pulverized form. It may be sold as bulk or in bags. Hydrated lime is normally shipped in bags. Prices vary with the type of product, type of shipment, amount sold, and supply and demand. In 1963 shipments of quicklime and hydrated lime averaged respectively $12.38 and $14.60 a ton at the plant.

View of Wabush, with airstrip in background.

Limestone

J.S. ROSS*

Coinciding with the continuing rise in construction activity, Canada's limestone production reached a new record in 1964. Limestone output has risen steadily almost every year since 1946 and has more than doubled in the last 10 years.

In 1964, 66.1 million tons were produced for all purposes, up 5 per cent from the previous record of 1963. Gains were made in consumption in the three major categories, of which the miscellaneous category increased the most. Shipments for the miscellaneous, or noncement-nonlime group, amounted to a record 53.0 million tons, up 4 per cent in quantity and 6 per cent in value from 1963. Practically all the limestone was of the sedimentary type, the remainder being recrystallized limestone and marl. Limestone used in the production of cement reached a new high of about 10.3 million tons and that for lime manufacture increased slightly to 2.8 million tons.

A remarkable 92 per cent of Canada's production of limestone for nonlime and noncement purposes came from Quebec and Ontario with more than half the total supplied by Quebec. The commodity was shipped from more than 475 quarries in eight provinces. As usual, none originated from Saskatchewan or Prince Edward Island.

Limestone made up 83 per cent of the total stone production of 63.6 million tons in 1964. The balance included igneous rock and sandstone as well as some shale and slate. The output value of stone of all types exclusive of that used in the manufacture of cement and lime, remained in twelfth place in Canada's mineral production.

Despite the low unit value of limestone and the United States tariff on the crushed type, the commodity is traded in substantial amounts between Canada and the United States. However, the tonnage involved is small compared with total production. In 1964, 0.9 million ton of crushed and refuse limestone valued at $1.3 million went to the United States and 1.3 million tons of crushed, ground and broken limestone were imported from that country. Both exports and imports are up considerably from those of 1963; the former because of additional requirements for high-quality chemical-grade limestone in northwestern United States and the latter mainly because of expanding markets in Ontario. Exports are mostly of chemical-grade limestone from Ontario, British Columbia and Alberta

*Mineral Processing Division, Mines Branch

TABLE 1

Limestone – Production, Trade and Consumption

	1963		1964p	
	Short Tons	$	Short Tons	$
Production[1]				
By province				
Quebec	25,379,221	28,830,411	27,675,621	31,393,769
Ontario	19,205,898	20,544,057	21,272,197	24,327,128
British Columbia	1,500,497	2,305,367	1,791,644	2,711,242
Manitoba	3,666,644	4,318,636	1,084,915	1,406,231
New Brunswick	754,844	828,740	792,745	931,849
Alberta	138,577	409,880	116,749	442,223
Newfoundland	297,607	575,092	208,219	369,906
Nova Scotia	78,108	241,138	77,258	230,199
Total	51,021,396	58,053,321	53,019,348	61,812,547
By type	1962		1963	
General[2]	41,465,369	50,073,338	50,850,587	56,995,742
Marl	86,216	241,778	99,095	301,690
Recrystallized	71,888	707,724	71,714	755,889
Total	41,623,473	51,022,840	51,021,396	58,053,321
By use				
Metallurgical	1,905,407	2,070,943	..	..
Pulp and paper	451,940	1,395,114	..	..
Glass	64,816	216,442	..	..
Sugar refining	42,453	85,214	..	..
Other chemical uses	518,940	558,981	..	..
Pulverized for agricultural use	1,192,105	3,201,782	..	..
Pulverized for other use	380,052	1,119,668	..	..
Road metal	20,316,924	22,101,509	..	..
Concrete aggregate	10,829,627	11,618,168	..	..
Rubble and riprap	1,280,693	1,061,562	..	..
Railroad ballast	971,861	1,009,231	..	..
Structural[3]	60,514	1,969,896	..	..
Other uses	3,608,141	4,614,330	..	..
Total	41,623,473	51,022,840	51,021,396	58,053,321
Exports				
Limestone, crushed and refuse	1963		1964	
United States	633,998	975,636	910,829	1,290,311
Bermuda	57	1,424	–	–
Total	634,055	977,060	910,829	1,290,311

Table 1 (cont.)

	1963		1964p	
	Short Tons	$	Short Tons	$
Exports (cont.)				
Crude stone, not elsewhere specified				
United States	185,314	306,048	186,771	358,057
Bermuda	91	2,320	323	1,275
Belgium and Luxembourg	—	—	80	6,080
Leeward and Windward Islands	—	—	30	589
Japan	—	—	3	1,364
Other countries	1	3,928	3	2,978
Total	185,406	312,296	187,210	370,343
Imports				
Total crushed stone, including stone refuse				
United States	750,310	1,023,434	1,045,104	2,815,868
Italy	—	—	7,222	115,207
Portugal	—	—	142	3,200
Total	750,310	1,023,434	1,052,468	2,034,275
Crushed, ground and broken limestone exported by United States to Canada[4]	699,783	1,476,157	1,269,747	1,776,164
Consumption				
In production of cement	9,384,412		10,310,000e	
In production of lime	2,703,709		2,818,000e	
Miscellaneous	51,021,396		53,019,348p	
Total	63,109,517		66,147,348e	

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 small amounts of marl and marble.
[2]Includes sedimentary limestone and minor coloured recrystallized limestone. [3] Includes building, monumental and ornamental stone as well as flagstone and curbstone. [4]U.S. Department of Commerce, UNITED STATES EXPORTS OF DOMESTIC AND FOREIGN MERCHANDISE (Report FT410). Values are in United States dollars.
Symbols: e Estimated; p Preliminary; — Nil; .. Not available.

in addition to that for construction purposes from Ontario. Pulverized, crude and probably ornamental and building stone were also exported but the amounts are unknown. Imports of crushed limestone go mostly to Ontario for construction and chemical purposes. The import value of marble was $1.8 million in 1964. Almost all was for finished rather than rough marble and most came from the United States and Italy.

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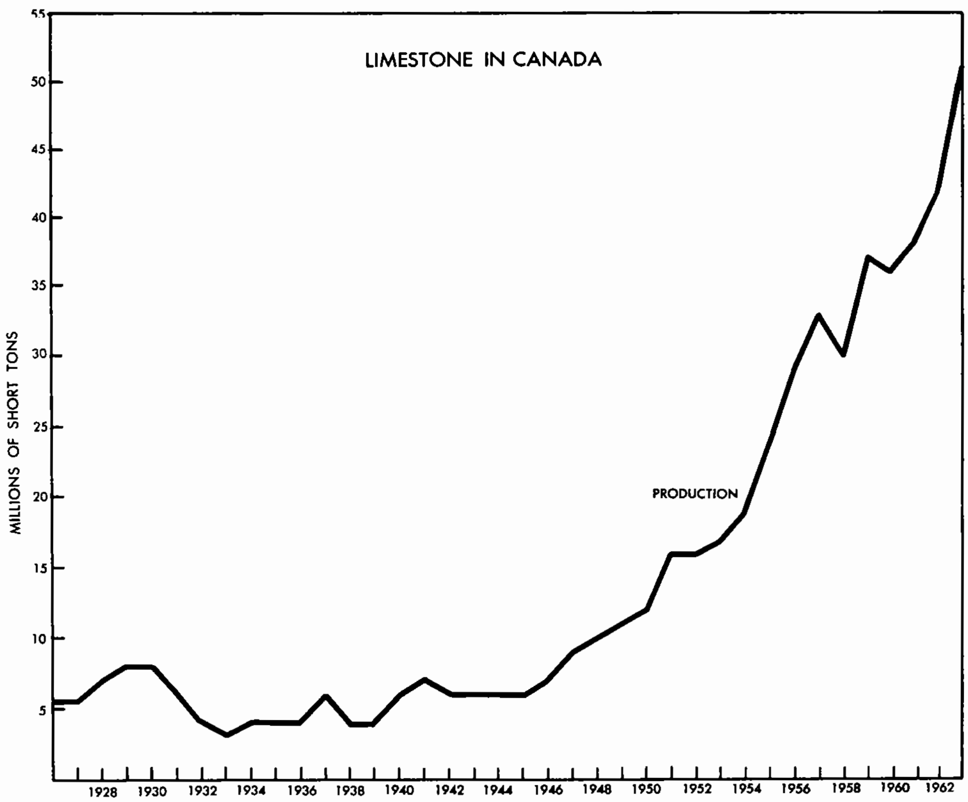

Many limestone operations underwent minor changes during 1964. In general, these involved improvements to crushing and sizing facilities to improve volume and quality of output. The marble industry of southeastern Ontario became more active during the year, resulting in the production of a variety of colours of marble. During the first part of the year, new markets in Oregon were supplied with chemical-grade limestone from Texada Island, British Columbia. Maritime Cement Company Limited is planning to start a new limestone quarrying and crushing operation in 1965 in conjunction with cement production near Brookfield, Nova Scotia.

DISTRIBUTION OF DEPOSITS

Suitable deposits of most types of limestone occur near many of Canada's more populated regions, particularly in the southern parts of Quebec and Ontario, where most of the nation's limestone is quarried and consumed. However, suitable and easily accessible limestone generally does not occur in the following areas of southern Canada: eastern Alberta, southern Saskatchewan, northwestern Ontario and Prince Edward Island. Chemical-grade dolomitic and high-calcium limestone are quarried in British Columbia, Manitoba, Ontario, New Brunswick and Nova Scotia. The other producing provinces also supply high-calcium limestone.

Marl, an unconsolidated form of limestone, occurs in all provinces and is recovered in Quebec, British Columbia and Nova Scotia. Recrystallized limestone is produced in British Columbia, Ontario, Quebec and New Brunswick.

USES

Limestone is the preferred type of stone for many uses because of its physical properties, abundance and low value. The extent to which a particular limestone is used is determined mainly by the distance between the deposit and markets. Other criteria include chemical composition, accessibility, texture, hardness and colour, as well as thickness and extent of formation. Limestone may be used in large fragments as rubble and riprap, chemical stone, flagstone, curbstone, or building, monumental and ornamental stone. It is usually crushed to minus 6 inches in size for chemical and most other purposes. Pulverized limestone is used in the construction, chemical, cement, ceramics and agricultural industries. The main uses for limestone may be divided into construction, cement and lime production, chemical processing and agriculture.

In Canada, more than three quarters of the limestone production is used by the construction industry as road metal, concrete aggregate, rubble and riprap, railroad ballast, structural and ornamental stone, terrazzo, stucco, fillers in construction products, and in the production of cement and mason's and finishing lime. Except in the production of cement and lime, the physical properties of limestone are the most important for construction purposes. The cement industry consumes calcium and high-calcium limestone that contains minor amounts of magnesia. In lime production both calcium and dolomitic limestone are used as raw materials. However, only a small proportion of lime output is purchased by the construction industry.

In the chemical and metallurgical industries, high-calcium limestone is the most desired, although the dolomitic type is extensively used. Most high-calcium limestone goes into the production of lime for chemical purposes. It serves as a flux in smelting ferrous and nonferrous ores and in the preparation of calcium bisulphite liquor and lime for processing paper pulp. It is also a raw material in glass and other ceramic products and a filler in paint, linoleum, rubber, plastics, paper, gypsum, asbestos and asphalt products. Dolomitic limestone is used in smelting ferrous ores, in processing paper pulp and in the production of glass. It is a source of magnesium metal, which is produced by Dominion Magnesium Limited near Haley, Ontario. Steetley of Canada Limited dead-burns dolomitic limestone near Dundas, Ontario, for use as a refractory in open-hearth and electric furnaces. Brucitic limestone is quarried and processed into magnesia and lime

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by Aluminum Company of Canada, Limited, near Wakefield, Quebec. This magnesia is consumed for refractory, chemical and agricultural purposes. Brucitic limestone is also a raw material in the processing of paper pulp.

The agriculture industry requires large quantities of limestone to control soil acidity and as a source of calcium, magnesium and other elements. The rock is also used in manufactured fertilizers and in stock and poultry feed. It is pulverized or finely crushed for these applications. Marl is also used to control soil acidity.

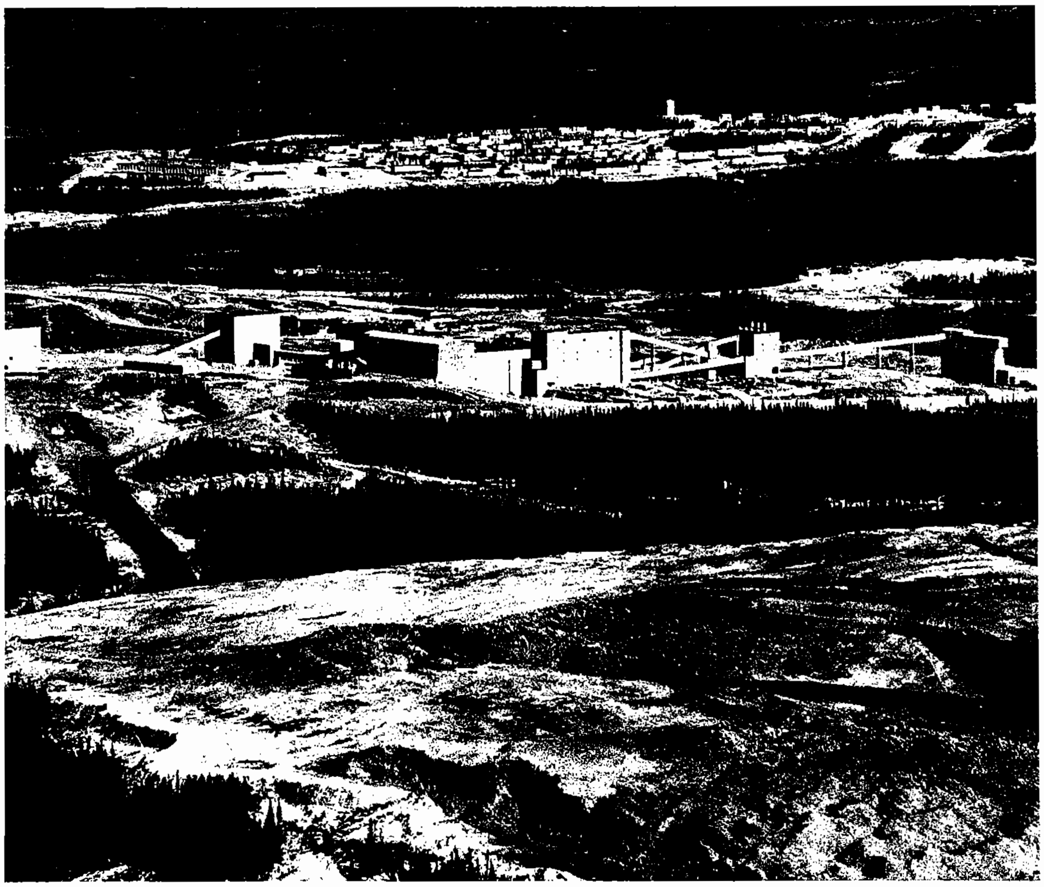
PRICES AND TARIFFS

Prices depend on many factors and vary according to location, local supply and demand, quantity of sale, type, quality and degree of preparation. Limestone screenings may be sold for as little as 50 cents a ton, whereas finished ornamental recrystallized limestone may be valued at more than $90 a ton. Most limestone in the crushed form sells for about $1.10 to $1.15 a ton at the plant. Dry-ground whiting substitute is marketed for about $12 a ton at the plant. Owing to transportation costs, the final price for such a low-priced commodity is usually much greater than plant price.

Tariffs on limestone entering Canada and the United States are as follows:

CANADA	British Preferential (%)	Most Favoured Nation (%)	General (%)
Limestone, not further processed than crushed or screened	free	free	25
All building stone, not hammered, sawn or chiselled other than marble or granite from New Zealand, which is free	10	10	20
UNITED STATES			
Limestone, crude, broken, or crushed, when imported for use in the manufacture of fertilizer	free		
Limestone and articles of limestone, crude, not suitable for use as monumental, paving or building stone	20¢ per short ton		
Limestone suitable for use as monumental, paving or building stone			
Not hewn, sawed, dressed polished or otherwise manufactured	2¢ per cubic foot		
Hewn, sawed, dressed, polished or otherwise manufactured	21% ad val		

In August 1963 the United States tariff on crude limestone, not suitable for use as monumental, paving or building stone, was reduced to its current rate of 20 cents a short ton. This reduction had some effect on Canada's exports of crushed and refuse limestone to the United States. In 1964 exports of this material increased 44 per cent over those for 1963.



Aerial view of the Wabush orebody, concentrator and townsite in background.

Iron Ore Co. of Canada, Labrador City. Labrador City townsite, concentrator in background.

Lithium Minerals

J.E. REEVES*

Quebec Lithium Corporation remains the only producer of a lithium mineral in Canada. It mines, concentrates and decrepitates spodumene north of Val d'Or, Quebec, and consumes the decrepitated spodumene in its own chemical plant adjacent to the mine, in the manufacture of lithium carbonate and lithium hydroxide monohydrate.

Sales of lithium chemicals by Quebec Lithium Corporation have increased steadily since it first produced lithium carbonate in late 1960. During 1964 it shipped lithium carbonate and lithium hydroxide monohydrate with a total lithia (Li_2O) content in excess of a million pounds, about 60 per cent more than in 1963. The lithium carbonate is mostly exported to the United States and Europe for use in porcelain enamel frits. The lithium hydroxide monohydrate is mostly consumed domestically in the manufacture of lubricants.

Canada imports some lithium chemicals. Partial statistics for 1963, the latest available, indicate imports of lithium hydroxide monohydrate, lithium bromide, lithium fluoride and lithium chloride but no longer any lithium carbonate.

OCCURRENCES IN CANADA

QUEBEC

The property controlled by Quebec Lithium Corporation in LacorneTownship, north of Val d'Or, contains an extensive group of parallel pegmatite dikes bearing a vast quantity of spodumene ore. Indicated reserves are more than 20 million tons in the area near the shaft, with an average of 1.15 per cent Li_2O.

*Mineral Processing Division, Mines Branch

Lithium-bearing pegmatites occur in other parts of Lacorne Township and in the neighbouring Figuery and Landrienne Townships. They are associated with the contact of a large granitic intrusive mass known as the Lacorne batholith. Spodumene is the main lithium mineral in this area although there are small amounts of lepidolite and lithiophilite.

In several places to the north and west of Chibougamau, pegmatites with abundant spodumene have been found.

MANITOBA

Numerous lithium-bearing pegmatites occur in the Winnipeg River-Cat Lake area, in the southeastern part of the province. The most significant occurrence is that of Chemalloy Minerals Limited, on the north shore of Bernic Lake. Its flap dip and unusual mineral assemblages make it notably different from most other Canadian deposits. Zones containing large quantities of spodumene, lepidolite (more properly, lithian muscovite), amblygonite and an unusual concentration of the cesium mineral, pollucite, make this deposit one of considerable interest.

Lithium-mineral reserves have been estimated at 9 million tons containing more than 2 per cent Li_2O.

OTHER 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.

WORLD PRODUCTION AND RESOURCES

The United States is the dominant producer and consumer of lithium minerals, chemicals and metal. Its principal domestic sources of raw material at present are the extensive spodumene-bearing pegmatites in North Carolina and the vast brine deposits of Searles Lake, California, from which byproduct dilithium sodium phosphate is obtained. Production of raw material in 1964 was apparently a little lower than in 1963.

Future recovery of lithium compounds is expected from brine deposits in Utah and Nevada. Utah's Great Salt Lake reportedly contains about 4 million tons of lithium chloride.

Southern Rhodesia is the principal source of lepidolite and petalite, a large part of which is exported to the United States for direct use in the ceramics industry. It also produces small quantities of spodumene, amblygonite and eucryptite. Southern Rhodesia has sizeable reserves of these minerals.

TECHNOLOGY

Lithium is a not uncommon element that occurs in many different minerals in the earth's crust. As primary commercial products these minerals occur in sufficient concentration only in a few granitic pegmatites. The recovery of lithium compounds from brines is only possible as a byproduct. Of the most common lithium minerals, listed in Table 1, the first five are of economic importance.

TABLE 1

Principal Lithium Minerals

Mineral	Simplified Formula	Theoretical Li_2O Percentage	Actual Range Li_2O Percentage
Spodumene.......	$LiAlSi_2O_6$	8.0	4 – 7.5
Petalite	$LiAlSi_4O_{10}$	4.9	3 – 4.5
Lepidolite	$KLi_2AlSi_4O_{10}(F,OH)_2$	7.7	3 – 5
Amblygonite	$LiAlFPO_4$	10.1	7.5 – 9
Eucryptite	$LiAlSiO_4$	11.9	5.5 – 6.5
Zinnwaldite......	$KLiFeAl_2Si_3O_{10}(F,OH)_2$	3.4	2 – 3
Lithiophilite-triphylite	$Li(Mn,Fe)PO_4$	9.6	2 – 6

In North America the chief method of concentrating spodumene is flotation. In Southern Rhodesia, where the various lithium minerals occur in a high degree of natural concentration, handpicking is used.

Most spodumene concentrate, part of the other mineral concentrates and all the byproduct dilithium sodium phosphate are converted to various lithium chemicals. In Canada, decrepitated spodumene is reacted with sodium carbonate under close environmental control as a first step in the production of lithium carbonate and lithium hydroxide monohydrate.

A small proportion of the spodumene and much of the petalite and lepidolite are consumed without further processing. Very little lithium metal is produced.

USES

The ceramics 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. 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.

Lithium chloride and lithium bromide are important in air conditioning and refrigeration. They are extremely hygroscopic and are used primarily for moisture absorption.

Lithium hydroxide monohydrate is added to the electrolyte in nickel-iron alkaline storage batteries to increase their life and output; lithium chloride and fluoride are added to welding and brazing fluxes to remove the oxide film from aluminum and magnesium surfaces; and lithium hypochlorite is used as a bleach.

A newly developing use for lithium compounds, probably lithium carbonate principally, is as an additive to the electrolyte in the Hall cell of aluminum smelters. The strong fluxing action of lithia would reduce power requirements.

Lithium metal is used as a scavenger of oxygen, nitrogen and sulphur in copper and in some brasses and bronzes, and as a reducing agent in the synthesis of 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, particularly in space craft.

PRICES

There was little change in the prices of lithium chemicals during 1964. According to *Oil, Paint and Drug Reporter* of December 28, 1964, prices of the principal lithium chemicals were:

Lithium carbonate...........	$0.58
Lithium hydroxide monohydrate	0.54
Lithium chloride	1.23½
Lithium fluoride	1.55
Lithium stearate	0.47½
Lithium hydride	9.50

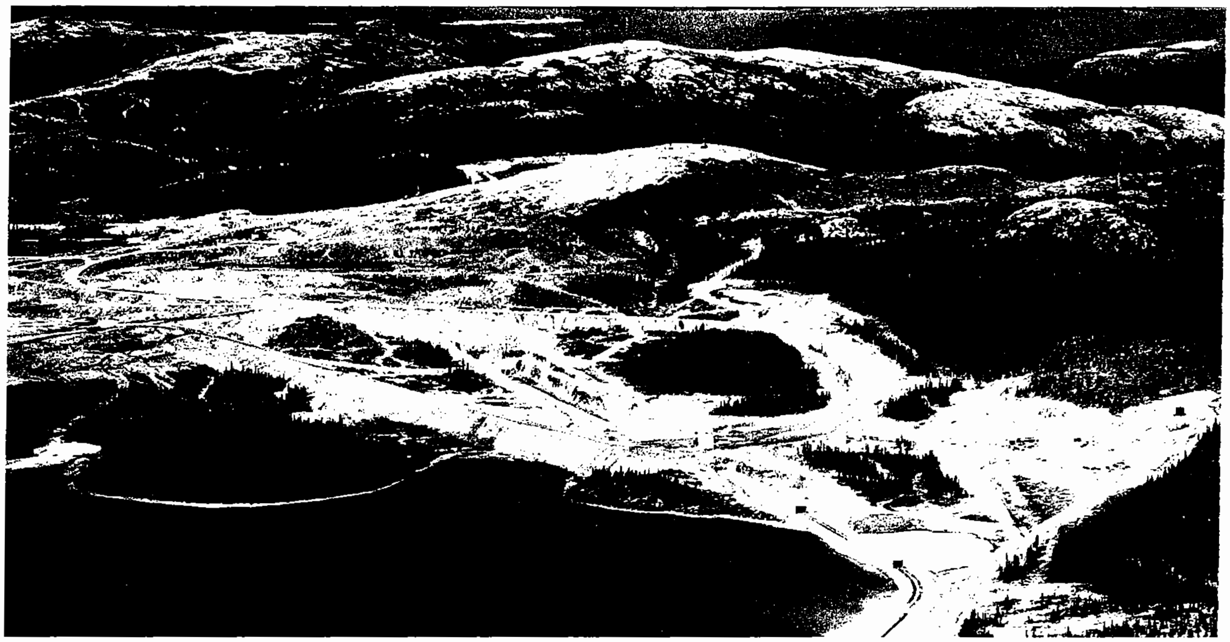
TARIFFS

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	10.5%
Lithium stearate	1.5¢ a pound plus 10% ad val
Lithium metal	25%



Iron Ore Co. of Canada, over-all aerial view of the Carol Lake orebodies.

Magnesite and Brucite

J. S. ROSS*

Canada's magnesia industry, based on magnesite and brucite, experienced several significant changes in 1964. Most of these took place in Ontario, although all Canada's commercial production of magnesite and brucite comes from Quebec. The first noteworthy output of magnesite from a deposit in Ontario was recovered as a concentrate from a pilot mill near Beaucage by Canadian Magnesite Mines Limited. During 1964 at least three paper-pulp producers, all in Ontario, started to use a considerable amount of magnesium hydroxide for pulp processing. In addition, two Ontario producers of magnesia products started plant expansions during the year.

In 1964 the production value of dead-burned and calcined magnesia in Quebec was $3,467,029 (preliminary), a slight increase over the previous record established in 1963. It represents the output of dead-burned magnesia from a dolomitic magnesite deposit and calcined magnesia from a deposit of brucitic limestone. In addition, several hundred tons of magnesite concentrates were produced in Ontario for testing purposes and have not been included in production statistics. Magnesium hydroxide is also produced.

World production of magnesia closely follows the demands of the metallurgical industry because most of it finds use in refractories. In 1963, world production of crude magnesite continued to increase appreciably and amounted to 9.1 million tons, according to U.S. Bureau of Mines, MINERALS YEARBOOK 1963. More than half was supplied by Russia, Austria and China in that descending order. Sea water and brine are also important sources of magnesia; however world output from these raw materials is unknown. About three quarters of the United States production of magnesia is derived from brine and sea water.

* Mineral Processing Division, Mines Branch

TABLE 1

Magnesite and Brucite – Production and Trade

	1963		1964	
	Short Tons	$	Short Tons	$
Production[1] (Quebec)				
Magnesia from dolomitic magnesite and brucite.........		3,439,890		3,467,029p
Exports				
Crude refractory materials[2]				
United States................	774,395	1,577,821	1,149,842	2,230,307
Australia	–	–	84	2,423
Bermuda....................	–	–	58	1,520
Britain	–	–	56	1,800
Other countries.............	–	–	32	4,274
Total..................	774,395	1,577,821	1,150,072	2,240,324
Imported by United States[3]				
Refractory magnesia including fused magnesia and dead-burned magnesia and dolomite....................	82	19,052	736	41,993
Magnesia, brick and other shapes	16,308	2,633,397	18,165	2,970,670
Imports				
Magnesia, dead-burned and sintered				
United States................	11,447	869,927	19,599	1,441,147
Yugoslavia..................	2,205	129,000	6,595	364,303
Greece	1,323	93,311	1,543	108,646
Republic of South Africa......	36	9,479	13	3,591
Others......................	1,337	105,615	5	376
Total..................	16,348	1,207,332	27,755	1,918,063
Magnesia, not elsewhere specified				
United States	2,192	186,758	2,921	300,272
Netherlands.................	60	3,725	94	6,474
India.......................	24	4,347	10	1,778
Britain	18	2,638	–	–
Total..................	2,294	197,468	3,025	308,524
Magnesium oxide				
United States................	..	..	3,531	574,291

Table 1 (cont.)

	1963		1964	
	Short Tons	$	Short Tons	$
Britain	..	..	95	44,064
Total	..	..	3,626	618,355
Dolomite, calcined				
United States	..	..	14,993	283,023
Magnesite firebrick and other shapes			Millions	
United States	..	99,434	201	376,802
Britain	..	88,833	319	255,200
West Germany	..	10,681	125	110,795
France	..	16,261	67	58,934
Austria	—	—	21	32,342
Total		215,209	733	834,073

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. Some magnesium hydroxide was 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.
Symbols: p Preliminary; — Nil; . . Not available.

TABLE 2

Magnesite and Brucite – Production* 1955-64

	$
1955	2,151,820
1956	2,783,181
1957	3,046,298
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	3,467,029p

* 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,

Magnesia and its products command prices that allow them to be traded widely. However, there are no separate Canadian export statistics for these products. Incomplete Canadian statistics indicate that in 1964 this country exported 1,150,072 tons of crude refractory materials valued at $2,240,324. This was mostly clay and only an insignificant amount of that was magnesia. United States trade statistics indicate that for the same year, Canada exported to that country 736 tons of refractory magnesia valued at $41,993 and 18,165 tons of magnesia brick and other shapes valued at $2,970,670. Exports of these materials were made to other countries as well.

Canada's imports of magnesia products are substantial in value. In 1964 those listed in Table 1 amounted to almost $4 million, about double the value for 1963. About half the value was for dead-burned magnesia and the remainder pertained to magnesite brick and other shapes and to calcined magnesia and dolomite. Magnesium chemicals were also imported, including noteworthy but unknown amounts of magnesium hydroxide for paper-pulp manufacture.

PRODUCERS

Canada's commercial production of magnesia comes from two plants in western Quebec. One ships dead-burned magnesia and the other markets calcined magnesia and magnesium hydroxide.

Canadian Refractories Limited produces dead-burned magnesia at Kilmar. A magnesite-dolomite rock is mined by underground methods and beneficiated in a heavy-media separation plant, and the concentrate is dead burned. The dead-burned product is crushed and sized and is used mostly in the manufacture of basic refractories at the company's Marelan plant which is nearby. Occasional small shipments are exported for refractory use mainly to the United States.

Other magnesite deposits occur in British Columbia, the Northwest Territories, Saskatchewan, Ontario, Quebec, Nova Scotia and Newfoundland. However, except for test shipments, no magnesite has been produced from these deposits. In 1964 Canadian Magnesite Mines Limited produced several hundred tons of magnesite concentrates for test purposes at a pilot mill at Beaucage, Ontario. The crude magnesite was quarried from the Company's deposit in Deloro and Adams townships south of Timmins, Ontario.

Calcined magnesia and magnesium hydroxide are produced by Aluminum Company of Canada, Limited. Brucitic limestone is used as the raw material. The quarried rock is crushed, sized and calcined and the product is hydrated and separated into magnesia and hydrated lime. After classification into various grades, the magnesia is sold for use in refractories, fertilizers and chemical processing and for minor industrial applications. Another product, magnesium hydroxide, is used in chemical processing.

Brucitic limestone also occurs near Rutherglen, Ontario, but it has been quarried for use as an aggregate in construction and as a source of crude magnesia rather than for the production of the compound magnesia. Deposits of brucite occur in other areas of Quebec and Ontario, as well as in British Columbia and Nova Scotia.

High-magnesia refractories are produced at four plants in Canada. Canadian Refractories Limited at Marelan, Quebec, and General Refractories Company of Canada Limited at Smithville, Ontario, produce basic refractory mixes, bricks and other shapes. Refractories Engineering and Supplies Limited prepares basic refractory mixes at Bronte, Ontario. Norton Company manufactures fused magnesia at Chippawa, Ontario. All but the first of these plants are normally wholly dependent upon imported magnesia.

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.

DEVELOPMENTS

The first significant output of magnesite in Ontario came in 1964, from a deposit controlled by Canadian Magnesite Mines Limited. The magnesite was shipped from Deloro Township south of Timmins, to a pilot mill at Beaucage where the company carried out milling and metallurgical tests in anticipation of commercial production. Considerable processing and testing were undertaken on this magnesite also at other laboratories and plants.

General Refractories Company began a $400,000 expansion of its basic refractories plant at Smithville, Ontario. The plant's capacity will be doubled by the addition of another kiln and accessory equipment.

Refractories Engineering started a $250,000 expansion of its Bronte, Ontario, plant. This addition will increase the production capacity of ceramic mixes.

In Canada, the first commercial use of magnesium hydroxide in the Magnefite pulping process took place in 1964. This process is employed in the manufacture of paper pulp and is based on magnesium bisulphite pulping. It has the advantage of reducing pollution caused by plant effluent and of allowing for the recovery of magnesia and sulphur. In 1964 the Fort William, Ontario, plant of Great Lakes Paper Company Limited and the Kenora, Ontario, mill of Minnesota and Ontario Paper Company were converted to the Magnefite process. That same year, Spruce Falls Power and Paper Company Limited started operating its new plant near Kapuskasing, Ontario, using that process. The Kapuskasing plant has a magnesia recovery unit whereas the other two have none.

TECHNOLOGY

The minerals magnesite and brucite theoretically contain 47.6 and 69.0 per cent magnesia, respectively. They may be converted to magnesia by calcination. Dolomite, sea water, sea-water bitterns and other brines may also be processed into magnesia. Since 1954 there has been an appreciable increase in the recovery of this commodity from brines and sea water in the United States. 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. The former is chemically active and a product of mild calcination. The latter forms during intense calcination and is chemically inactive. Periclase is dead-burned magnesia containing minor amounts of iron and a minimum of 92 per cent magnesia. Other magnesium compounds such as the hydroxide, carbonate and chloride are also marketed.

As with most industrial minerals, the specifications are becoming more stringent. Consumers are requesting higher magnesia and lower calcium and silica contents mainly because of the increased efficiencies required.

CONSUMPTION AND USES

The first consumption survey for magnesia in Canada has been completed for 1964 and the results will be available during the latter part of 1965. Pending the results of that survey, it is estimated that about 80,000 tons of the dead-burned and calcined types were consumed in Canada in 1964 and an additional 10,000 tons of dead-burned magnesia went into products that were exported. Of the total of 90,000 tons, about 82,000 tons went into refractories. This total is up from the comparable amount for 1963, particularly because of additional demands by the steel industry, and resulted in a 70-per-cent increase in imports of dead-burned magnesite which accounted for more than one quarter of the total consumption in 1964. Other magnesian compounds were also consumed. For instance, the three previously mentioned pulp companies started the first significant consumption in Canada of magnesium hydroxide. The amount required for this purpose depends on the proportion of plants having recovery units. It is estimated that at least 10,000 tons of magnesia in the form of magnesium hydroxide went for this use in 1964. The prospects are for increased consumption in 1965, all in Ontario.

Dead-burned magnesia, the most commonly used type, 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. Its use will increase with the rising demand for magnesium hydroxide as an ingredient in dissolving liquor for paper-pulp manufacture. Occasionally, calcined magnesia is used as a raw material 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 usually 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.

In the near future, domestic consumption of dead-burned magnesite for refractories and of magnesium hydroxide for paper-pulp processing will increase greatly.

PRICES AND TARIFFS

Prices vary with product quality and product demand. The December 28, 1964, issue of OIL, PAINT AND DRUG REPORTER quotes the following United States prices per short ton. These are unchanged from a year ago.

Magnesia, dead-burned, standard grade, bulk, car lots, Chewela, Washington	$46.00
Magnesia, calcined, technical, heavy, bags, car lots, f.o.b. Lunning, Nevada	
90%	49.50
93%	52.50
95%	57.50
Magnesia, calcined, chemical grade, powdered, bags, car lots, works	86.25

Canadian tariffs on magnesium compounds are numerous and require close study for proper interpretation. Some of these are listed below and, as with many tariffs, the correct interpretation involves knowledge of all tariff legislation concerning each compound.

	British Preferential (%)	Most Favoured Nation (%)	General (%)
CANADA			
Magnesite, crude rock	free	free	free
Magnesia, dead-burned or sintered; magnesia, caustic calcined; plastic magnesia			
Derived from the mineral magnesite	15	15	30
Derived from the mineral brucite	15	20	25
Derived from sea water or brine	free	15	25

	British Preferential (%)	Most Favoured Nation (%)	General (%)
Magnesia, dead-burned, containing not less than 83% MgO for use in the manufacture of magnesia firebrick or chrome firebrick.....	7½	7½	30
Magnesium oxide and magnesium carbonate, not further manufactured than ground, when imported by manufacturers of insulating materials for use exclusively in the manufacture of such insulating materials in their own factories ..	free	free	free
Dead-burned dolomite.............	15	15	25

UNITED STATES

Magnesite

Crude, per long ton	$ 5.25
Caustic calcined, per long ton	$10.50

Refractory magnesia, including dead-burned magnesia, fused magnesia and dead-burned dolomite

Not containing lime or containing by weight not over 4% lime	0.38¢ per lb
Containing by weight over 4% lime	12% ad valorem

Refractory and heat-insulating bricks of all sizes and shapes

Chrome bricks	25% ad valorem
Magnesia bricks	0.38¢ per lb plus 5% ad valorem

Magnesium

W.H. JACKSON*

Shipments of magnesium set a record in 1964 and still higher shipments are expected in 1965. Value of exports increased slightly to $3.95 million of which $3.2 million represented shipments to the main markets of western Europe. In that area the relative positions of Britain and West Germany, the top purchasers, changed in 1964 (Table 1). Britain imported 4,027 tons of magnesium in 1963 of which 3,408 tons were from Canada, and 3,148 tons in 1964 of which 2,294 tons were from Canada. A new market is developing in Australia where a new automobile plant will use magnesium castings.

Magnesium ingot consumed in Canada from domestic production and imports was 3,762 tons in 1964 of which 2,494 tons were used for alloying with aluminum. In addition, 354 tons of semifabricated products, mainly sheet, were imported for further processing. Canada imported from the United States in 1964, magnesium worth $966,735 (U.S.) as metal or scrap and magnesium semifabricated products valued at $596,644. From U.S. export data, the value of such metal originating in the United States was 30.3 cents (Can.) a pound; from Canadian import data the value was 39.6 cents a pound the difference reflecting transportation and duty. Canadian exports to the United States were valued at $255,338.

CANADIAN DEVELOPMENTS

Dominion Magnesium Limited, with mine and smelter at Haley, Ontario, is the only magnesium producer in Canada. Operations are based on the reduction of dolomite by ferrosilicon. The ore is a band of Precambrian dolomite lying between a quartzite hangingwall and a paragneiss footwall. Reserves are in the order of 4 million tons to 100-foot depth. Mining is by open pit with benches

* Mineral Resources Division

20 feet high. Mill capacity is 300 tons daily. Following crushing and calcining, the ore is mixed with ferrosilicon and fluorspar, briquetted, bagged and charged into horizontal retorts. The ore has exceptional physical characteristics

TABLE 1

Magnesium–Production, Trade and Consumption

	1963		1964p	
	Short Tons	$	Short Tons	$
Production[1], metal	8,905	5,357,816	9,022	5,592,989
Imports[2]				
Magnesium metal[3]				
United States	..	..	1,596	1,264,000
Magnesium alloys				
United States	..	181,738	184	452,000
Britain	–	–	1	9,000
Total	..	181,738	185	461,000
Exports, metal[4]				
West Germany		493,710		1,374,416
Britain		2,118,500		1,332,564
France		258,852		398,642
United States		243,991		255,338
Belgium and Luxembourg		189,608		129,550
Mexico		93,304		126,496
Australia		43,059		77,795
Israel		10,103		39,343
Republic of South Africa		–		35,103
Rumania		–		26,560
India		10,627		25,881
Other countries		214,971		129,698
Total		3,676,725		3,951,386
Consumption, metal				
Castings	314		389	
Extrusions (structural shapes, tubing)	355		347	
Aluminum alloys	2,569		2,494	
All other products[5]	403		532	
Total	3,641		3,762	

Source: Dominion Bureau of Statistics.
[1]Shipments of metal in all forms, ingots, crowns, powder, and in alloys. [2]New import classification effective 1964. Statistics for 1964 not completely comparable with previous years. [3]New class, not available prior to 1964. [4]Quantities not available from 1963. [5]Including other alloys and magnesium used for cathodic protection and as a reducing agent.
Symbols: p Preliminary; – Nil; .. Not available.

TABLE 2

Magnesium—Summary of Production, Trade and Consumption, 1955-64

	Production (short tons)	Imports			Exports	Consumption (short tons)
		Alloys ($)	Alloys (s.t.)	Metal (s.t.)	($)	
1955	..	186,034	..	..	4,887,980	833
1956	9,606	366,837	..	..	5,153,509	1,003
1957	8,385	276,742	..	..	4,535,570	840
1958	6,796	255,768	..	..	2,871,991	711
1959	6,102	273,021	..	..	3,879,588	1,668
1960	7,289	336,548	..	..	3,232,805	2,199
1961	7,635	426,566	..	..	3,608,523	2,776
1962	8,816	178,757	..	..	3,967,932	3,614
1963	8,905	181,738	..	..	3,676,725	3,641
1964p	9,022	461,000*	185	1,596	3,951,386	3,762

Source: Dominion Bureau of Statistics.
*Not completely comparable with previous years.
Symbols: p Preliminary; .. Not available.

TABLE 3

Magnesium Imports from the United States into Canada*

	1963		1964p	
	Short Tons	$ (U.S.)	Short Tons	$ (U.S.)
Magnesium metal and alloys in crude form and scrap	597	311,131	1,726	966,735
Magnesium semifabricated forms	207	603,189	354	596,644
Total	804	914,320	2,080	1,563,379

*As reported in UNITED STATES EXPORTS REPORT 410.
p Preliminary.

and purity permitting efficient use of smelter capacity. At high temperature under vacuum, magnesium is reduced, distilled and collected as crystalline rings called crowns in the water-cooled head sections of the retorts. For the commercial grade of magnesium, these are remelted and cast into ingot forms. Alloying with aluminum to produce intermetallic compounds, followed by redistillation, is the basis of the special grade.

Annual smelter capacity was increased from 8,000 to 10,000 tons in 1962. The plant has 14 furnace units, one of which was shut down from March to August in 1964. A further expansion to 11,000 tons a year by the addition of two furnaces will be completed in the third quarter of 1965 at a cost of $390,000.

Production of magnesium crowns, according to the company's annual report, was 10,169 tons in 1964 and shipments were 10,290 tons. Comparable data for 1963 were respectively 10,000 and 9,565 tons.

The following grades and purities of magnesium are available: Commercial, 99.90 per cent; High Purity, 99.95 per cent; Special, 99.97 per cent; and Refined, 99.99 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 granules in minus 4-plus 50-mesh size. The other magnesium products are master alloys, rods, bars, wire, structural shapes and magnesium alloys to all specifications.

Other metals are produced at Haley by similar reduction methods. Calcium and thorium are discussed in other reviews in this series. Thorium metal capacity is 200,000 pounds annually as sintered pellets of 98-per-cent purity or as powder of 99.5-per-cent purity. In 1964, shipments were 6,455 pounds. Calcium shipments were 138,358 pounds. Barium and strontium of 99.0-per-cent purity are available as extruded sticks. Sintered pellet shipments were 15,087 pounds of titanium and 6,048 pounds of zirconium. The latter is used in the production of magnesium alloys.

WORLD DEVELOPMENTS

Preliminary estimates place world magnesium production at 164,000 tons (Table 4) in relation to an estimated capacity of 214,000 tons.

TABLE 4

World Production of Magnesium
(short tons)

	1963	1964e
United States	75,845	79,000
U.S.S.R.	35,000e	36,000
Norway	18,700	25,000
Canada	8,905	9,022
Italy	6,300e	6,300
Britain*	4,200e	4,200
Japan*	2,500e	2,800
France	1,970	1,200
China	1,000e	1,000
West Germany	550e	550
Total	154,970	164,172

Source: 1963 data, U.S. Bureau of Mines; for Canada, Dominion Bureau of Statistics.
*Includes remelt.
e Estimate.

The economic aspects of developing magnesium ore sources are parallel to those of industrial minerals. Markets, technology, cost and transportation are the key factors. The raw material base (sea water or brine) to recover magnesium by electrolysis of magnesium chloride, is readily available. For ferrosilicon processes good-grade dolomite, low-cost ferrosilicon and low-cost transportation are necessary and in combination are not as common as might be expected. Competition for markets among existing producers, the need for more diversified uses and metal processing technology are factors that tend to deter more companies from producing magnesium. Table 5 lists the main world producers of magnesium.

TABLE 5

Principal Producers of Primary Magnesium, 1964

	Raw Material	Process	Estimated Capacity (short tons)	Planned Expansion
Canada				
Dominion Magnesium Limited	Dolomite	Pidgeon ferro-silicon	10,000	1,000
France				
Société Magnetherm..........	Dolomite	Magnetherm ferro-silicon	1,000	–
Société des Produits Azotes...................	Dolomite	Magnetherm ferro-silicon		3,200
Germany (West)				
Knapsack Griesheim A.G.	..	..	500	–
Vereinigte Aluminum Werke A.G.	..	..		
India				
National Metallurgical Laboratory	Dolomite	..	–	250
Italy				
Societe Italiana per il Magnesio e Leghe di Magnesio, S.P.A.	Dolomite	Ferrosilicon	7,000	–
Japan				
Furukawa Magnesium Company	Dolomite	Ferrosilicon	3,000	–
Norway				
Norsk Hydro-Elektrisk	Dolomite, sea water	Electrolytic	27,000	–
United States				
Alamet Division of Calumet and Hecla	Dolomite	Pidgeon ferro-silicon	7,000	–

Table 5 (concl.)

	Raw Material	Process	Estimated Capacity (short tons)	Planned Expansion
Dow Chemical Company Limited	Sea water	Electrolytic	100,000	–
Nelco Division of Charles Pfizer and Company	Dolomite	Pidgeon ferro-silicon	5,000	–
Titanium Metals Corporation ..	Recycled $MgCL_2$	Electrolytic	12,000	–
United Kingdom				
Magnesium Elektron Limited ..	Dolomite	Pidgeon ferro-silicon	5,000	–
China (mainland)............	..	..	1,100	–
Soviet Union	Dolomite, carnallite	Electrolytic	35,000	–

Symbols: – Nil; .. Not available.

In the United States, National Lead Company announced plans to build a 30,000-ton electrolytic plant that will be based on brines from the Great Salt Lake in Utah. These brines contain potash as well as magnesium. In France, a magnesium smelter of 3,200-ton capacity is under construction at Marignac after successful pilot plant tests at the pilot plant of Société Magnesium Thermique. It will use a semicontinuous process wherein dolomite is reduced by ferrosilicon under vacuum in an electric furnace with slag being the resistor. The Ugine organization closed its Jarrie plant based on magnesite in 1963.

Magnesium supply in the United States in 1964 totalled 95,000 tons, equivalent to about half of world production. Production was 79,000 tons, an increase of 4 per cent. Consumption rose 8 per cent to 55,300 tons and primary stocks increased from 11,000 tons at the end of 1963 to 16,000 tons at the end of 1964.

USES

Canadian ingot consumption, 3,762 tons in 1964, was composed of castings, 389 tons; extrusions, 347 tons; and in aluminum alloys, 2,494 tons. The remaining 532 tons was used mainly in cathodic protection. Applications such as luggage frames and lawn mower housings are of increasing importance. The largest use of magnesium in Canada and the United States is in destructive applications as an alloying agent in the production of aluminum alloys whereas the largest use in West Germany is in automobile components. In Canada all sheet requirements are imported and are not included in consumption data.

PRICES

In 1964 the Canadian price of magnesium f.o.b. Haley remained unchanged at 31 cents a pound. According to E & M J METAL AND MINERAL MARKETS, December 28, 1964, prices in the United States were as follows:

Per lb, f.o.b. shipping point, 10,000-lb lots

Pig ingot, 99.8%	35.25 – 36.65¢
Notched ingot	36 – 37.45

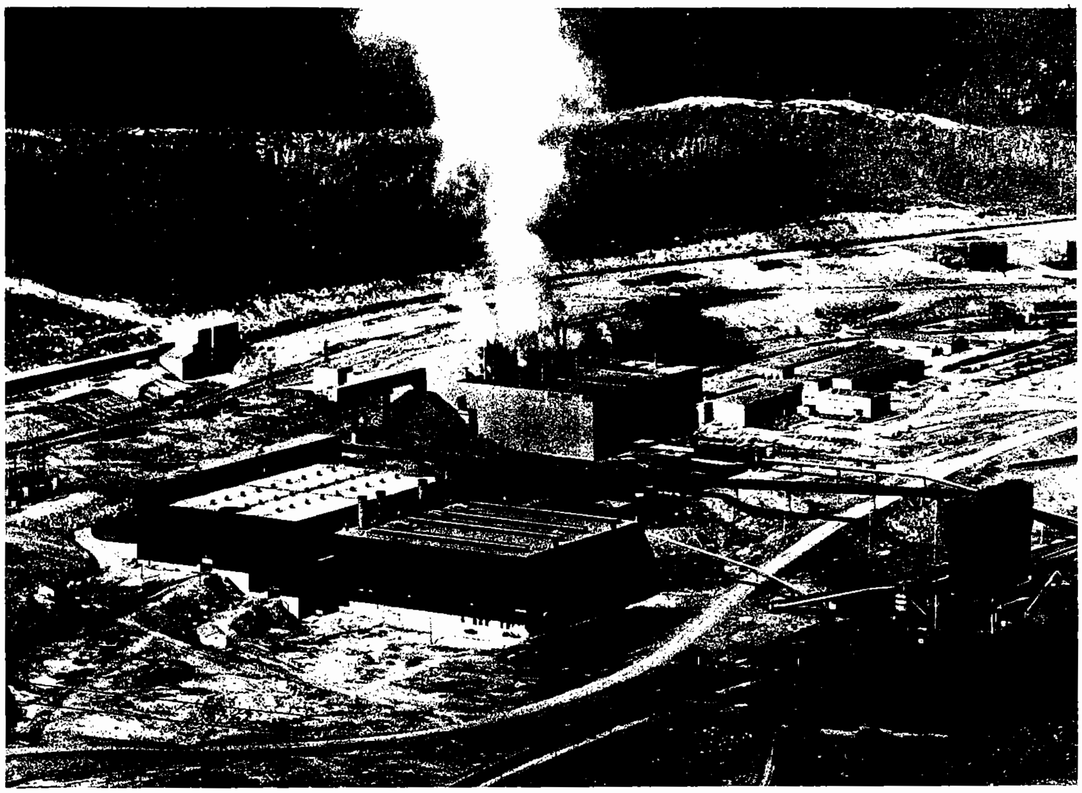
TARIFFS

	British Preferential (%)	Most Favoured Nation (%)	General (%)
CANADA			
Magnesium in lumps, powder, blocks, ingots (if ruled as a class or kind made in Canada)	free	15	20
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
Magnesium wire	10	20	35

UNITED STATES

Magnesium, unwrought	
Other than alloys; and magnesium waste and scrap (duty on waste and scrap suspended to June 30, 1965)	40% ad val
Alloys	16¢ per lb on magnesium content + 8% ad val
Magnesium, wrought	13.5¢ per lb on magnesium content + 7% ad val

98115—24½



Iron Ore Co. of Canada, Labrador City. Concentrator and pelletizing plant at Carol operation in Labrador.

Manganese

V.B. SCHNEIDER*

In 1964, Canadian imports of manganese ore increased for the fifth consecutive year; they amounted to 63,008 tons of contained Mn valued at approximately $4 million. A direct quantity comparison with previous years is not possible because in 1964 the Dominion Bureau of Statistics reported for the first time the manganese content in ores and concentrates rather than the gross weight as in previous years. Imports of manganese addition agents were nearly 24,000 tons, down slightly from those of 1963, which were an all-time high. Exports of ferromanganese, all to the United States, amounted to 3,359 tons valued at $428,196, higher than any year since 1957, the last year in which exports of ferromanganese were significant.

The Canadian iron and steel industry expanded production by approximately 11 per cent during 1964 and this resulted in a similar increase in the demand for ferromanganese, with domestic consumption increasing from 59,000 tons in 1963 to 66,000 tons in 1964. Canadian ferroalloy producers managed to increase their share of the Canadian market for ferromanganese in competition with foreign suppliers and domestic production of ferromanganese increased in 1964. The principal manganese alloys produced in Canada are high-carbon silicomanganese, medium-carbon ferromanganese and low-carbon ferromanganese. The most serious competition in manganese alloys was from the Republic of South Africa.

Reports in various trade publications indicate that the rather substantial producers' stockpiles of manganese ores and concentrates, which have been depressing the ore market, have been much depleted; and although no shortage exists, the prospects in 1965 for manganese ore producers are good. Since posted prices are nominal, with grade and impurities affecting bonuses and penalties, it is difficult to forecast prices, but it is generally believed that consumers without long-term contracts are going to pay more for their ore requirements throughout 1965 and 1966.

*Mineral Resources Division

TABLE 1

Manganese – Trade and Consumption

	1963		1964p	
	Short Tons	$	Short Tons	$
Imports				
Manganese in ores and concentrates				
Ghana	45,439	1,480,564	16,883	959,000
Brazil	20,634	583,551	14,412	797,000
United States	16,535	1,107,971	8,687	1,011,000
Angola	–	–	6,935	330,000
Congo	23,972	586,487	6,908	308,000
India	–	–	6,616	386,000
Uruguay	–	–	2,451	139,000
Japan	189	51,169	76	30,000
Mexico	82	7,073	19	3,000
Britain	29	3,575	14	2,000
France	11	1,582	7	1,000
Total	106,891[1]	3,821,972	63,008[2]	3,966,000
Ferromanganese including spiegeleisen				
Republic of South Africa	18,686	2,393,446	19,606	2,361,000
Japan	2,618	679,982	1,291	346,000
United States	575	99,680	798	170,000
France	721	204,137	79	27,000
Italy	–	–	51	14,000
Belgium and Luxembourg	–	–	5	2,000
Britain	39	18,767	–	–
Total	22,639	3,396,012	21,830	2,920,000
Silicomanganese including silico spiegeleisen				
United States	1,563	204.524	867	128,000
Norway	244	41,780	827	98,000
Japan	408	49,606	50	6,000
Mexico	60	11,916	–	–
U.S.S.R.	55	7,018	–	–
Yugoslavia	25	3.723	–	–
Total	2,355	318,567	1,744	232,000
Exports				
Ferromanganese				
United States	–	–	3,359	428,196
Colombia	9	1,768	–	–
Dominican Republic	1	55	–	–
Total	10	1,823	3,359	428,196
Consumption				
Manganese ore				
Metallurgical grade	90,364		136,867	
Battery and chemical grade	1,904		1,951	
Total	92,268		138,818	

Source: Dominion Bureau of Statistics.

[1] Gross weight; [2] Mn content.

Symbols: p Preliminary; – Nil.

For some time, United States ferromanganese producers have been protesting the import duty on manganese ore and, to help United States ferromanganese producers, President Johnson signed a bill in June 1964 that suspended for three years the import duty on manganese ores from all countries other than the Sino-Soviet bloc. The duty, which amounted to ¼¢ a pound on Mn content of ore, had been of little help to the country's domestic ore producers but had added an extra burden on U.S. ore consumers who, in any year, import more than 99 per cent of total U.S. requirements.

No manganese ore is now mined in Canada. Small amounts of manganese ore have been mined from occurrences in New Brunswick, Nova Scotia and British Columbia from low-grade bog deposits. Large low-grade deposits occur in New Brunswick and Newfoundland.

There are some 125 manganese minerals but only a few are of economic importance. Most manganese is obtained from two minerals – pyrolusite (MnO_2) and psilomelane, an impure hydrated oxide ($MnO_2.H_2O$, K and Ba variable). These may be accompanied by other oxides such as wad or 'bog manganese', braunite and manganite. The carbonate rhodochrosite ($MnCO_3$) and the silicate rhodonite ($MnSiO_3$), except where they have been oxidized, are usually not of commercial importance.

PRODUCTION AND TRADE

The United States Bureau of Mines in its COMMODITY DATA SUMMARIES, January 1965, estimated that world mine production in 1964 was 16 million tons, about the same as in 1963. Russia is by far the largest producer with about 50 per cent of the world's output. The Republic of South Africa, Brazil and India follow in that order with each producing slightly more than 1.3 million tons a year.

World reserves, other than in Russia, are reported by Elyutin et al.* to be about 1,700 million tons; they further state that "The manganese ore reserves of the deposits explored in the U.S.S.R. by far exceed all the other countries together. The largest deposit of manganese ore of world-wide importance is the Chiatura deposit (Georgia SSR)." Most of the remaining known manganese deposits are in India, the Republic of South Africa, Gabon, Ghana, Brazil and British Guiana. The reserves of India and Gabon have been estimated to exceed 100 million tons each; those of Brazil, 150 million; and of the Republic of South Africa, more than 50 million tons.

The United States is the leading importer and consumer of manganese ore. According to the U.S. Bureau of Mines Mineral Industry Series – MANGANESE

*Elyutin, V.P. et al. PRODUCTION OF FERROALLOYS ELECTROMETALLURGY. The State Scientific and Technical Publishing House for Literature on Ferrous and Non-Ferrous Metallurgy, Moscow 1957, translated from Russian and published for the National Science Foundation, Washington, D.C.

MONTHLY, April 12, 1965 – U.S. imports of manganese ore in 1964 amounted to 2,064,986 tons; imports of ferromanganese, in terms of ore, amounted to an additional 431,874 tons. The U.S. consumption of manganese ore was 2.2 million tons. Imports were received from some 33 countries with Brazil being the largest source, followed by India, Congo (Leopoldville), Ghana and Gabon. Again, according to the Bureau, consumption of ferromanganese and other manganese additives was some 1.2 million tons (gross weight) the highest since 1957, an increase of 148,000 tons (gross weight) from 1963. Imports of ferromanganese into the United States amounted to 215,937 tons (gross weight) with a manganese content of 164,465 tons and valued at $26.4 million. This is an 11–per–cent increase from 1963 and reflected the continuing competition in the United States from foreign-produced alloys. India, France, Belgium-Luxembourg and West Germany were the principal suppliers of ferromanganese.

The Department of Mines of the Republic of South Africa reports in its Quarterly Information Circular – MINERALS, October to December, 1964 – that production of manganese ore there in 1964 amounted to 1.5 million tons, an increase of 13,768 tons from 1963. Local sales in the Republic amounted to some 505,000 tons and exports were 1,056,098 tons, both higher than in 1963.

USES AND SPECIFICATIONS

Most of the world's output of manganese ore is used by the steel industry. In the United States, 93 per cent of the manganese ore consumed in 1963 was used by the steel industry; the chemical industry used 5 per cent and the dry-cell battery industry accounted for the remainder.

The importance of manganese is due principally to its scavenging action in steelmaking furnaces since it is the cheapest material known for desulphurization and dephosphorization of the steel bath. In the proportion of one to two per cent it increases strength and toughness of steel; in proportions of 12 to 14 per cent it greatly increases toughness and resistance to wear and abrasion. About 14 pounds of manganese is used for every net ton of ingot steel produced.

Electrolytic manganese, made in an electrolytic cell where the manganese is deposited on an electrode and stripped off as thin plates, is used in place of low-carbon ferromanganese to reduce the carbon content of stainless steels and thus eliminate the need for a carbon stabilizer. It serves the aluminum industry in the production of high-purity aluminum 'hardener' alloys; also, it is added either as metal or as a 30–70 manganese-copper master alloy in the production of manganese bronzes. Improvements in technology in recent years now enable ferroalloy manufacturers to produce a low-carbon ferromanganese with 0.07 per cent carbon, maximum, and 85–90 per cent manganese at a price competitive with electrolytic manganese for many applications, particularly in the manufacture of the '200 series' of stainless steels.

TABLE 2

Manganese – Trade and Consumption, 1955–64

(short tons of 2,000 pounds)

	Imports			Exports	Consumption	
	Manganese Ore	Addition Agents		Ferro-Manganese	Ore	Ferro-Manganese
		Under 1% Silicon	Over 1% Silicon			
1955	175,282	3,945	272	29,404	113,075	32,358
1956	207,977	2,191	1,130	59,445	219,141	37,420
1957	131,318	743	2,257	46,733	195,088	37,906
1958	42,060	2,483	2,185	225	46,143	31,242
1959	118,454	2,334	2,989	193	90,311	40,976
1960	56,350	15,495	2,366	729	73,019	40,177
1961	76,016	12,121	2,173	238	78,642	44,545
1962	90,725	14,986	2,726	136	85,410	52,284
1963	106,891	22,639	2,355	10	92,270	58,555
1964p	63,008	21,830	1,744	3,359	138,818	66,202

Source: Dominion Bureau of Statistics.
p Preliminary.

TABLE 3

World Production of Manganese Ore, 1963–64

(short tons)

	1963	1964e
U.S.S.R.	7,385,000e	8,000,000
Republic of South Africa	1,441,503	1,455,271
Brazil	1,320,000e	1,300,000
India	1,184,983	1,300,000
China	1,100,000e	1,200,000
Republic of Gabon	701,716	1,000,000
Ghana	434,410	..
Morocco	369,283	..
Republic of the Congo	348,547	..
Japan	305,506	..
Other countries	1,499,052	..
Total	16,090,000	16,000,000

Source: U.S. Bureau of Mines MINERALS YEARBOOK, 1963; U.S. Bureau of Mines COMMODITY DATA SUMMARIES, January 1965; Republic of South Africa, Department of Mines; QUARTERLY INFORMATION CIRCULAR, October-December, 1964.
Symbols: e Estimated; .. Not available.

METALLURGICAL-GRADE MANGANESE ORE

Most of the manganese consumed by the steel industry is in the form of high-carbon ferromanganese. The remainder is in the form of low- and medium-carbon ferromanganese and of silicomanganese, spiegeleisen, manganese metal and ore in that order.

98115—25

For making ferromanganese, the manganese-iron ratio should be 7:1 or more because the production capacity for the ferro-plant is handicapped as this ratio drops. High silica is undesirable because it increased the quantity of slag, which is attended by a manganese loss. In preparing their furnace charges, ferromanganese producers prefer to blend commercial ores to their own specifications. Since no single ore is generally considered ideal, consumers usually purchase ore from more than one source.

General specifications for metallurgical-grade manganese ore are a minimum of 48 per cent manganese and maxima of 7 per cent iron, 8 per cent silica, 0.15 per cent phosphorus, 6 per cent alumina and 1 per cent zinc. The ore should be in hard lumps of less than four inches and not more than 12 per cent should pass a 20–mesh screen.

BATTERY-GRADE MANGANESE ORE

Manganese ore for dry-cell use must be pyrolusite (MnO_2) of not less than 75 per cent MnO_2 and not more than 1.5 per cent iron; it should be very low in arsenic, copper, zinc, nickel and cobalt. The physical properties of the oxide are also important. It should be porous and moderately hard. Ghana and the Republic of South Africa are important sources of battery-grade manganese ore. However, there has recently developed a tendency for battery manufacturers to use synthetically-produced manganese dioxide, which is made electrolytically.

CHEMICAL-GRADE MANGANESE ORE

Chemical-grade manganese ore should contain at least 35 per cent manganese. It is used to make manganese sulphate and manganese fertilizer, and in the production of other salts for use in the glass, dye, paint, varnish and photographic industries.

CANADIAN CONSUMERS

Union Carbide Canada Limited, Metals and Carbon Division, uses metallurgical-grade ore to manufacture silicomanganese and high- and low-carbon ferromanganese at its Welland, Ontario, plant. Chromium Mining & Smelting Corporation, Limited produces manganese alloys at its Beauharnois, Quebec, plant.

The main consumers of ferromanganese are The Algoma Steel Corporation, Limited, Sault Ste. Marie, Ontario; Dominion Steel and Coal Corporation, Limited, Sydney, Nova Scotia; The Steel Company of Canada, Limited, and Dominion Foundries and Steel, Limited, both at Hamilton, Ontario; and Atlas Steels Company, a division of Rio Algom Mines Limited, with plants at Welland, Ontario, and Tracy, Quebec.

Electrolytic manganese imported from the United States is used by Atlas Steels Company in making low-carbon stainless steel. It is also used by the aluminum-, magnesium- and copper-alloy industries.

Consumers of battery-grade ore are National Carbon Limited and Mallory Battery Company of Canada Limited, both of Toronto; Burgess Battery Company Limited, Niagara Falls; and Ray-O-Vac (Canada) Limited, Winnipeg.

PRICES

Prices of manganese in the United States according to E & M J METAL AND MINERAL MARKETS of December 28, 1964, were as follows:

MANGANESE ORE

per long-ton unit, c.i.f. United States ports, import duty extra	
Minimum 48% Mn (low impurities)	78 – 80¢
" 46% Mn	72 – 77¢
Prices vary depending on impurities	

MANGANESE METAL

per lb 99.9%, carloads, electrolytic f.o.b. shipping point, freight allowed east of Mississippi	31¼¢ – 33¾¢
ton lots	33¾¢ – 36¼¢
premium for hydrogen removed	¾¢

FERROMANGANESE

carload lots, lumps bulk, f.o.b. shipping point	
Standard, per lb, 74–76% Min	8¼¢ (nominal)
Imported, delivered, Pittsburgh, per long ton	$158 (nominal)
Medium carbon, lb Mn content, 80–85% Mn, 1¼–1½% C	18¢ (nominal)
Low carbon, lb Mn content, 85–90% Mn, max. 0.1% C	27¢

SILICOMANGANESE

per lb, carload lots, lump, bulk, f.o.b. shipping point	
18½ to 21% Si, max. 1½% C	8.3¢
16 to 18% Si, max. 2% C	8¢
12½ to 16% Si, max. 3% C	7.8¢

SPIEGELEISEN

per gross ton, carload lots, lump, bulk, f.o.b. Pelmerton, Pa.	
16–19% Mn, max. 3% Si	$85
19–21% Mn, max. 3% Si	87
21–23% Mn, max. 3% Si	89.50

98115—25½

TARIFFS

	British Preferential	Most Favoured Nation	General
CANADA			
Manganese ore	free	free	free
Electrolytic manganese metal for alloying purposes	free	5%	20%
Ferromanganese and spiegeleisen			
Not more than 1% Si on Mn content	free	1¢	1¼¢
Silicomanganese			
More than 1% Si on Mn Content	free	1½¢	1¾¢
UNITED STATES			
Manganese ore*	0.25¢ per lb of Mn content		
Manganese metal, unwrought	1.875¢ per lb + 15% ad val		
Ferromanganese			
Not over 1% C	0.6¢ per lb on Mn content plus 4.5% ad val		
Over 1% but under 4% C	0.9375¢ per lb on Mn content		
Over 4% C	0.625¢ per lb on Mn content		
Spiegeleisen	75¢ per long ton		

*Duty temporarily suspended to 30 June, 1967.

Mercury

J.G. GEORGE*

With the exception of a small quantity produced in the Bridge River district of British Columbia in 1964, there has been no mine production of mercury in Canada since 1944 when the Pinchi Lake and Takla mines, both in British Columbia, were closed. The Pinchi Lake mine, formerly operated by The Consolidated Mining and Smelting Company of Canada Limited, was by far the more important source and still remains Canada's largest known mercury deposit. During the years it operated, from 1940 to 1944 inclusive, it produced more than 4 million pounds of mercury. In 1943 and 1944, Bralorne Mines Limited (now Bralorne Pioneer Mines Limited) produced from the Takla mine but output was considerably less than from Pinchi. Both were underground mines; the principal ore mineral was cinnabar (HgS). The two deposits are about 75 miles apart and lie along the Pinchi Fault zone which trends north-northwest through central B.C. in the Fort St. James area. In southern British Columbia, small mines to the east and north of Bralorne have sporadically yielded mercury; intermittent mining operations in the vicinity of Kamloops Lake produced more than 11,000 pounds between 1895 and 1927. To date, all Canadian mercury production has come from B.C.

WORLD REVIEW

Consumption in the United States, the largest consuming nation, reached a record 82,600 flasks in 1964, about 4,600 more than in 1963. Accurate statistics are not available on consumption in other countries but France, India, Japan, U.S.S.R., West Germany, other industrial nations and developing countries are consuming increasing quantities of mercury. The recent substantial increase in consumption is due in large measure to world-wide expansion of the plastics industry that has necessitated building more chlorine-caustic soda plants, and to the growth of the electrical industry. China and Russia, which normally have been exporters of mercury (quicksilver), virtually ceased exporting about January 1963 and both countries reportedly made substantial purchasesof the metal in Europe in the latter part of 1964. Higher imports by Japan also contributed to the shortage that developed in the Western world.

*Mineral Resources Division

The United States Government in November 1964 declared 72,500 flasks of stockpiled mercury to be surplus to its requirements. Of the total, 17,000 flasks were transferred to the Department of Health, Education and Welfare and other governmental agencies for use in their programs. The remaining 55,500 flasks were to be made available for sale to domestic consumers and a plan for the immediate release of 14,000 flasks to meet their needs was announced in December 1964.

Spain and Italy continued to dominate world mercury production and in 1964 together furnished more than half of estimated world output of 251,000 flasks. Smaller, but significant, quantities were produced by the U.S.S.R., China, Yugoslavia, United States and Mexico.

TABLE 1

Mercury – Production, Trade and Consumption

	1963		1964p	
	Pounds	$	Pounds	$
Production				
British Columbia	–	–	5,548	22,192
Imports				
Metal				
Spain	231,153	515,215	141,800	407,781
Italy	131,125	311,479	47,300	184,193
Yugoslavia	22,800	50,262	34,200	132,871
Britain	2,382	6,253	29,000	107,748
United States	6,902	19,313	26,400	99,652
Turkey	–	–	15,200	59,125
China (Communist)	37,988	84,123	–	–
Mexico	7,642	16,524	–	–
Netherlands	7,600	19,096	–	–
Total	447,592	1,022,265	293,900	991,370
Salts				
Britain		4,532		..
United States		3,290		..
West Germany		1,256		..
France		443		..
Total		9,521		..
Consumption, metal				
Heavy chemicals	124,528		190,846	
Pharmaceuticals and fine chemicals	15,652		36,570	
Electrical apparatus	3,603		2,875	
Gold recovery	3,050		2,653	
Miscellaneous	563		8,821	
Total	147,396		241,765	

Table 1 (Cont.)

	Production, Metal (pounds)	Imports		Exports, Metal (pounds)	Consumption, Metal (pounds)
		Metal (pounds)	Salts ($)		
1955	75	555,526	11,258	3,781	416,632
1956..............	–	450,006	1,819	5,953	212,800
1957	–	400,710	24,225	1,425	215,344
1958	–	197,073	10,918	2,830	151,021
1959	–	141,219	6,137	10,458	161,987
1960..............	–	243,091	6,915	1,918	139,627
1961..............	–	312,913	3,764	*	150,588
1962..............	–	245,059	3,838	*	135,291
1963..............	–	447,592	9,521	*	147,396
1964p.............	5,548	293,900	*	*	241,765

Source: Dominion Bureau of Statistics.
* Not available as a separate class.
Symbols: p Preliminary; – Nil; .. Not available.

TABLE 2

World Production of Mercury* 1960, 1963 and 1964
(flasks of 76 pounds)

	1960	1963	1964
Spain	53,369	56,954	74,956
Italy	55,492	54,443	57,001
U.S.S.R.^{e}	25,000	35,000	35,000
China (Communist)^{e}	23,000	26,000	26,000
Yugoslavia	14,069	15,838	17,318
United States	33,223	19,117	14,142
Mexico	20,114	16,302	12,400^{e}
Japan	5,791	4,668	4,668**
Peru	3,034	3,086	3,200^{e}
Turkey	1,339	3,042	3,000^{e}
Philippines	3,041	2,651	2,500^{e}
Czechoslovakia**	725	725	725
Rumania	413	194	190
Chile	2,876	613	170
Tunisia	166	–	–
Colombia	149	3	–
World total	242,000	239,000	251,000

Source: U.S. Bureau of Mines MINERAL INDUSTRY SURVEYS, MERCURY in the first quarter of 1965.

*Data do not add to totals shown because of rounding where estimated figures are included in detail. **1963 data.

Symbols: – Nil; e Estimate.

USES

The oldest but now relatively unimportant use of mercury was for recovering gold and silver from their ores by amalgamation. One of the major uses in recent years has been for electrical apparatus. Another large and growing use for mercury is as a cathode in the electrolytic production of chlorine and caustic soda. Substantial quantities are required for first requirements when building and expanding such plants; consumption of mercury for replacing losses in the electrolytic cells is small compared with requirements for the original installation. Other applications for mercury, in descending order of consumption, include industrial and control instruments, mildew-proofing paints, pharmaceuticals, pulp and paper manufacture, insecticides and fungicides, dental preparations, general laboratory work and instruments. Its military uses include fulminate for munitions and blasting caps, electric batteries and as a catalyst in the manufacture of chemicals for chemical warfare.

Because of its capacity to absorb neutrons, mercury in recent years has been used as a shield against atomic radiation. A relatively new application for

TABLE 3

United States Mercury Consumption, by End Use

(flasks of 76 pounds)

End Use	1960	1963	1964
Agriculture (includes fungicides and bactericides for industrial purposes)	2,974	2,538	3,144
Amalgamation	255	306	667
Catalysts	1,018	612	656
Dental preparations	1,783	2,346	2,612
Electrical apparatus	9,268	11,115	10,690
Electrolytic preparations of chlorine and caustic soda	6,211	7,999	9,572
General laboratory use	1,302	2,085	18,516*
Industrial and control instruments	6,525	4,943	4,972
Paint:			
Antifouling	1,360	252	547
Mildew-proofing	2,861	6,403	4,898
Paper and pulp manufacture	3,481	2,831	2,148
Pharmaceuticals	1,729	4,081	5,047
Redistilled**	9,678	9,227	11,405
Other	2,722	23,225	7,734
Total	51,167	77,963	82,608

Sources: Statistics for 1960 and 1963 from preprint from U.S. Bureau of Mines MINERALS YEARBOOK 1963; statistics for 1964 from U.S. Bureau of Mines MINERAL INDUSTRY SURVEYS, MERCURY in the first quarter of 1965.

* Figure represents combined total; source reference lists separate figures as follows: general laboratory use —Commercial, 1,516; Government, 17,000.

** Redistilled mercury is also consumed for many of the same uses as virgin mercury.

the metal is to use frozen mercury patterns in the manufacture of precision or investment castings.

PRICES AND TARIFFS

Except for a slight decline in May 1964, the monthly average price of mercury per flask (76 pounds) f.o.b. New York, as quoted in E & MJ METAL AND MINERAL MARKETS, rose continuously from $234.364 in January to $484.545 in December 1964. In the latter part of November it reached an all-time high of $490 to $505 a flask. Average for the year was $314.79 a flask, $125.34 higher than in 1963. The London exwarehouse price, as quoted in METAL BULLETIN (LONDON), showed a rising trend throughout 1964. At the beginning of January it was £77 per flask (76 pounds) and at the end of December it had risen to £140, a record high.

The New York price, which declined from $290.35 in 1955 to $189.45 a flask in 1963, rose to an average level of $314.79 during 1964. Average yearly prices of mercury from 1954 to 1964 are listed in Table 4.

TABLE 4

Mercury Prices at New York and London

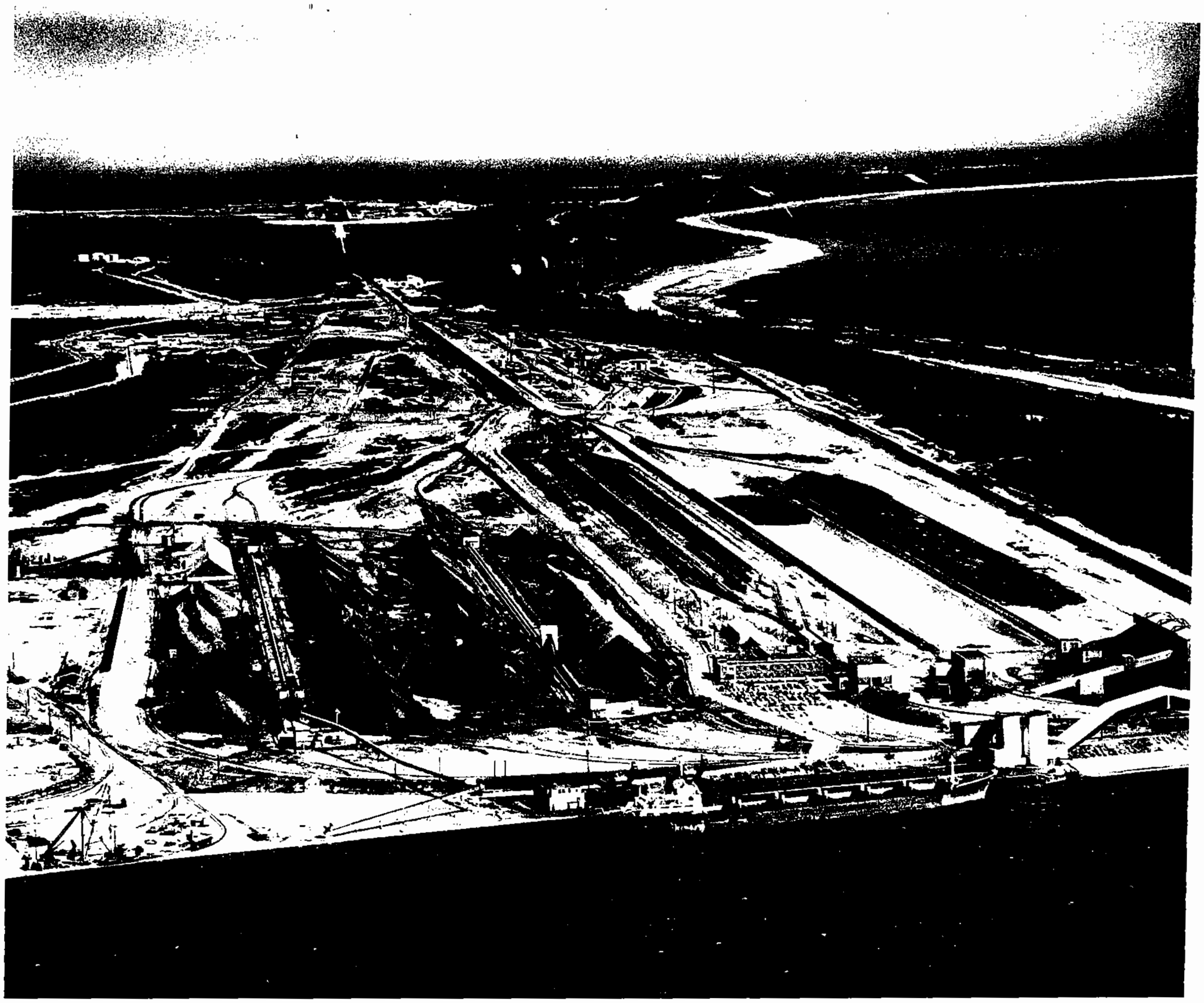
($ per flask of 76 pounds)

	New York*	London**
1954...........	264.39	255.33
1955...........	290.35	280.22
1956...........	259.92	238.68
1957...........	246.98	232.36
1958...........	229.06	214.98
1959...........	227.48	208.61
1960...........	210.76	197.86
1961...........	197.61	181.87
1962...........	191.21	172.79
1963...........	189.45	171.42
1964...........	314.79	280.90

* ENGINEERING AND MINING JOURNAL.

** MINING JOURNAL (London), U.S. equivalent.

Imports of mercury into Canada are duty-free. A duty of 25 cents a pound ($19 a flask) of mercury continued in effect in the United States.



Seven Islands harbour and ore classification yards.

Mica

J.E. REEVES*

Preliminary statistics indicate that in 1964, production of mica in Canada remained at the comparatively low level of little more than 1 million pounds. All was phlogopite.

During the year Canada imported 544,000 pounds of rough muscovite mica, for use in the electrical industry, worth an average of about 3½ cents a pound; and 5,340,000 pounds of mica with an average value of more than a dollar a pound, consisting mainly of high-priced muscovite splittings for electrical use and ground muscovite for use as a filler. The rough muscovite and muscovite splittings originate mainly in India, although much of it comes from the United States. Imports of ground muscovite originate in the United States.

Changes in import classifications by the Dominion Bureau of Statistics have resulted in more definitive information, but make difficult a comparison between imports in 1964 and those of previous years. To facilitate comparison, the sum of the two classifications for imported unfabricated mica is shown in the third part of the section on imports in Table 1, alongside the statistics for imported unmanufactured mica in 1963. Imports of ground mica from the United States are included in this part of the table for 1964 but not for 1963. The addition of the reported exports of ground mica from the United States to Canada, 2,713,787 pounds worth about $137,000 (Can.), makes the comparison as complete as possible. The fourth part of the import section of Table 1 shows the value of imports of fabricated mica in 1964 compared with the value of imports of manufactured mica in 1963, which includes ground mica from the United States. The subtraction of $137,000, the value in Canadian dollars of reported U.S. exports of ground mica, from the figure for 1963, indicates a little more than one half million dollars in fabricated mica imports in 1963 and a considerable increase in value, to $741,605, in 1964.

Small-size sheet phlogopite was exported to Japan and high-quality scrap phlogopite to the United States. Because of the small quantity of exports over the last few years, statistics are no longer recorded separately.

*Mineral Processing Division, Mines Branch

TABLE 1

Mica – Production, Trade and Consumption

	1963		1964p	
	Pounds	$	Pounds	$
Production, shipments				
Trimmed	4,235	2,606	..	..
Rough	12,021	1,390	..	..
Ground	813,935	36,759	..	..
Scrap	352,850	3,529	..	..
Total	1,183,041	44,284	1,202,800	95,583
Imports[1]				
Rough[2]				
United States	...	...	542,000	14,075
Brazil	...	...	2,000	4,803
Total	...	...	544,000	18,878
Sheet and ground[2]				
United States	...	...	5,190,700	512,038
India	...	...	103,000	48,891
Britain	...	...	45,600	5,567
Brazil	...	...	700	1,587
Total	...	...	5,340,000	568,083
Total unmanufactured mica[3]				
United States	1,552,200[4]	269,168[4]	5,732,700[5]	526,113[5]
India	157,100	54,759	103,000	48,891
Britain	22,400	1,004	45,600	5,567
Brazil	5,900	8,527	2,700	6,390
Total	1,737,600	333,458	5,884,000	586,961
Ground, from United States[6]	2,713,787	137,000	...	...
Adjusted total	4,451,387	470,458	5,884,000	586,961
Fabricated mica[7]				
United States	..	625,061[5]	..	737,086[4]
Britain	..	16,064	..	4,519
Other countries	..	1,570	..	–
Total	..	642,695	..	741,605
Ground, from United States,[6] subtracted		137,000		...
Adjusted total		505,695		741,605

Table 1 (cont.)

	1962		1963	
	Pounds	$	Pounds	$
Consumption, available data				
Paints and wall-joint sealers	1,780,000		1,972,000	
Rubber	576,000		646,000	
Electrical apparatus	252,000		428,000	
Paper and wallboard	266,000		272,000	
Asphalt products	42,000		36,000	
Other products	38,000		78,000	
Total	2,954,000		3,432,000	

Source: Dominion Bureau of Statistics, unless otherwise indicated.
[1]Owing to changes in classification, import statistics for 1964 are not completely comparable with previous years. [2]Not recorded as a separate class prior to 1964. [3]The recorded imports of 'unmanufactured' mica in 1963, compared with the sum of the recorded imports of unfabricated mica in 1964. [4]Does not include imports of ground mica. [5]Includes imports of ground mica. [6]From U.S. Bureau of Mines, MINERALS YEARBOOK, 1963. [7]The recorded imports of 'manufactured' mica in 1963, compared with the recorded imports of fabricated mica in 1964.

Symbols: p Preliminary; — Nil; .. Not available; ... Not applicable.

TABLE 2

Mica – Production, Trade and Consumption, 1955–64
(pounds)

	Production[1]	Imports[2]	Exports[2]	Consumption
1955	1,640,708	198,900	362,800	3,356,904
1956	1,843,811	324,900	277,800	4,524,810
1957	1,282,416	501,900	362,200	4,028,926
1958	1,504,933	1,047,700	300,100	3,547,396
1959	813,834	1,340,400	423,800	3,622,000
1960	1,702,605	1,838,800	488,800	3,448,000
1961	1,816,160	1,475,800	222,400	3,782,000
1962	1,204,034	2,306,300	200,200	2,954,000
1963	1,183,041	1,737,600	..	3,432,000
1964p	1,202,800	5,884,000[3]	..	..

Source: Dominion Bureau of Statistics.
[1]Producers' shipments. [2]Unmanufactured mica. [3]Includes ground mica for the first time.
Symbols: p Preliminary; .. Not available.

TABLE 3
World Production of Mica – 1963
('000 pounds)

United States	218,749
India	75,121
Republic of South Africa	4,723
Brazil	2,758
Malagasy Republic	2,128
South West Africa	1,197
Canada	1,183
Australia	1,100
Other countries	93,041
Total	400,000

Source: U.S. Bureau of Mines, MINERALS YEARBOOK, 1963.

DOMESTIC PRODUCTION

Shipments of phlogopite were made intermittently from various sources in southwestern Quebec and southeastern Ontario. Blackburn Brothers, Limited, operated its mine near Cantley, Quebec, for sheet phlogopite for export to Japan, and dry-ground scrap phlogopite from several sources. The mine is now closed. Higher-quality scrap phlogopite for use in the manufacture of mica paper was shipped to the United States from near Kingston, Ontario, and from two properties in Quebec.

WORLD PRODUCTION

In 1963, the last year for which statistics are available, world production was about 400 million pounds. The United States is the principal producer with more than half of the total, virtually all scrap muscovite. India dominates muscovite sheet production; about one quarter of the 75,121,000 pounds produced in 1963 was muscovite sheet. The Malagasy Republic is the only other source of phlogopite besides Canada. A considerable amount of world trade takes place.

TECHNOLOGY

Mica is important because of its unusual physical characteristics. It has consistent and relatively high dielectric properties, high-temperature resistance and low thermal conductivity, and its perfect basal cleavage permits it to be readily split into very thin sheets that are flexible, elastic, strong and generally transparent. The preparation of sheet mica is done mostly by hand and requires experience. When ground to a fine powder, mica retains its flaky particle shape, which is advantageous in its many uses as a filler and dusting agent.

High-quality muscovite possesses the best dielectric properties of all types of mica and is used extensively for insulation at high frequencies and voltages and in capacitors. Its high strength and transparency make it useful for glazing. It may be colourless, reddish, green or brown and is found in granitic pegmatites. The wet-grinding of select muscovite scrap and waste yields a polished, well-delaminated powder with a high reflectivity.

Phlogopite, or amber mica, varies considerable in dielectric strength, hardness, structural strength and other properties but its superior thermal resistance gives it some value. In southwestern Quebec and southeastern Ontario it is commonly found in irregular veins with green apatite and pink calcite. Its properties vary in relation to its composition and it may range from almost colourless to a deep brown.

USES

Mica is used in three forms: natural sheet, splittings and ground mica.

Natural sheet mica is used for insulation in electrical and electronic equipment and appliances for home and industry. In lesser amounts it is used in thermal insulation and for glazing boiler gauges and furnace windows. It is sold according to variety, size and quality, depending on the intended application. A trend toward the use of substitute materials has developed but the highest-quality muscovite is in high demand.

Mica splittings are bonded together in the manufacture of built-up sheet, tape and cloth. Suitable processes of forming the products and curing the binder result in a wide variety of these flexible insulation products. Built-up sheet has replaced natural sheet, within the limits of its physical and electrical characteristics. It can be cut or moulded into washers, tubes and many other forms. Most of the splittings used are muscovite.

Mica paper and mica board have been developed as substitutes for built-up sheet, using ground mica and a binder and essentially some modification of paper-making techniques. Mica paper is not as strong physically as built-up sheet but has a more consistent thickness.

Most of the mica consumed is ground mica. Dry-ground mica, muscovite or phlogopite, is used for dusting asphalt products, and rubber tires and tubes; as a filler in wall-joint sealing compounds and some paints and as an aid against loss of circulation of drilling mud in oil-well drilling. Wet-ground muscovite is used as an extender pigment in paints, a filler in plastic products and hard rubber, a mould lubricant and dusting agent in the manufacture of rubber tires and, to a minor extent, for adding decorative effects to wallpaper and wallboard.

SPECIFICATIONS

NATURAL BLOCK MUSCOVITE

Block muscovite is graded for size and quality according to Designation D351-57T of the American Society for Testing and Materials. The criteria for grading size are the area of minimum rectangle and the minimum dimension of one side; the standard for grading visual quality is the degree of staining by included impurities.

NATURAL PHLOGOPITE SHEET

In Canada, phlogopite sheet is graded in terms of its linear dimensions, the following sizes being in common use: 1 × 1, 1 × 2 and 1 × 3 inches.

No formal quality-grading for phlogopite has been established, but the softer, lighter-coloured varieties are generally regarded as having the best electrical qualities.

GROUND MICA

The only formal specification is for mica pigment. A.S.T.M. Designation D607-42 requires a wet-ground muscovite with a maximum bulk density of 10 pounds per cubic foot, very low moisture and other impurity contents, and a particle size that is 93 per cent minus 325 mesh. For other uses, the specifications are a matter of agreement between producer and consumer.

Dry-ground mica is sold in a wide range of particle sizes, from as coarse as minus 20 mesh for use as a dusting agent, to as fine as minus 200 mesh for other purposes. Wet-ground mica is generally at least minus 200 mesh. Mica ground in a fluid-energy mill is becoming more important because of the increasing demand for a particle size below 325 mesh.

PRICES

Prices for mica in the United States, according to E & M J METAL AND MINERAL MARKETS of December 28, 1964, included:

Punch mica, per lb.	$ 0.07 – $ 0.12
Wet-ground mica, per short ton	160.00 – 180.00
Dry-ground mica, per short ton	34.00 – 75.00
Scrap mica, per short ton	30.00 – 40.00

Mineral Pigments and Fillers

J.S. ROSS*

Fillers are industrial minerals which impart desirable physical properties or take the place of more expensive materials in industrial products, while remaining relatively inert chemically. Mineral fillers produced in Canada include asbestos, barite, bentonite and various other clays, cement, whiting substitute and other types of limestone, mica, nepheline syenite, shale, silica, talc and diatomite. Fillers also include aggregates of gravel, crushed rock and of lightweight and heavy mineral products used in masonry and concrete. Some of these industrial minerals also impart colour and, to a limited extent, serve as pigments but are rarely used solely as pigments because of their low hiding power and limited colour range. Other than iron oxide, whiting is the only natural filler dealt with in detail in this review. Others are discussed individually in other reviews. Most mineral fillers are used widely and in larger quantities than pigments.

Iron oxide is the only true natural mineral pigment produced in Canada, although some industrial minerals are marketed for their combined whiteness and filler properties. Natural mineral pigments have been replaced largely by their synthetic counterparts, which are derived by the chemical and metallurgical processing of metals and minerals. The quantity of mineral pigments consumed is relatively small but these materials are used widely to impart colour and opacity to materials. Although invariably categorized separately, pigments are basically fillers.

*Mineral Processing Division, Mines Branch

TABLE 1

Iron Oxide – Production, Trade and Consumption

	1963		1964	
	Short Tons	$	Short Tons	$
Production (shipments)				
Natural (crude and calcined)...............	978	74,505	914p	79,015p
Exports				
Natural and synthetic iron oxide				
United States..........................	1,813	336,719	2,163	405,692
France	127	22,590	85	15,134
Britain	86	35,890	61	28,660
Australia	69	15,341	31	11,845
Belgium and Luxembourg................	6	990	16	2,546
Switzerland	5	890	11	1,778
Other countries	112	19,738	41	7,978
Total...............................	2,218	432,158	2,408	473,633
Imports				
Natural and synthetic iron oxide*				
United States..........................			1,542	352,660
West Germany			921	123,018
Spain................................			482	25,235
Britain			126	34,939
Total...............................			3,071	535,852
	1961		1962	
Consumption by the paint industry				
Calcined and synthetic iron oxide..........	1,755	434,206	1,955	470,000
Ochres, siennas, umbers..................	130	45,481	150	56,000

Source: Dominion Bureau of Statistics.
*Not available as a separate class prior to 1964.
p Preliminary.

IRON OXIDE

Production of natural iron-oxide pigments continued at a low rate in 1964, following the general level established shortly after 1957. Shipments amounted to 914 tons valued at $79,015 (preliminary) and virtually all went to the pigment and abrasives industries. The natural pigment industry remained in a depressed state because of a limited demand for its products. Prior to 1960, most of the output was used in the purification of producer gas but that market has virtually disappeared. At the same time, synthetic pigments of excellent quality and with a wide range of colours are competing with natural mineral pigments. Statistics on the production of synthetic iron-oxide pigments are not available.

In 1964, Canada had a trade deficit in synthetic and natural iron oxides. Trade was relatively small and mainly with the United States. Exports amounted to 2,408 tons valued at $473,633, up slightly from 1963. Imports were 3,071 tons valued at $535,852. Much of this material was used as a pigment but some served other purposes.

TABLE 2

Iron Oxide – Production, Trade and Consumption, 1955–64

(short tons)

	Production	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	Ochres, Siennas, Umbers
1955	7,702	..	986	5,707	3,623	6,835	2,298	221
1956	8,803	..	1,162	6,237	3,203	8,745	2,166	220
1957	7,518	..	946	4,826	3,440	5,999	1,895	263
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	..	..	..
1964	914p	3,071	..	..	2,408	..	..	..

Source: Dominion Bureau of Statistics.
*Partial.
Symbols: p Preliminary; .. Not available.

OCCURRENCES AND PRODUCTION

The production of natural pigment-grade iron oxide indicated in Table 1 came from the Red Mill, Quebec, plant of The Sherwin-Williams Company of Canada, Limited. Raw material for this product is recovered nearby from bog deposits formed by the precipitation of iron oxides leached from ferruginous rocks and overburden. The ore is trucked to the company's mill, air-dried, calcined when necessary, pulverized and sized. Much of the output is exported. Small quantities of bog oxide have occasionally been recovered by other interests.

Many bog iron-oxide deposits occur in Champlain County, Quebec, principally near Three Rivers. They are also found in Laviolette and Yamaska counties, Quebec; Colchester County, Nova Scotia; near New Westminster, British Columbia; and in other areas of British Columbia, Saskatchewan, Manitoba and and Ontario.

In the latter part of 1964, Ferrox Iron Ltd. started to produce natural iron oxide concentrates from a new plant at Prescott, Ontario. The initial plant capacity of 10 tons a day has since been raised to 20 tons a day. This company converts iron ore into high-purity iron oxide mainly for use as a constituent in the production of ferrites and iron powder. Part of the output will probably find use as abrasives and pigments.

USES AND SPECIFICATIONS

In 1964, Canada's output of natural iron oxide was used mainly for abrasive purposes in the United States, and as a paint pigment and in the production of ferrites and iron powder in Canada.

As an abrasive, the commodity is used for metal and glass polishing.

The natural oxide encounters the most competition from the synthetic variety in the pigment industry. Synthetic iron oxides can be produced more uniformly in numerous pigmentary shades and consequently are in greater demand. Both types are used in paints, rubber, linoleum, vinyl and plastic products, ceramics, concrete, mortar, paper, wood and leather stains as well as in other materials. Iron-oxide pigments are available in colours from yellow through brown to black. They are used because of their permanence of colour and ability to inhibit the oxidation of metal surfaces. The pigment should either compare with a standard colour or have a tinting power that will allow it to be conditioned to compare with a standard. The particle size should be less than 325 mesh and the oil absorption should approximate that of a standard. A high degree of opacity and hiding power is required.

PRICES

Prices vary considerably, particularly with quality or grade. The average price of the refined natural iron oxide produced in Canada in 1964 was $86.45 a ton at the plant.

United States prices for various types of iron oxides were quoted by the December 28, 1964 OIL, PAINT AND DRUG REPORTER as ranging from 6½ to 16½ cents a pound.

WHITING

Whiting substitute is the most commonly used whiting and is white or near-white pulverized limestone that is usually composed mainly of calcium carbonate. True whiting is ground chalk, and precipitated whiting is a synthetic chemical precipitate of calcium carbonate.

Whiting substitute is the only variety produced in Canada and virtually all is derived from limestone from Missisquoi County, Quebec. Production is small and amounted to an estimated 17,000 tons valued at $235,000 in 1964. For the first time in Canada, a significant quantity of near-white, pulverized, recrystallized dolomitic limestone was produced. In addition, a much larger amount of off-white pulverized limestone was shipped from plants in Quebec, Ontario, Manitoba and British Columbia. This darker limestone is not normally classified as whiting substitute but it does compete in some of the lower-quality applications of whiting.

TABLE 3

Whiting – Production, Imports and Consumption

	1963		1964	
	Short Tons	$	Short Tons	$
Production				
Stone processed for whiting	16,195	231,492	17,000e	235,000e
Imports[1]				
Whiting				
United States	5,861	292,605	6,044	233,326
Britain	2,354	49,639	1,454	26,416
France	1,568	17,247	1,143	10,580
West Germany	6	579	–	–
Total	9,789	360,070	8,641	270,322
Consumption[2]				
Ground chalk, whiting, and whiting substitute				
Paints and varnishes	20,219			
Linoleum, oilcloth and floor tile	14,790[3]			
Rubber goods	10,366[3]			
Gypsum products	8,268[3]			
Paper	2,373			
Adhesives	923			
Ceramics	611			
Tanneries	255			
Soaps and toilet preparations	180			
Pharmaceuticals	158			
Starch and glucose	7			
Miscellaneous chemicals	573			
Miscellaneous	6,359			
Total	65,082[3]			

Source: Dominion Bureau of Statistics.
[1]True and precipitated whiting only. [2]Calculated from information provided by the Dominion Bureau of Statistics. [3]Includes pulverized, off-white limestone.
Symbols: – Nil; e Estimate.

TABLE 4

Whiting – Production, Imports and Consumption, 1955–64
(short tons)

	Production[1]	Imports[2]	Consumption[3]
1955	16,007	11,905	33,171
1956	17,448	11,356	34,241
1957	21,527	9,844	31,374
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	17,000e	8,641	62,322

Source: Dominion Bureau of Statistics.
[1]Rock processed for whiting substitute. [2]Whiting only.
[3]Whiting and whiting substitute; includes some ground, off-white limestone. For 1959 on, calculated from information provided by the Dominion Bureau of Statistics.
e Estimate.

There are no statistics for whiting exports but it is doubtful whether any whiting is exported from this country. In 1964, Canada imported 8,641 tons of true and precipitated whiting valued at $270,322 in addition to a larger unknown amount of whiting substitute. Almost all this whiting substitute and the precipitated whiting come from the United States and most of the true variety originates in Britain and France.

CONSUMPTION AND USES

Whiting is used generally as a filler to improve physical properties or to replace more expensive materials in industrial products. All types are used as white fillers. The less expensive true whiting and whiting substitute are used in larger quantities than the other type and mainly for replacing more expensive materials. On the other hand, the precipitated type is used mainly because of its whiteness. However, the opacity and covering power of whiting is not nearly as effective as such synthetic pigments as titanium dioxide and zinc oxide. Off-white limestone is used in large quantities and serves as a filler where colour is unimportant or where dark colours are involved.

In Canada, by far most of the whiting is used in paints in which its whiteness, particle shape and size, chemical composition, bulk density and, on occasion, oil absorption are important. It is also used in paper, ceramics, adhesives, soaps, toilet preparations, pharmaceuticals, rubber products, linoleum, oilcloth, floor tile, tanneries, starch and glucose, explosives, plastics and miscellaneous chemicals and products. Significant quantities of off-white limestone go into the manufacture of linoleum, oilcloth, vinyl and asphalt floor tile, rubber goods and gypsum products.

The following United States prices for the three main types of whiting were quoted in the OIL, PAINT AND DRUG REPORTER of December 28, 1964. They refer to one ton of bagged material, in a carlot, at the producing plant. They are unchanged from the previous December.

Calcium carbonate, natural, dry-ground, 325 mesh....			$ 10.50
natural, water-ground, 30 microns.	$ 17.00	–	$ 30.00
chalk, 325 mesh	32.00	–	34.00
precipitated, dense	30.00	–	38.50
ultrafine...........	117.50	–	167.50

OTHER PIGMENTS

Canada also produces synthetic pigments, yet imports significant quantities of these materials. In 1964, imports were valued at $7.1 million and included iron oxide, chromium oxide, lithopone, litharge, red lead, white lead, zinc oxide, blanc fixe, satin white, copper oxide, cobalt oxide and tin oxide.

Synthetic iron oxide is produced by Northern Pigment Company, Limited at New Toronto, Ontario. This company is a leading world producer and exports part of its output to many countries.

Chemically prepared titanium dioxide is used widely as a pigment. Canada's output, supplied by two companies in Quebec, is adequate for its needs, but is relatively small compared with that of the United States. However,Canada is a major supplier of a raw material for the production of pigment – titania slag.

Refined titanium dioxide is produced by Canadian Titanium Pigments Limited from a plant at Varennes having a rated capacity of 25,000 tons a year. Tioxide of Canada Limited, formerly British Titan Products (Canada) Limited, produces the commodity at Ville-de-Tracy, from a plant having an annual capacity of 22,000 tons. Both companies use titania slag as the basic raw material. This slag is a product of Quebec Iron and Titanium Corporation, which mines ilmenite near Havre St. Pierre and ships it to Sorel where it is concentrated, roasted, and then reduced in electric furnaces to form titania slag and iron. In 1964 the company shipped the record quantity of 387,788 tons of slag valued at $21 million. This material was marketed for use in pigments, mainly in the United States. Continental Titanium Corp. also mines ilmenite but the product is sold as a heavy aggregate rather than as a source of titanium dioxide. The ilmenite is mined in the St. Urbain area of Quebec and is shipped from the company's plant at Baie St. Paul, mainly to the United States.

TABLE 5

Titanium Dioxide – Trade and Consumption

	1963		1964	
	Short Tons	$	Short Tons	$
Imports				
Titanium dioxide, pure				
Britain	1,895	811,924	1,120	470,562
United States	1,472	794,221	693	360,725
West Germany	–	–	26	11,843
Total	3,367	1,606,145	1,839	843,130
Titanium dioxide extended				
United States	9,319	1,785,904	10,443	2,000,248
Exports				
Titanium dioxide				
United States[1]	280	109,790	3,298	1,344,287
	1961		1962	
Consumption				
Refined titanium dioxide				
Industrial chemicals	23		83	
Other chemicals	345		443	
Linoleum and Coated Fabrics Industry[2]	2,328		2,608	
Paint and varnish	17,291		18,293	
Paper	2,444		3,268	
Rubber	935		951	
Synthetic textiles	32		..	
Toilet preparations	24		28	
Other non-metallic products	572		604	
Total	23,994		26,278	
Extended titanium dioxide pigments				
Paints	13,104		10,935	
Estimated TiO_2 content	3,875		3,237	

Source: Dominion Bureau of Statistics.
[1]As reported by United States IMPORTS FOR CONSUMPTION FT110 & FT125. Values are in United States dollars. [2]Includes also "Asphalt Roofing Manufactures".
Symbols: – Nil; .. Not available.

It is estimated that for 1964 domestic production of the titanium dioxide pigment was valued at about $15 million. Because of the establishment in 1962 of a second producer, Tioxide of Canada, imports of the pure type have been reduced from 12,620 tons valued at $5.7 million in 1962 to 1,839 tons valued at $0.8 million in 1964. Imports of the extended type have decreased slightly during that period. In the meantime, exports have risen appreciably resulting in Canada becoming a net exporter of pure titanium dioxide.

In 1962, consumption of the refined product increased over that of the previous year to 26,278 tons. In addition, 10,935 tons of the extended type were used in paints. Seventy per cent of the former variety was used in paints and the rest was employed in paper, linoleum and coated products, rubber goods, textiles, toilet preparations, chemicals and other products such as enamels, ceramics and plastics.

In 1964, Canadian Titanium Pigments Limited quoted the following prices for its products, delivered in Eastern Canada, bagged, in 20-ton carlots and per 100 pounds:

Anatase	
A–WD	$22.00
Other	23.75
Rutile	25.50
30% TiO_2 extended pigment	10.30 and $10.55
50% TiO_2 extended pigment	15.80
Technical	31.00

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Iron ore stockpiles in Seven Islands classification yards.

Molybdenum

V.B. SCHNEIDER*

Production of molybdenum in Canada increased for the fifth consecutive year and shipments of molybdenum contained in molybdic oxide (MoO_3) and molybdenite (MoS_2) concentrates reached an all-time high of 1.3 million pounds valued at $1.8 million. This is an increase of about 450,000 pounds and $300,000 from 1963. Imports of molybdic oxide and ferromolybdenum increased from 1963 despite record domestic production.

World mine production for 1964 was estimated by the United States Bureau of Mines in its MINERALS AND METALS COMMODITY DATA SUMMARIES, January 1965, at 93.8 million pounds; it was an all-time high exceeding the previous record of 91.6 million pounds established in 1963. United States production** exceeded 65 million pounds and was the third highest output in history being exceeded only in 1960 and 1961. Climax Molybdenum Company, a division of American Metal Climax, Inc., the world's largest producer, sets the pattern of world prices for molybdenum products. Effective April 3, 1964, it increased the prices of its molybdenum products for the first time since June 1, 1961. The new prices remained in effect at the end of the year.

During 1963-64 an unprecedented expansion occurred in the demand for molybdenum and, despite increased production, a serious shortage remained at the end of 1964. In the United States, the shortage was somewhat relieved by the release of 8 million pounds of molybdenum from the U.S. government's Strategic and Critical Stockpile. The outlook for 1965 is for a continued shortage but because of the expansion programs under way by established producers and rapid preparation for production by some new producers, particularly in Canada, it is expected that by 1966 supply will meet demand.

*Mineral Resources Division
**U.S. Bureau of Mines, MOLYBDENUM MONTHLY, March 19, 1965.

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TABLE 1

Molybdenum – Production, Imports and Consumption

	1963		1964p	
	Pounds	$	Pounds	$
Production (shipments)[1]	833,867	1,344,004	1,278,404	1,789,234
Imports				
Molybdic oxide[2]				
United States	258,765	245,553	422,300	478,000
U.S.S.R.	–	–	37,700	186,000
Total	258,765	245,553	460,000	664,000
Ferromolybdenum			11 months	
United States[3]	125,869	215,964	236,805	347,788
Consumption (Mo content)			12 months	
By type				
Molybdic oxide	831,973			
Ferromolybdenum	414,260			
Molybdenum metal	10,104			
Molybdenum wire	6,531			
Other forms[4]	43,325			
Total	1,306,193		1,107,454[5]	
By end-use				
Ferrous and nonferrous alloys	1,256,306			
Lubricants and pigments	43,325			
Electrical and electronic products	6,562			
Unspecified	–			
Total	1,306,193		1,107,454[5]	

Source: Dominion Bureau of Statistics.
[1] Producers' shipments of molybdic oxide and molybdenum concentrates (Mo content). [2] Gross weight. [3] United States exports of ferromolybdenum (gross weight) to Canada as reported by the U.S. Bureau of Commerce, EXPORTS OF DOMESTIC AND FOREIGN MERCHANDISE (Report 410). Imports of ferromolybdenum are not available separately in official Canadian trade statistics. [4]Molybdic acid, molybdenum disulphide, ammonium molybdate. [5]Breakdown not yet available.
Symbols: p Preliminary; – Nil.

TABLE 2

Molybdenum – Production, Trade and Consumption, 1955-64

(pounds)

	Production[1]	Exports[2]	Imports: Calcium Molybdate[3]	Imports: Molybdic Oxide[4]	Imports: Ferro-Molybdenum[5]	Consumption[6]
1955	833,506	1,478,900	139,130	658,060	174,504	634,061
1956	842,263	1,318,200	322,295	955,308	495,748	855,468
1957	783,739	6,009,800[7]	285,576	477,304	237,233	698,420
1958	888,264	1,892,200	135,333	304,822	196,000	519,124
1959	748,566	3,748,300	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
1964p	1,278,404	..	..	460,000	236,805[8]	1,107,454

Source: Dominion Bureau of Statistics.
[1] For 1955 and 1956 producers' shipments of molybdenum concentrates (Mo content); from 1957 molybdic oxide and molybdenum concentrates (Mo content). [2]For 1955 and 1956, exports of molybdenum concentrates (gross weight); for 1957 to 1959 inclusive, exportsof molybdic oxide and molybdenum concentrates (gross weight).[3] Gross weight, including vanadium oxide and tungsten oxide.[4] Gross weight.[5] United States exports to Canada reported in UNITED STATES EXPORTS OF DOMESTIC AND FOREIGN PRODUCE. Gross weight. [6]Molybdenum addition agents (Mo content) reported by consumers.[7]Includes 4,892,600 pounds of molybdic oxide exported to the United States. This was derived from molybdenum concentrates imported from the United States for roasting in Canada. [8] First 11 months only.
Symbols: p preliminary; ..Not available.

PRODUCTION

CANADA

Canadian production in 1964 came from Molybdenite Corporation of Canada Limited, Gaspé Copper Mines, Limited, a wholly-owned subsidiary of Noranda Mines Limited and Bethlehem Copper Corporation Ltd. Molybdenite Corporation's mine is at Lacorne, Quebec, where the company also operates a roasting plant to convert most of its MoS_2 concentrates to technical-grade MoO_3, the material from which all types of molybdenum salts and compounds are produced. Mill capacity is in the order of 900 tons a day and the blocked ore reserves were reported to be 282,667 tons grading 0.28 per cent MoS_2 at October 1, 1964. This included 126,379 tons of broken ore in stopes. The average ore grade treated in the mill in 1964 was 0.242 per cent MoS_2.

Molybdenite concentrates are recovered as a byproduct by Gaspé Copper Mines, Limited, at its copper operations at Murdochville, Quebec. Recovery in 1964 amounted to 444,000 pounds of contained molybdenum and the company expects about the same recovery in 1965. Completion of the company's Copper Mountain mine development and concentrator expansion program, scheduled for 1967, will probably increase molybdenum recovery to a million pounds a year. The company markets its molybdenum as concentrates, mostly in Europe.

Bethlehem Copper Corporation Ltd. added a molybdenite circuit to its copper concentrator in the Highland Valley, British Columbia, in 1964 and recovery for the few months the plant operated was about 48,000 pounds of contained Mo in an 82.27-per-cent MoS_2 concentrate. Bethlehem exports its molybdenum concentrates to Japan.

Preissac Molybdenite Mines Limited, in which Molybdenite Corporation of Canada Limited holds a substantial interest, completed preparation of its property for production, which will commence early in 1965. The mine site is in Preissac Township about 5 miles north of Cadillac, Quebec. The company has installed at the mine site a roaster for converting molybdenite to molybdic oxide and facilities for converting molybdic oxide to ferromolybdenum. Production at the Preissac mine will be in the order of 1,200 tons of mill feed a day and, like that of Molybdenite Corporation of Canada, its output will be available in the desired forms for domestic consumption.

Anglo-American Molybdenite Mining Corporation announced final financing for putting its property into production by August 1965. Its mine is also in the Lake Preissac area about 3 miles north of Cadillac and plans call for mining about 1,000 tons of ore a day. The company has arranged for Continental Ore Corporation, New York, N. Y., to act as its sales agent.

Also in Quebec, Copperstream-Frontenac Mines Limited continued exploration of its property in Grayhurst and Dorset townships, 48 miles southeast of Thetford Mines. The company reported that exploration and development work indicated reserves in the order of a million tons assaying 0.5 per cent MoS_2 and inferred reserves of 2 million tons of minable-grade ore.

Pax International Mines Limited commenced preparation of its mine at Ryan Lake, near Matachewan, Ontario. Production at the rate of 500 tons a day is expected late in 1965. Some 400,000 pounds of low-grade concentrate were shipped to Masterloy Products Limited in Ottawa, Ontario, for conversion to calcium molybdate.

In British Columbia, important developments undertaken by Noranda Mines Limited, Endako Mines Ltd., and British Columbia Molybdenum Limited, will, by 1968, make Canada the second largest producer of molybdenum in the world.

The Noranda property on Boss Mountain is about 50 miles east of Williams Lake. Access to the property is via the Canim Lake road, which joins Highway 97 just north of One Hundred Mile House. The mine is scheduled to commence production in 1965 at the rate of from 1,000 to 1,500 tons of millfeed a day and can be expected to produce about 3 million pounds of molybdenum in concentrates when operating at capacity.

The Endako Property of Canadian Exploration, Limited, is about 4½ miles south of Highway 16, just west of Endako. This mine is expected to be in production at the rate of 10,000 tons a day sometime in 1965. Molybdenum recovery could well be in the order of 10 million pounds a year when the property is operating at capacity.

British Columbia Molybdenum Limited, a wholly-owned subsidiary of Kennecott Copper Corporation, announced that it is preparing its property in the Alice Arm area for production in 1967. The property is on Patsy Creek, a tributary of Lime Creek, 6 miles southeast of the township of Alice Arm, which is at the east end of Alice Arm Inlet, an extension of Observatory Inlet. Announced production rate is 6,000 tons of ore a day, which is expected to produce about 5 million pounds of molybdenum a year.

Torwest Resources (1962) Ltd. explored and developed the Coxey Claim at Rossland, B.C., during the summer and fall of 1964. The company reports that diamond drilling proved one ore zone (the 'A' zone) to contain 400,000 tons of material grading 0.5 per cent molybdenite (MoS_2). Two other ore zones were indicated by diamond drilling and trenching; they will be further explored in 1965. An agreement between Torwest, Metal Mines Limited, and The International Nickel Company of Canada, Limited, resulted in plans to bring the property into production by the fall of 1965 at an initial rate of 400 tons of millfeed a day.

Other properties, many of which have been mentioned for years in B.C. Department of Mines publications, are being reinvestigated as potential molybdenum prospects. The Consolidated Mining and Smelting Company of Canada Limited, Phelps Dodge Corporation of Canada, Limited, and Climax Molybdenum Company conducted exploration work on possible molybdenum producers through their exploration subsidiaries.

TABLE 3

Canadian Molybdenum Production and Mine Preparation

Company	Mine Location	Start-up Date	Mill Capacity* (tons/day)	Annual Mo Recovery in lb*
Molybdenite Corporation of Canada Limited	Lacorne, Quebec	1943	900	750,000
Gaspé Copper Mines, Limited	Gaspé, Quebec	1963	Byproduct recovery	450,000
Preissac Molybdenite Mines Limited	Lake Preissac, Quebec	Early 1965	1,200	1,900,000
Anglo-American Molybdenite Mining Corporation	Lake Preissac, Quebec	July 1965	1,000	1,000,000
Pax International Mines Limited	Ryan Lake, Ontario	1965	500	400,000
Bethlehem Copper Corporation Ltd.	Highland Valley, British Columbia	1964	Byproduct recovery	200,000
Noranda Mines Limited	Boss Mountain, British Columbia	1965	1,000–1,500	3,000,000
Endako Mines Ltd.	Endako, British Columbia	1965	10,000	10,000,000
British Columbia Molybdenum Limited	Alice Arm, British Columbia	1966 or 1967	6,000	5,000,000
Torwest Resources (1962) Ltd.	Rossland, British Columbia	1965 or 1966	400	400,000

* Estimated.

UNITED STATES

United States is the largest producer and consumer of molybdenum and molybdenum products. In 1964 production and shipments amounted to 65.2 million and 64.7 million pounds of contained molybdenum in concentrates. Production was above 1963's 65.0 million pounds but shipments were slightly below 1963's 65.8 million pounds. Exports of molybdenum contained in concentrates and in molybdic oxide at 24.9 million pounds were about 1.6 million pounds less than in 1963 and nearly 10 million pounds below the all-time high of 35.7 million pounds in 1961.

The Climax mine of Climax Molybdenum Company, a division of American Metal Climax, Inc., is the largest producer of molybdenum in the world; it is also the only mine in the United States operated chiefly for molybdenum. According to the company's 1964 annual report, production at the Climax mine was about 47 million pounds of Mo, the same as in 1963.

In September, American Metal Climax, Inc., announced plans to construct a $5-million plant in Rotterdam, Netherlands, for the conversion of molybdenite concentrates to molybdenum additives. The plant will have an annual capacity of some 6,000 short tons and is expected to be in operation early in 1966. The construction of the plant is an acknowledgment by Climax of the increasing importance of the European market, which during the last five years has accounted for an increasing share of the company's sales and now uses about 17,500 short tons of molybdenum a year. In its annual report, the company attributed the use of molybdenum in stainless steel for automobile trim; molybdenum-containing stainless steel for chemical plant equipment; and an increase in the demand for molybdenum in high-strength structural steel for construction machinery, pressure vessels, bridges, buildings, etc., for the expanded demand for molybdenum.

Among the major producers of byproduct molybdenum from copper operations are Kennecott Copper Corporation, Bagdad Copper Corporation, Phelps Dodge Corporation, San Manual Copper Corporation, Union Carbide Nuclear Company, American Smelting and Refining Company and Duval Corporation. Kennecott, the world's second largest molybdenum producer, reported production of 13.9 million pounds in 1964.

Molybdenum Corporation of America is second to American Metal Climax as a producer of molybdic oxide and ferromolybdenum. Since 1937, Molybdenum Corporation has purchased a large part of its molybdenum concentrates from Kennecott Copper Corporation; the present contract with Kennecott expires in 1965. An exploration and development program that has been carried out during the last two or three years on Molybdenum Corporation's former producing mine at Questa, New Mexico, has proved up a new low-grade orebody and the company is preparing it for production at the rate of 10,000 tons of millfeed a day. Total investment is expected to be $35 million. Production capacity will be a minimum of 9 million pounds of molybdenum annually with mining scheduled to begin in 1967.

The United States stockpile of molybdenum in ores and concentrates as of November 30, 1964, was 74.1 million pounds, about 3.8 million pounds over the maximum objective; most of the excess was committed for sale early in 1965.

OTHER COUNTRIES

Chile is second in the non-communist world as a producer of molybdenum, all of which is obtained as a byproduct of its large porphyry-copper operations. Since 1939 molybdenite concentrate has been recovered by Braden Copper Company from the copper ores of its El Teniente mine. In 1958, The Anaconda Company installed a molybdenite-recovery unit at its Chuguicamata copper property. The copper ore of Anaconda's El Salvador mine also contains considerable molybdenum. Most of Chile's output of molybdenite concentrate was

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exported to Western Europe. Recovery of contained molybdenum in concentrates at the Chuguicamata and El Salvador mines amounted to 6 million pounds in 1964, according to 1964 company reports. Chilean production in 1964 was about 9.3 million pounds. Japan, Norway and Yugoslavia are minor producers. Phelps Dodge Corporation reported the recovery of 835 short tons of MoS_2 concentrates at its copper concentrator at Toquepala, Peru.

China, North Korea and the U.S.S.R. also produce molybdenum but data on their output are not available. Reports indicate that three large molybdenum deposits were discovered during the 1950s in China, somewhere in the middle section of the Ch'in Ling Mountains of Shensi Province and in Shansi and Kirin provinces. The U.S. Bureau of Mines has estimated that production in the Sino-Soviet bloc totalled 16 million pounds in 1964. This places Russia, with an annual output 7 million pounds greater than that of third-place Chile, second to the United States.

TABLE 4

World Production of Molybdenum in Ores and Concentrates
(short tons)

	1962	1963
United States	25,622	32,506
U.S.S.R.	6,250e	6,250e
Chile	2,628	3,352
China	1,650e	1,650e
Canada	409	417
Japan	413	366
Norway	288	275e
Other countries	290	909
Total	37,550	45,725

Sources: Dominion Bureau of Statistics; U.S. BUREAU OF MINES MINERALS YEARBOOK, 1963.
e Estimate.

CONSUMPTION AND USES

About 67 per cent of molybdenum consumed is in the form of molybdic oxide followed in order by ferromolybdenum and molybdenum powder. Molybdenum is used in lesser amounts in calcium, sodium and ammonium molybdate, in molybdenum disulphide and in molybdenite concentrate added directly to molten steel.

Small additions of molybdenum promote uniform hardness and strength in heavy steel sections. This ability to improve combinations of strength and toughness is the most notable effect of molybdenum as a steel additive.

Metallic molybdenum is a refractory metal produced in the form of bars, sheet, plate, tube and wire. It is superior to most other metals in high-temperature applications and is used extensively in electronics and for missile parts that have a short working life. The design of solid-fuel rocket engines, which will operate beyond the melting point of molybdenum, will reduce the role of this metal in certain missile parts.

The uses of molybdenum chemicals have been increasing in recent years. As a catalyst, molybdenum is applied in processes designed to raise the octane rating of gasoline and in desulphurization. About 55 per cent of the molybdenum consumed by the pigment industry is employed in the production of molybdenum orange. The use of molybdenum as a trace element in soil conditioners, though still small, is becoming increasingly important.

TABLE 5

United States Consumption of Molybdenum by Use
(000's pounds of contained molybdenum)

	1962	1963	1964e
Steel			
High-speed	2,273	2,089	..
Other alloys	21,043	22,869	..
Miscellaneous*	718	931	..
Grey and Malleable castings	3,248	3,287	..
Rolls (steel mills)	1,564	1,907	..
Welding rods	239	238	..
High-temperature alloys	1,314	1,396	..
Molybdenum metal wire, rod and sheet	2,250	1,548	..
Chemicals			
Catalysts	690	688	..
Pigments and other colour compounds	859	908	..
Miscellaneous**	1,476	1,617	..
Total	35,674	37,478	41,000

Source: U S. BUREAU OF MINES MINERALS YEARBOOK 1962 AND 1963.* Includes casting as well as hot-work and tool steels. ** Includes special alloys, lubricants, refractories, magnets and corrosion- and heat-resistant casting.

Symbols: e Estimated; .. Not available.

Molybdenum is of great strategic value to the United States not only for its particular alloying properties but also because it can be used as a partial substitute for tungsten, nickel, chromium and vanadium in low-alloy and certain highspeed steels.

Among the more important Canadian consumers of molybdenum primary products are: in Ontario – Atlas Steels Division of Rio Algom Mines Limited, Welland; The Algoma Steel Corporation, Limited, Sault Ste. Marie; Dominion Foundries and Steel, Limited, Hamilton; Welmet Industries Limited, Welland; Canadian General Electric Company Limited, Toronto; The Steel Company of Canada, Limited, Hamilton; and Dominion Colour Corporation Limited, New Toronto; in Quebec – Crucible Steel of Canada Ltd., Sorel; Canadian Steel Foundries Limited, Montreal; and Dominion Brake Shoe Company, Limited, Joliette; in Nova Scotia – Dominion Steel and Coal Corporation, Limited, Sydney.

PRICES

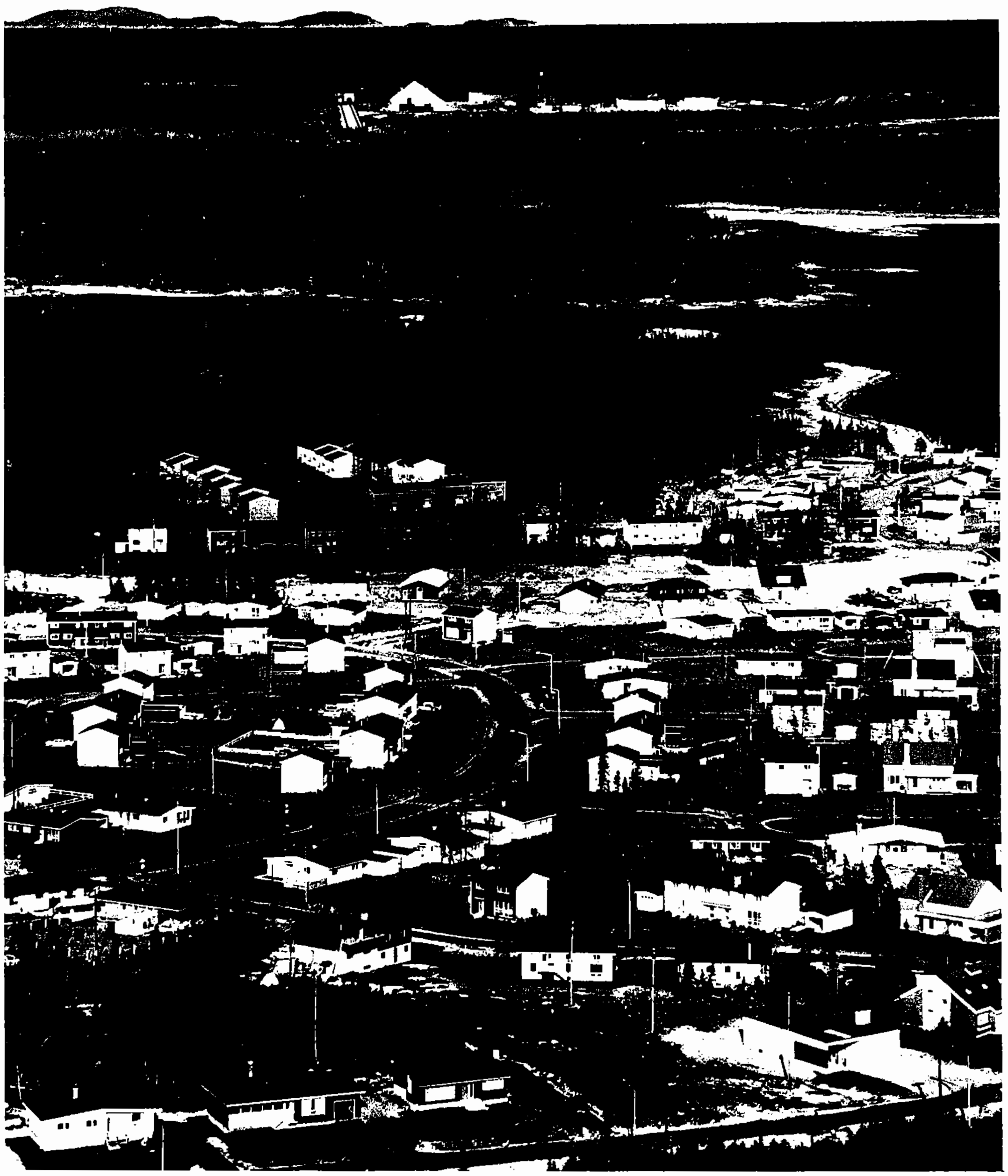
E & MJ METAL AND MINERAL MARKETS of December 28, 1964, quotes molybdenum prices in the United States as follows:

	($ per lb)
Molybdenum powder, carbon-reduced, f.o.b. shipping point	3.35
Molybdenum ore, contained Mo, 95% MoS_2, f.o.b. shipping point Climax, cost of containers extra	1.55
Molybdic trioxide, contained Mo, f.o.b. shipping point	
bags	1.74
cans	1.75
Ferromolybdenum, contained Mo, packed, f.o.b. shipping point, 58–64% Mo, powdered,	
lots 5,000 lb or more	2.10
other sizes	2.04
Calcium molybdate, contained Mo, lumps, packed	1.78

TARIFFS

CANADA	British Preferential	Most Favoured Nation	General (%)
Calcium molybdate and molybdic oxide........	free	free	5
Molybdenum strip	free	free	30
Molybdenum wire, rod and tubing, and molybdenum imported by manufacturers of radio tubes and parts...................	free	free	30
Ferromolybdenum	free	5%	5
Molybdenum ores and concentrates	free	free	free

UNITED STATES	(¢ per lb contained Mo)
Molybdenum ores and concentrates	24
Calcium **molybdate,** ferromolybdenum and other compounds of molybdenum	20 plus 6%
Molybdenum metal	
unwrought.....................................	20 plus 6%
wrought.......................................	25.5%
waste and scrap	21%
(duty on scrap suspended to June 30, 1965)	



Port Cartier townsite with harbour in distance.

Natural Gas

D.W. RUTLEDGE*

The most important development in the natural gas industry during the year was the unusually large increase in reserves, which were the greatest in the history of the Canadian industry. The centre of gas resources shifted in a northwesterly direction as large new reserves were outlined in western and northern Alberta and in northeastern British Columbia. The spectacular rise in production that began in 1956 following the Alberta government's decision in 1953 to permit large extra-provincial exports continued in 1964. Main areas of market growth in 1964 were Ontario and the western United States. Before any further major expansion of exports can take place, new export permits must be obtained by the industry.

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 be included. 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 differ 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 non-hydrocarbon 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 heating 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.

*Mineral Resources Division
Notes[1] All volumes of gas are given at 14.73 pounds per square inch absolute (psia) except where noted.[2] Mcf = 1,000 cubic feet.

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 from the sour gas (hydrogen sulphide bearing) fields in western Canada.

PRODUCTION

New net production of natural gas, exclusive of withdrawals from storage and gas flared and wasted, totalled 1,317,718 million cubic feet, or 3,570 million cubic feet a day in 1963. The rate of production increase was 18.5 per cent, approximately the same as in 1963. Table 1 lists the main gas producing fields in Canada. Production from several of these fields was not marketed, but was

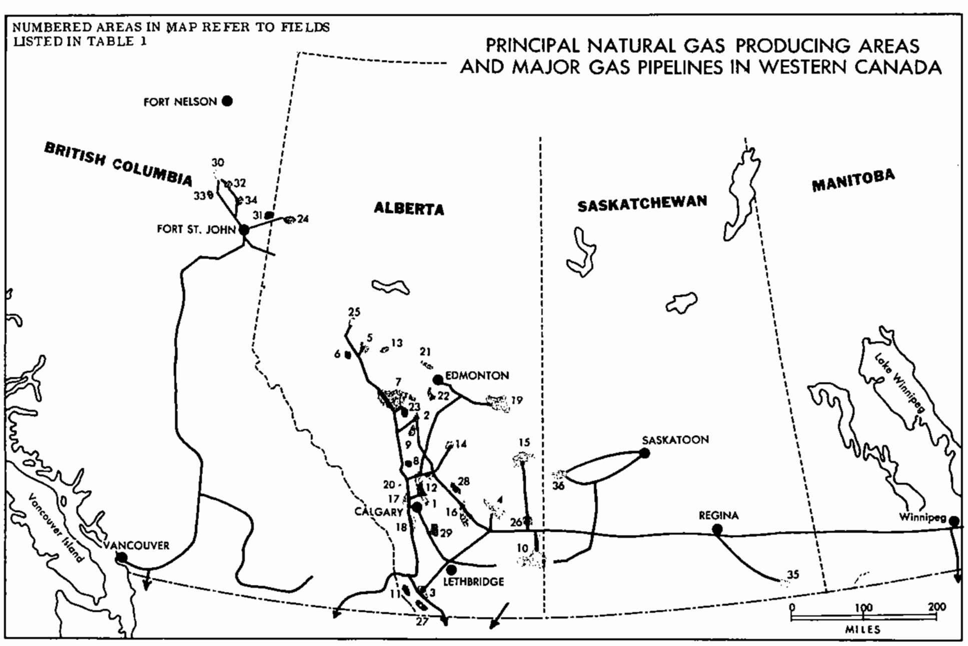


TABLE 1

Natural Gas Fields Producing 10 Million Mcf or More
(Mcf)*

(The numbers following field names refer to map locations)

	1963	1964
Alberta		
Crossfield 1	73,297,707	80,635,737
Westerose South 2	55,302,613	69,253,614
Cessford 4	48,510,110	65,004,470
Pine Creek 6	43,545,929	55,718,714
Windfall 5	49,825,062	52,886,732
Waterton 11	31,755,383	51,335,462
Homeglen-Rimbey 9	35,999,139	50,737,457
Medicine Hat 10	34,311,118	41,692,395
Pembina 7	37,983,029	40,146,487
Harmattan-Elkton 8	36,358,851	36,713,390
Carstairs 12	31,407,118	36,654,864
Pincher Creek 3	48,516,912	34,737,409
Carson Creek 13	26,087,649	32,843,099
Harmattan East 21	2,097,000	31,626,514
Provost 15	24,089,738	27,779,541
Nevis 14	24,798,738	25,685,971
Gilby 9	13,577,274	25,273,346
Jumping Pound 17	21,976,123	21,549,071
Viking-Kinsella 19	20,674,453	21,095,058
Turner Valley 18	21,378,145	20,796,276
Hussar 16	22,640,040	19,798,864**
Wildcat Hills 20	16,148,593	16,879,268
Leduc-Woodbend 22	15,113,286	16,555,267
Bindloss 26	11,689,549	16,454,730
Minnehik-Buck Lake 23	14,285,826	14,974,439
Worsley 24	13,781,072	13,934,722
Countess 16	4,985,108	12,643,866**
Kaybob 25	13,245,527	12,356,561
Lookout Butte 27	3,732,958	11,777,799
Wayne-Rosedale 28	5,769,513	10,454,371
Okotoks 29	9,998,586	10,289,153
British Columbia		
Jedney 30	17,128,154	21,530,222
Laprise Creek 30	12,089,044	14,835,933
Boundary Lake 31	13,025,613	12,467,240
Nig Creek 32	11,412,777	12,114,908
Beg 33	10,035,869	11,390,482
Buick Creek 34	8,435,867	11,234,488
Saskatchewan		
Steelman 35	15,106,896	14,570,452
Coleville-Smiley 36	14,630,100	14,134,117

Source: Provincial government reports: gross reservoir withdrawals.

*At 14.65 psia. **In 1964, Countess includes a former portion of the Hussar field.

reinjected underground after removal of gas liquids to maintain reservoir pressure. Table 2 shows fields where gas was re-injected for pressure maintenance or storage. Table 3 gives an accounting of total gas withdrawn from reservoirs and amounts that were wasted to obtain net production. Table 4 shows percentage increases by province and provincial shares of production. Table 5 shows values of gas produced and Table 6 gives a historical coverage of production, imports, exports and sales of gas in Canada. For production of liquid Hydrocarbons and sulphur extracted from natural gas, reference should be made to Table 7 which illustrates the important position these gas byproducts have attained.

TABLE 2

Pressure Maintenance Injection and Storage of Natural Gas

(Mcf)

Alberta fields*	1963 Input	1963 Reproduction	1964 Input	1964 Reproduction
Bow Island	1,649,552	1,461,570	1,524,861	1,258,706
Campbell-Namao	–	–	–	–
Carson Creek	22,993,240	–	29,456,791	–
Duhamel	148,010	–	151,773	–
Garrington	2,285	–	–	–
Golden Spike	2,146,538	–	3,997,483	–
Harmattan East	2,097,000	–	27,520,743	–
Harmattan-Elkton	33,995,781	19,332	34,094,248	–
Jumping Pound	2,459,786	2,526,368	2,420,485	1,723,724
Leduc-Woodbend	6,000,921	–	6,779,918	–
Lookout Butte	3,009,692	–	11,158,467	–
Pembina	12,035,201	–	14,223,032	–
Pincher Creek	–	1,614,452	66,705	980,173
Sundre	616,769	–	592,815	–
Turner Valley	871,186	102,136	1,391,098	505,040
Westerose	1,162,413	–	953,062	–
Windfall	46,052,173**	–	56,939,541**	–
Total (14.65 psia)	135,240,547	5,723,858	191,271,022	4,467,643
Volume adjusted to 14.73 psia	134,510,248	5,692,949	190,238,158	4,443,518
Ontario*	26,210,562	24,387,443	26,176,247	23,980,409
Saskatchewan*	3,959,532	937,787	3,712,816	1,787,642
Total, Canada	164,680,342	31,018,179	220,127,221	30,211,569

*Source: Provincial government reports. **Mainly from Pine Creek field, for pressure maintenance.

– Nil

TABLE 3

Production of Natural Gas

	1963r		1964p	
	Mcf*	$	Mcf*	$
Gross new production**				
New Brunswick	103,524		105,055	
Ontario	15,920,055		13,738,588	
Saskatchewan	60,414,372		62,692,732	
Alberta	995,599,564		1,174,112,187	
British Columbia	133,026,478		146,008,139	
Northwest Territories	51,478		34,297	
Total, Canada	1,205,115,471		1,396,690,998	
Waste and Flared				
Saskatchewan	20,693,834		21,335,753	
Alberta: Plant and System	7,220,814		9,344,733	
Fields	50,117,894		47,028,592	
British Columbia	15,605,003		10,609,053	
Total, Canada	93,637,545		78,973,398	
Net New Production				
New Brunswick	103,524	109,520	105,055	111,998
Ontario	15,920,055	6,049,621	13,738,588	5,082,144
Saskatchewan	39,720,538	2,364,223	41,356,979	4,676,866
Alberta	938,260,856	129,428,302	1,127,083,595	154,635,870
British Columbia	117,421,475	12,495,718	135,399,086	12,143,944
Northwest Territories	51,478	21,330	34,297	14,275
Total, Canada	1,111,477,926	150,468,714	1,317,717,600	176,665,097

Source: Dominion Bureau of Statistics.
*At a pressure base of 14.73 psia at 60 F. **Excludes withdrawals from storage.
Symbols: p Preliminary; r Revised.

TABLE 4

Comparison of 1963 and 1964 Production

	1964 Net New Production Increase or Decrease	Share of Production 1963	Share of Production 1964
	%	%	
Alberta	+20.1	84.4	85.5
British Columbia	+15.3	10.6	10.3
Saskatchewan	+10.4	3.5	3.1
Ontario	−13.7	1.4	1.0
New Brunswick	+ 1.5	negligible	negligible
Northwest Territories	−33.4	negligible	negligible

TABLE 5

Value of Net Gas produced 1963-1964

	1963		1964p	
	Total Value ($)	Average Value (¢ per Mcf)	Total Value ($)	Average Value (¢ per Mcf)
Alberta	129,428,302	13.7	154,635,870	13.7
British Columbia	12,495,718	10.6	12,143,944	9.0
Saskatchewan	2,364,223	5.9	4,676,866	11.3
Northwest Territories	21,330	41.4	14,275	41.6
Ontario	6,049,621	38.0	5,082,144	37.0
New Brunswick	109,520	105.8	111,998	106.6
Total, Canada	150,468,714	13.5	176,665,097	13.4

Source: Dominion Bureau of Statistics.
p Preliminary.

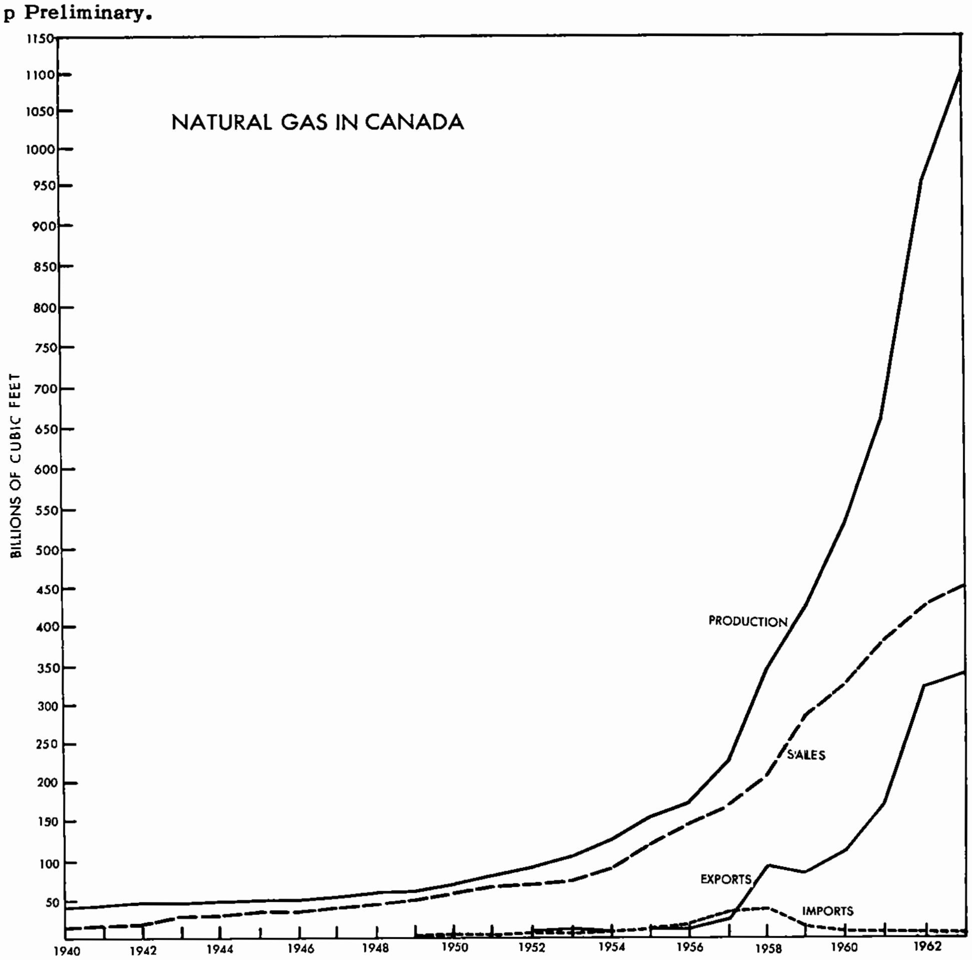


TABLE 6

Production, Trade and Total Sales, 1954–64
(Mcf)

	Production	Imports	Exports	Sales in Canada
1954	120,735,214	6,235,859	6,983,985	87,466,838
1955	150,772,312	11,165,756	11,356,252	117,800,311
1956	169,152,586	15,695,359	10,828,338	143,725,649
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
1964p	1,317,717,600	8,046,365	404,143,095	504,503,388

Sources: Dominion Bureau of Statistics. Production and total sales, from The Crude Petroleum and Natural Gas Industry. Imports, from Trade of Canada. Exports: 1954–1956, from Gas Utilities. 1957–64 from Trade of Canada.

p Preliminary.

EXPLORATION AND DEVELOPMENT

GENERAL

A total of 391 gas wells were completed in Canada compared to 444 in 1963 (Table 8). The decrease was largely attributable to reduced development in gas fields in western Canada where present production capacity is more than capable of meeting immediate requirements. Exploration for new gas reserves was concentrated in a few specific areas where initial work indicated large gas accumulations. Exploration drilling was particularly successful in the Edson, Cutbank River, Marten Hills and Calling Lake regions of Alberta, and in the general Fort Nelson region of northeastern British Columbia. A significant increase in exploratory activity occurred in the Yukon and Northwest Territories. Geophysical field work declined slightly, but seismic surveys were successful in indicating the gas-bearing horizons in some of the aforementioned regions. In terms of crew-months, seismic surveys were regionally distributed as follows: Alberta, 406; British Columbia, 89; Saskatchewan, 53; Yukon and Northwest Territories, 61; Manitoba, 1; and Eastern Canada, 17. The total was 627 crew-months.

ALBERTA

In Alberta, a total of 10.3 million feet was drilled, surpassing the previous records of 10.1 million feet drilled in both 1956 and 1960. Exploratory drilling comprises 38 per cent of this total, and though the primary objective of a large proportion of the exploratory drilling in some parts of the province was to find oil, a substantial number of natural gas occurrences were found in the course of this search. Ninety-three exploratory oil wells were completed compared to 121 exploratory gas wells. The latter figure represents a marked increase from the preceding year, but this was offset by a corresponding decrease in the number of development wells completed in gas fields.

Considerable success was attained in locating new reserves of natural gas in 1964. One of the more outstanding areas was the Cutbank River region, 25

TABLE 7

Liquids and Sulphur Production from Canadian Natural Gas, 1954–64

	Propane (barrels)	Butane (barrels)	Condensate/ Pentanes plus (barrels)	Sulphur (long tons)
1954	529,117	245,189	700,461	19,929
1955	796,482	492,051	1,028,516	25,976
1956	925,716	591,638	1,078,145	29,879
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	4,353,871r	3,273,625r	21,759,526	1,281,999
1964p	7,610,727	5,654,797	25,263,008	1,472,583

Sources: Dominion Bureau of Statistics and provincial government reports.
Symbols: p Preliminary; r Revised.

TABLE 8

Wells Completed*

	Oil Wells		Gas Wells		Dry Holes		Total	
	1963	1964	1963	1964	1963	1964	1963	1964
Alberta	869	861	275	266	560	663	1,704	1,790
Saskatchewan	572	636	41	30	338	588	951	1,254
British Columbia	31	45	70	37	82	60	183	142
Manitoba	29	63	–	–	15	37	44	100
Yukon and Northwest Territories	–	–	–	3**	6	15	6	18
Total, western Canada	1,501	1,605	386	336	1,001	1,363	2,888	3,304
Ontario	32	33	57	55	113	128	202	216
Quebec	–	–	–	–	14	10	14	10
Maritimes	–	–	–	–	1	1	1	1
Total, eastern Canada	32	33	57	55	128	139	217	227
Total, Canada	1,533	1,638	443	391	1,129	1,502	3,105	3,531

Sources: Provincial and federal government reports.
*Service wells excluded. **Suspended wells.
– Nil.

miles south of Grande Prairie, where in 1963 a 'land play' involving the sale of costly drilling reservations attracted much attention. Seismic surveys had indicated reefs at considerable depths. The first successful well was Pan Am Gold Creek 4–34–67–4–W6, completed in January 1964 on a $3.2 million drilling reservation. The well was unofficially reported to have intersected 250 feet of wet gas pay zone at a depth of 11,000 feet in the Devonian Wabamun (D–1) formation. Shell Smoky River 10–20–67–5–W26, completed two months later, eight miles to the west, found more than 200 feet of gas zone in the Wabamun as well as gas in Leduc (D–3) reef.

The 1962 gas discovery in the Mississippian Elkton formation at Edson has been expanded to a field some 30 miles long and up to 12 miles wide. More than two dozen widely-spaced gas wells have been drilled but the field has not yet been delimited, especially at the southern end. More than a trillion (1,000,000 million) cubic feet of gas have been indicated, one of the largest gas reserves to be found in Canada in many years. In the Obed region, 35 miles west of Edson, the deepening of a 1956 Mississippian gas well revealed significant gas occurrences in two Devonian horizons near a depth of 13,000 feet. The well, Imperial et al. Obed 5–13–54–23–W5, produced a large flow of sour gas (20 per cent H_2S) from the Winterburn formation and an unspecified amount of gas from a D–3 reef.

Three more gas wells were completed in the Marten Hills region, 40 miles northeast of Lesser Slave Lake. Since the discovery of natural gas in the Marten

TABLE 9

Footage Drilled in Canada, by Provinces, 1963 and 1964

	Exploratory		Development		All Wells	
	1963	1964	1963	1964	1963	1964
Alberta	3,121,629	3,921,753	6,685,162	6,418,769	9,806,791	10,340,522
Saskatchewan*	997,375	1,501,532	2,215,745	2,688,250	3,213,120	4,189,782
British Columbia	522,422	289,166	376,298	385,676	898,720	674,842
Manitoba	31,789	81,216	110,774	175,515	142,563	256,731
Northwest Territories	62,643	113,088	Nil	Nil	62,643	113,088
Total, western Canada	4,735,858	5,906,755	9,387,979	9,668,210	14,123,837	15,574,965
Ontario	217,600	232,364	187,782	256,909	405,382	489,273
Quebec	20,121	23,905	794	–	20,915	23,905
Maritimes	3,507	9,853	Nil	Nil	3,507	9,853
Total, eastern Canada	241,228	266,122	188,576	256,909	429,804	523,031
Total, Canada	4,977,086	6,172,877	9,576,555	9,925,119	14,553,641	16,097,996

Sources: Provincial government departments and agencies and Department of Northern Affairs and National Resources; for Quebec and Maritimes, Geological Survey of Canada.

*Excludes 238,861 feet in service wells in 1963 and 266,149 feet in 1964.

– Nil.

Hills in 1961, 11 widely separated gas wells have been completed, and have delineated a productive area at least 21 miles long and up to 13 miles wide. Pan American Petroleum Corporation, the main operator in the region, outlined drilling objectives with seismic surveys and obtained a high degree of success in drilling. Large gas reserves have been outlined, mainly in the Lower Cretaceous Wabiskaw formation at the relatively shallow depth of 2,000 to 3,000 feet. An apparently large gas reservoir was discovered in 1964 in the Calling Lake region 40 miles southeast of the Marten Hills. The discovery well, HB Calling Lake 7–23–71–18–W4, intersected about 100 feet of highly porous gas-bearing zone in the buried, eroded edge of the Devonian Nisku formation at a depth of 1,500 feet. A 'follow-up' well, drilled 4½ miles to the northwest, obtained similar results, but three other wells, drilled along the trend by the same operator, were abandoned.

A marked decline in gas field development was evident in 1964, but nevertheless the number of gas wells capable of production was increased from 1,437 to 1,628. The increase was partly the result of the conversion to productive capability of many formerly capped gas wells. At the end of 1964, 92 per cent of the 'capable' gas wells were in production. An additional 1,437 gas wells remained capped, mainly because of a lack of pipeline facilities. With continuing development, acreage and reserves of the established Cretaceous gas fields in southeastern Alberta were enlarged, particularly the larger fields such as Medicine Hat, Provost and Princess.

Eighteen more tracts were designated as gas fields, many of them consisting of relatively small groups of gas wells in the southeastern quadrant. Among the larger of the newly designated gas fields were Edson, Bigstone, Olds, Lone Pine Creek, Hunter Valley and Wildhorse Creek, all in western Alberta. In central Alberta, considerable development was carried out in the multiple-zone oil and gas fields of Sylvan Lake and Medicine River. Production was increased from the Westlock field, north of Edmonton following completion of new marketing arrangements and a gas pipeline.

BRITISH COLUMBIA

Drilling declined for the second successive year. Total drilling amounted to 674,800 feet, 25 per cent less than in 1963. Forty-three per cent of the drilling was exploratory and 57 per cent was development. As in previous years, exploration for natural gas was almost wholly in the northeastern part of the province in two main sectors: the area within 100 miles of Fort St. John where Triassic sandstone and dolomites were the main horizons tested, and the Fort Nelson region where Middle Devonian Slave Point carbonate reefs were the chief exploratory targets. About 60 per cent of the exploratory wells were drilled in the Triassic sector where several gas discoveries were made.

The most southerly gas discovery yet made in the Foothills of British Columbia was Gray Oil PRP NW Grizzly c–25–A, which found a thick gas-bearing section in the Jurassic Nikanassin Formation in the Monkman Pass, 100 miles south of Fort St. John The largest gas discoveries were in the northern sector along the extensive Slave Point reef front that extends from the Clarke Lake gasfield to the Northwest Territories. Two of these wells, drilled 15 miles southwest of Kotcho Lake, enlarged the known extent of the Yoyo pool. A gas well completed in the Cabin District, Western Natural gas Cabin a–19–G, provided further clarification of the productive reef trend between Kotcho Lake and the Petitot River field. On the whole, the extensive gas-bearing region northeast of Clarke Lake remains only sparsely drilled, and will probably remain so until conditions warrant the extending of the gas transmission line from Clarke Lake. The pipeline to southern markets from the Clarke Lake field was nearly completed by the end of the year and led to the preparation of the field for full-scale production. The field had eight gas wells classed as capable of production.

SASKATCHEWAN AND MANITOBA

In Saskatchewan, output of natural gas from reservoirs that are primarily gas producers is relatively small, and most of the output is solution gas, a byproduct of oil production. Development of existing gas pools, mainly in the Hatton and Coleville-Smiley fields, declined in comparison with 1963. Thirty gas wells were drilled compared to 41 in 1963. No important gas discoveries were made. Exploration for gas in the province may be encouraged by new provincial legislation that ended the gas-purchase monopoly of Saskatchewan Power Corporation.

Because of the deficiency of gas reserves in Saskatchewan, underground gas storage has become very important. Solution mining of a 350 million cubic foot gas storage cavern in salt formation at Melville was completed. A solution cavern to hold 150 million cubic feet was created near Regina and a second cavern was started. Two water supply wells and a water disposal well were drilled near Prud'homme, northeast of Saskatoon, in preparation for solution mining of a storage cavern.

Manitoba has no commercial production of natural gas and no gas wells were drilled.

YUKON AND NORTHWEST TERRITORIES

A total of 113,100 feet was drilled, all of an exploratory nature. Eighteen wells were drilled compared to six in 1963. There were three gas discoveries. The known gas productive eastern edge of the Slave Point reef was extended into the Northwest Territories by the discovery of gas in HB Pan Am S Island River M–41 which was drilled immediately north of the British Columbia boundary. In the foothills, a northern extension of British Columbia's Beaver River gas occurrence was indicated by Canada Southern et al. North Beaver River YT–I–27. Technical difficulties encountered in the well in 1963 were overcome and a moderate flow of gas was produced from the Nahanni carbonate. Considerable exploration work was carried out in the Eagle Plains region of the northern Yukon Territory, and a natural gas discovery was reported in the Cretaceous. The third Arctic island well, on Bathurst Island, was completed as a dry hole at a depth of 10,000 feet. Traces of oil were intersected near 5,000 feet, and the well bottomed in a geologically significant thick section of Lower Paleozoic salt.

EASTERN CANADA

In Ontario, total footage drilled (excluding service wells) was 431,100 feet. Exploratory drilling constituted 54 per cent of the total. Fifty-five gas wells were completed out of the total of 216 drilled. Only three of the exploratory wells located gas; the remaining 52 gas wells were to develop existing fields. Eighteen of the gas wells were in Lake Erie. An apparently important new gas pool was found in one of the Lake Erie development gas wells. As in previous years, the majority of the gas wells produce from the Silurian; the oil wells, on the other hand, were predominantly Cambrian.

Several companies took out exploratory permits in Hudson Bay covering about 55 million acres in the southwestern quadrant of the bay. Offshore aeronagnetic and seismic surveys were carried out by combined federal and provincial government parties. One company plans to start extensive geophysical testing of its offshore Hudson Bay holdings in 1965.

In Quebec, 10 exploratory wells were drilled, all dry. In the Atlantic provinces, the one well undertaken was drilled to a depth of 9,853 feet near Pugwash, Nova Scotia, and found to be dry. Exploration permits covering large areas of the continental shelf were taken out by several companies. Two main areas are held: the shelf of Nova Scotia extending to just beyond Sable Island, and the Grand Banks off Newfoundland. Seismic reconnaissance surveys were undertaken off the Nova Scotia coast in 1964.

RESERVES

Additions to reserves of natural gas were the largest in the history of the industry. A compilation by the Canadian Petroleum Association (Table 10) shows that a net addition of 17.4 per cent increased recoverable reserves of natural gas to 43,391,000 million cubic feet. At the 1964 rate of gross new production, these reserves are sufficient to last 31 years. Eighty-three per cent of the added reserves were in Alberta, which possesses 81 per cent of total reserves. The

TABLE 10

Estimated Year-End Recoverable Reserves of Natural Gas

(Mcf)

	1963	1964
Alberta	29,916,388	35,198,661
British Columbia	5,765,790	6,931,445
Saskatchewan	1,008,955	1,040,669
Eastern Canada	210,907	161,243
Northwest Territories	56,114	55,383
Manitoba	1,869	3,473
Total	36,960,023	43,390,874

Source: Canadian Petroleum Association.

Alberta Oil and Gas Conservation Board's estimate of the province's gas reserves was 35,267,000 million cubic feet, slightly above the CPA estimate. Despite some evidently important gas discoveries in 1964 such as those at Cutbank River and Obed, a relatively small proportion of the reserve increase was assigned to new discoveries. Extensions and revisions of previously known occurrences accounted for most of the additions. The assessment of discoveries made since 1960 accounted for a major part of new reserves. The biggest individual additions in Alberta were in the Mississippian reservoirs of the Edson and Jumping Pound West fields, where in each case, an additional 600,000 million cubic feet were estimated as recoverable. Other main increases were in the Marten Hills, Waterton, Bigstone, Crossfield Mississippian, Burnt Timber and Pembina Cardium pools. Reserves at the Pincher Creek field were decreased by more than half on the basis of reservoir performance and water intrusion. In British Columbia, nearly all the new reserves were along the Middle Devonian reef fronts extending from Fort Nelson in a northeasterly direction to the boundary of the Northwest Territories.

NATURAL GAS PROCESSING

Processing is carried out in order to meet pipeline and consumer specifications or conservation requirements and most Canadian natural gas is processed in plants in or near the fields. Eighty-four per cent of the marketable gas produced in Alberta came from gas processing plants.

Thirteen new gas processing plants were completed in 1964, and two small plants closed down. A total of 95 plants were operative at the year's end, of which 84 were in Alberta. Total raw gas processing capacity of all plants was 5,469 million cubic feet daily compared to 3,841 million at the end of 1963. Pacific Petroleums, Ltd. built the largest gas plant in the world, in terms of capacity, on The Alberta Gas Trunk Line Company gas pipeline near Empress, close to the Alberta-Saskatchewan boundary. This plant has a daily input capacity of 1,000 million cubic feet. Most of the gas processed at this plant was previously processed at field plants in Alberta, before delivery to Alberta Gas Trunk, but additional quantities of propane, butane and heavier gas liquids are now being removed at the Empress plant. A separate new pipeline transports the extracted liquids to markets as far east as Winnipeg. Other new gas plants in Alberta were constructed in the Gilby, Olds, Cessford, Sylvan Lake, Retlaw, Wayne-Rosedale, Three Hills Creek and Crossfield fields. Westcoast Transmission Company Limited completed a 200 million cubic feet-a-day plant near Fort Nelson, British Columbia. This plant will not be fully operative until early 1965 following the completion of the new northern spur of Westcoast's pipeline system. Table 11 lists the fields served by natural gas processing plants and the number and capacities of plants.

TABLE 11

Processing Plant Capacities by Fields, 1964

(millions of cubic feet a day)

Fields Served	Raw Gas Capacity	Residue Gas Produced
Alberta		
Acheson	6	5
Alexander	55	53
Black Butte, Aden	10	10
Bonnie Glen, Glen Park, Wizard Lake	35	30
Boundary Lake South	25	22
Crossfield	190	152
Crossfield Cardium	3	2
Carbon	67	65
Carson Creek	100	re-inj.*
Carstairs, Crossfield	225	202
Cessford (5 plants)	202	195
Cessford, Connorsville	5	5
Chigwell (2 plants)	12	10
Countess	22	21
Enchant	5	5
Gilby (6 plants)	96	87
Golden Spike	26	22
Harmattan-Elkton, Harmattan East	230	re-inj.
Homeglen-Rimbey, Westerose South	367	314
Hussar (2 plants)	90	90
Innisfail	15	10
Judy Creek, Swan Hills, Virginia Hills	55	40
Jumping Pound, Sarcee	110	90
Kaybob	41	40
Kessler	6	6
Leduc-Woodbend	35	31
Lookout Butte	38	re-inj.
Minnehik-Buck Lake	57	51
Morinville, St. Albert-Big Lake, Campbell-Namao	25	25
Nevis	56	48
Nevis, Stettler, Fenn-Big Valley	45	35
Okotoks	30	13
Olds	44	34
Oyen	3	3
Pembina (9 plants)	96	77
Pembina (Cynthia)	10	9
Pembina (Lobstick)	25	22
Pincher Creek	204	145
Prevo	5	4
Princess (2 plants)	15	15
Provost (3 plants)	103	96
Redwater	11	8
Retlaw	7	7
Samson	3	3

Table 11 (cont.)

Fields Served	Raw Gas Capacity	Residue Gas Produced
Alberta (cont.)		
Savanna Creek	75	63
Sedalia	5	5
Sibbald	6	5
Sylvan Lake	22	20
Three Hills Creek (2 plants)	15	14
Turner Valley	100	85
Waterton	180	121
Wayne-Rosedale (3 plants)	37	34
Wildcat Hills	96	83
Windfall	215	132
Wood River	5	5
Worsley	55	52
Pipeline at Edmonton	70	66
Pipeline near Empress	1,000	965
Saskatchewan		
Alida, Nottingham, Carnduff	9	6
Coleville	60	59
Smiley	4	3
Steelman, West Kingsford	38	30
Cantuar	25	24
Dollard	2	2
British Columbia		
Fields in Fort St. John area	395	300
Boundary Lake (2 plants)	27	25
Clarke Lake	200	170
Ontario		
Fields in southwestern Ontario (2 plants)	18	18

Source: (Operators List 7), January 1965, Department of Mines and Technical Surveys, Natural Gas Processing Plants in Canada.

*A minor amount is sold.

TRANSPORTATION

At the end of 1964, there were 41,806 miles of gathering, transmission and distribution gas pipeline in Canada (Table 12). About 1,500 miles were laid during 1964. One of the largest pipeline construction projects undertaken during the year was the laying of 220 miles of 30-inch transmission line by Westcoast Transmission Company Limited from its existing system near Chetwynd, British Columbia, to Fort Nelson. The line will be completed early in 1965 making British Columbia's largest developed gas reserve, the Clarke Lake field, available to southern markets. Trans-Canada Pipe Lines Limited continued to add 34-inch loops in western Canada to its original system. Five sections totalling 149 miles were laid in Saskatchewan and Manitoba, bringing the total length of 34-inch loops to 413 miles.

The Alberta Gas Trunk Line Company added 87 miles of 34-inch loop between the Attlee-Buffalo field and Hussar, and completed a 74-mile extension of 34-inch line from Hussar to Carstairs. The company also added 41 miles of laterals to new sources of gas including the Sylvan Lake, Olds, Crossfield East, Retlaw and Verger fields. Gas gathering systems were laid in these fields by other companies. Mid-Western Industrial Gas Ltd. laid 18 miles of 10-inch line from the Westlock field to Fort Saskatchewan. Northwestern Utilities, Limited, added 64 miles of pipeline including lines to serve Whitecourt and Wabamun. Approximately 100 miles of gathering lines were added to the extensive

TABLE 12

Gas Pipeline Mileage in Canada, 1961–64

	1961	1962	1963r	1964p
Gathering*				
New Brunswick	6	6	6	6
Ontario	1,314	1,314	1,150	1,060
Saskatchewan	275	298	309	389
Alberta	2,439	2,540	2,920	3,094
British Columbia	429	409	409	409
Total	4,463	4,567	4,794	4,958
Transmission*				
New Brunswick	13	13	13	13
Quebec	25	25	25	25
Ontario	3,135	3,141	3,265	3,365
Manitoba	457	496	631	731
Saskatchewan	2,274	2,566	2,832	3,081
Alberta	4,088	4,293	4,311	4,739
British Columbia	1,225	1,311	1,311	1,319
Total	11,217	11,845	12,388	13,273
Distribution				
New Brunswick	33	33	33	33
Quebec	1,123	1,144	1,203	1,259
Ontario	10,184	10,865	11,700	12,292
Manitoba	854	947	1,117	1,171
Saskatchewan	1,273	1,425	1,536	1,637
Alberta	2,896	3,100	3,224	3,340
British Columbia	3,183	3,427	3,647	3,843
Total	19,545	20,940	22,459	23,575
Total, Canada	35,225	37,352	39,641	41,806

Source: Dominion Bureau of Statistics.

*Some lines in Ontario and Saskatchewan were reclassified or discontinued in 1961;some in New Brunswick were discontinued.

Symbols: p Preliminary; r Revised.

Medicine Hat-Hatton field by Saskatchewan Power Corporation and North Canadian Oils Limited. Saskatchewan Power Corporation added a total of 254 miles of gathering and gas transmission pipelines, including 16- and 14-inch lines in the Medicine Hat area. The company constructed 113 miles of distribution mains and extended natural gas service to 22 communities.

In Manitoba, Greater Winnipeg Gas Company added 86 miles of pipeline, including 16 miles of 12-inch line to provide gas to the town of Selkirk.

In Ontario, Union Gas Company of Canada, Limited initiated a new big-inch project by laying 56 miles of 34-inch line from underground storage facilities in Lambton County to London. This line will eventually be extended to the Trans-Canada pipeline at Oakville. The Consumers' Gas Company connected its system to the underground storage facilities of Tecumseh Gas Storage Limited near Sarnia. This program included the laying of 14 miles of 30-inch pipeline and several smaller lines.

At the end of 1964, the United States Federal Power Commission was studying an application from Trans-Canada Pipe Lines Limited requesting authority to construct a natural gas pipeline in the United States from the international boundary at Emerson, Manitoba, to Sarnia, Ontario. The proposed line would be 36 inches in diameter and 989 miles long, and would be 130 miles shorter than a line around the northern perimeter of the Great Lakes parallel to its present route.

TABLE 13

Sales of Natural Gas in Canada, 1964p

	Mcf	$	Average $/Mcf	Number of Customers Dec. 31, 1964
New Brunswick	63,186	205,046	3.25	2,539
Quebec	33,166,492	30,416,512	0.92	242,822
Ontario	194,253,775	166,886,369	0.86	628,383
Manitoba	27,768,074	18,955,343	0.68	78,339
Saskatchewan	45,809,157	21,827,794	0.48	98,775
Alberta	160,828,728	51,469,385	0.32	243,588
British Columbia	42,613,976	38,222,271	0.90	165,173
Total, Canada	504,503,388	327,982,720	0.65	1,459,619
Previous Totals				
1960	320,701,484	194,422,714	0.61	1,149,101
1961	370,739,542	226,678,494	0.61	1,227,658
1962	412,061,509	257,589,445	0.62	1,308,085
1963	451,598,298	287,584,177	0.64	1,397,138

Source: Dominion Bureau of Statistics.
p Preliminary.

TABLE 14

Sales of Natural Gas in Canada, on Percentage Basis

	1963	1964
Ontario	37.11	38.51
Alberta	34.70	31.88
Saskatchewan	9.27	9.08
British Columbia	7.86	8.45
Quebec	6.01	6.57
Manitoba	5.03	5.50
New Brunswick	0.02	0.01
Total	100.0	100.0

Source: Dominion Bureau of Statistics.

MARKETS AND TRADE

Sales of natural gas in Canada increased 11.7 per cent compared with 9.6 per cent in 1963. Consistent with the trend of the past several years, the main area of market growth in Canada was Ontario, which was the largest consumer for the second consecutive year. Although natural gas has been available to the densely populated and industrialized Montreal area since 1957, sales in Quebec province have been increasing at a relatively slow rate. Table 13 shows the distribution of sales by province, and Table 14 shows provincial sales on a percentage basis. As Table 15 indicates, industrial sales account for slightly more than half of sales in Canada, and residential and commercial sales for the remainder.

Exports of natural gas accounted for 45 per cent of total sales. Exports to the United States increased 18.5 per cent in 1964 compared with 6.7 per cent in 1963. The markets served by the Alberta to California gas pipeline received a major share of the increase in exports. Forty-eight per cent of exports moved via that line, crossing the boundary at Kingsgate, British Columbia. About one quarter of this gas was destined for the Pacific northwest and the rest to the more southern regions. The pipeline of Westcoast Transmission Company Limited at Huntingdon, British Columbia carried 26 per cent of exports, a smaller proportion than in 1963. All of this gas is consumed in the Pacific northwest region. Exports through the Trans-Canada pipeline lateral at Emerson, Manitoba also increased appreciably for use in the Lakehead region; this line carried 18 per cent of total exports. Other gas export points in western Canada were at Aden, Carway, and very minor amounts at Coutts, Alberta. The only export point for Canadian gas in eastern Canada was at Cornwall, Ontario, where 0.5 per cent of total exports moved into the Massena-Ogdensburg area of New York state.

Two important applications for increased exports of natural gas to the United States were presented to the National Energy Board late in 1964. Trans-Canada Pipe Lines Limited requested permission to export an additional 186,000,000 cubic feet of gas daily at Emerson. Alberta and Southern Gas Co. Ltd. applied to

TABLE 15

Natural Gas – Supply and Demand
(Mmcf)

	1963r		1964p	
Supply				
Gross new production*	1,205,116		1,396,691	
Field waste and flared gas	– 93,638		–78,973	
Net new production		1,111,478		1,317,718
Removed from storage	31,018		30,212	
Placed in storage	–164,680		–220,127	
Net withdrawals from storage		–133,662		–189,915
Net supply of domestic gas		977,816		1,127,803
Imports		6,877		8,046
Total supply		984,693		1,135,849
Demand				
Exports		340,953		404,143
Residential sales	145,856		163,626	
Industrial sales	235,379		257,402	
Commercial sales	70,363		83,475	
Total domestic sales		451,598		504,503
Consumption and losses in production		144,841		180,614
Pipeline consumption, losses and metering differences		33,048		46,063
Line pack changes		404		684
Gas unaccounted for		13,849		–158
Total demand		984,693		1,135,849
Total domestic demand		643,740		731,706
Average daily domestic demand		1,764		1,999

Sources: Dominion Bureau of Statistics, and provincial government reports.
*Excludes gas reproduced from storage.
Symbols: p Preliminary; r Revised.

increase exports over the present permits by another 207,000,000 cubic feet a day by November 1, 1967. The latter application is being strongly opposed by the British Columbia government and some companies with large gas reserves and pipelines in British Columbia.

Imports of natural gas from the United States have formed a relatively small proportion of Canada's supply since the completion of the Trans-Canada pipeline. All imported gas enters directly into Ontario except for a negligible amount entering Alberta. Imports of gas increased 17 per cent in 1964 and constituted 1.6 per cent of sales in Canada. The National Energy Board authorized Union Gas Company of Canada, Limited, to approximately triple its imports at Windsor, Ontario, from the Panhandle Eastern Pipe Line Company. Annual imports allowed

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over the next 12 years will be 15,500 million cubic feet. Corresponding export authorization for the supplying company in the United States was issued early in 1965. Trans-Canada Pipe Lines Limited requested governmental permission to import gas at Niagara Falls from Tennessee Gas Transmission Company on a short-term basis to augment supplies until additional capacity is available from western Canada.

Algoma Ore Div. George W. Macleod headframe with mined-out Helen mine in background.

Nepheline Syenite

J.E. REEVES*

The Canadian nepheline syenite industry continues to grow steadily; production has doubled in the last decade. Shipments in 1964 were about 13 per cent higher than in 1963. Exports, on which the industry depends, showed a comparative increase in 1964. Although markets in the United States remained dominant, much of the increase was due to larger shipments to Europe, Venezuela and Australia.

PRODUCERS

The large Blue Mountain deposit, northeast of Peterborough, Ontario, in Methuen Township, is the only Canadian source. Indusmin Limited, which controls most of the deposit, operates a processing plant near the southwestern end and two quarries. International Minerals & Chemical Corporation (Canada) Limited has a quarry and processing plant at the northeastern end of the deposit. Both companies produce glass-grade nepheline syenite principally, but also fine-ground high-quality grades and lower-quality (relatively high-iron) byproducts.

*Mineral Processing Division, Mines Branch

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OTHER CANADIAN OCCURRENCES

Nepheline-bearing rocks are relatively common in Canada but generally cannot be beneficiated sufficiently for use as a feldspathic raw material in the ceramics industry.

In the Bancroft area of southeastern Ontario a discontinuous band of nepheline gneiss and nepheline pegmatite extends for many miles. Prior to 1942, small quantities of these rocks were mined; although the nepheline content is relatively high, it is generally more variable than in the Blue Mountain deposit, making the control of product quality difficult.

TABLE 1
Production, Exports and Consumption

	1963		1964	
	Short Tons	$	Short Tons	$
Production (shipments)	254,000	2,699,202	288,493	3,027,116
Exports				
United States	184,522	1,995,980	196,443	2,214,853
Britain	11,535	111,719	16,863	199,173
Netherlands	3,037	35,390	3,774	45,850
Venezuela	16	308	3,360	45,186
Australia	722	15,257	1,939	39,230
Belgium and Luxembourg	896	19,264	1,613	35,050
Puerto Rico	1,300	14,110	1,200	16,980
Italy	341	7,346	716	15,404
Dominican Republic	500	6,724	560	7,440
Peru	100	2,048	200	4,325
Panama	80	1,320	160	3,440
Other countries	213	4,476	143	3,254
Total	203,262	2,213,942	226,971	2,630,185
Consumption*	1962		1963	
Glass	33,407		33,442	
Glass fibre	3,015		3,204	
Mineral wool	572		601	
Other ceramic products	5,632		6,908	
Other products	453		523	
Total	43,079		44,678	

Source: Dominion Bureau of Statistics.
* Available data.

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 the Big Bend of the Columbia River.

Nepheline is common in the alkaline rock complexes in northern Ontario and southern Quebec but is nowhere of any known commercial significance.

TABLE 2
Production and Exports, 1955–64
(short tons)

	Production	Exports
1955	146,068	118,275
1956	180,006	139,305
1957	200,016	164,342
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	288,493	226,971

Source: Dominion Bureau of Statistics.

FOREIGN PRODUCTION

Norway and the U.S.S.R. also produce nepheline-bearing ceramic raw materials.

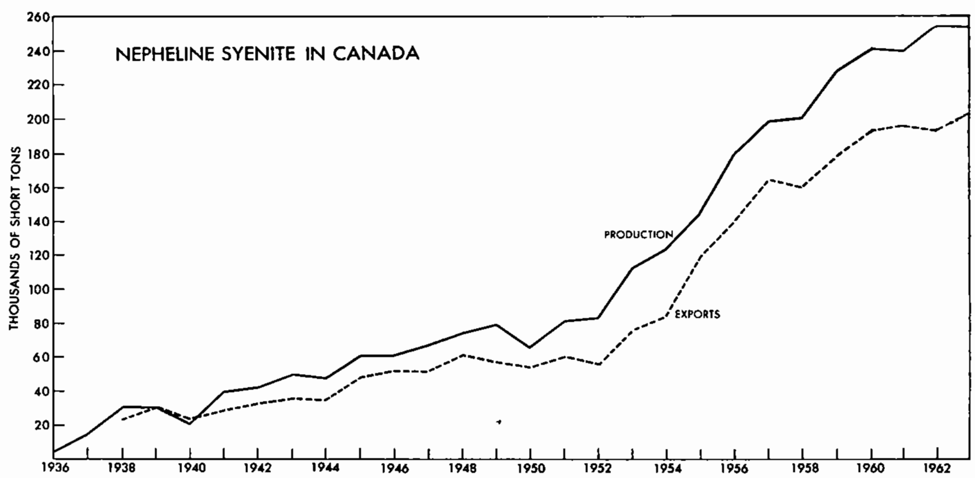
For more than four years a Norwegian company has been mining and dry processing nepheline syenite that looks similar to the Blue Mountain nepheline syenite, from a large deposit on Stjernøy, an island off the northern coast. High-quality glass- and ceramic-grade products are produced, which have an alumina (Al_2O_3) content of more than 24 per cent, a total alkali content of about 17 per cent – with potash (K_2O) predominating slightly over soda (Na_2O) – and an iron content of 0.08 per cent Fe_2O_3.

For many years, the U.S.S.R. has mined on a large scale the apatite-nepheline rock associated with the alkaline rock complex at Kirovsk in the Kola Peninsula, and produced a nepheline concentrate. The concentrate contains about 29 per cent Al_2O_3, 11 per cent Na_2O, 9 per cent K_2O and 3 to 4 per cent Fe_2O_3, and is used in the manufacture of green glass. It also is used as an aluminum ore, which has resulted in the search for nepheline-bearing rocks in other parts of the country as sources of aluminum.

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, about 20 to 25 per cent of both nepheline and potash feldspar and small quantities of the iron-bearing minerals magnetite, biotite and hornblende. Large parts of the deposit have comparatively little mineralogical variation. This consistency and the relative ease with which the iron-bearing minerals can be removed by high-intensity dry magnetic separators make the production of uniform high-quality products possible.

Ground and beneficiated nepheline syenite is commercially valuable because of its comparatively high alumina and alkali content and its relatively low melting temperature. Typically, products from the Blue Mountain deposit contain between 23 and 24 per cent Al_2O_3, about 15 per cent total alkali (with a soda - potash ratio of about 2:1) and no more than 0.08 per cent Fe_2O_3.



USES AND SPECIFICATIONS

The glass industry is the dominant consumer of nepheline syenite, accounting for about three-quarters of the total consumption in Canada. Nepheline syenite is important as a source of alumina and alkalis and lowers the melting temperature of the glass batch. Canadian glass producers have entirely substituted nepheline syenite for feldspar. The particle size specification is minus 30 plus 200 mesh, U.S. Standard. For clear glass, the iron content, expressed as Fe_2O_3, must be less than 0.1 per cent.

Nepheline syenite is used in smaller quantities in the whiteware industry as both a body and a glaze ingredient. Because of its lower fusion temperature, many Canadian manufacturers of sanitaryware, dinnerware, wall tile and pottery have substituted it for feldspar. Specifications require that the particle size be mainly minus 325 mesh and that the iron content be 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 quantities of fine-ground material are finding increasing acceptance as a filler in paints and foam rubber.

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

The price of glass-grade nepheline syenite is $10 a short ton, in bulk, f.o.b. plant. *Canadian Chemical Processing* of October 1964 quoted prices as follows: in bags, car lots, f.o.b. works, $11.50 to $28.50 per short ton.

The Algoma Steel Corp. Ltd., Sir James open-pit mine.

Nickel

C.C. ALLEN*

Nickel production in Canada during 1964 was 232,875 tons valued at $381,996,719. This was only slightly above the 1963 production of 217,030 tons even though world consumption increased considerably. The difference in consumption came in part from decreased company inventories; nickel deliveries by Canadian producers were greater than production.

The much higher Free World consumption at an estimated 640 million pounds was 20 per cent above the 533 million pounds consumed in 1963. The increased consumption was the result of generally excellent economic conditions.

The decision of the United States government to market 340 million pounds of surplus stockpile nickel over the next 12 years will tend to defer nickel expansion plans. Initial plans are to market about 16 million pounds in 1965 and gradually to increase releases to between 30 and 40 million pounds a year thereafter, although this target is dependent on market conditions.

CANADIAN OPERATIONS AND DEVELOPMENTS

Canada is traditionally the world's leading supplier of nickel and accounts for about 80 per cent of Free World production. Its leading producers, The International Nickel Company of Canada, Limited and Falconbridge Nickel Mines, Limited, are the world's largest. Both companies are in the forefront throughout the world in search of new sources of nickel and, along with Sherritt Gordon Mines, Limited, are prominent in metallurgical research on the extraction of nickel from its ores and in product development. The interests of these companies are widespread and their operations embrace all phases of the nickel industry from the search for ore through its development, mining, concentration, smelting, refining, research and product development to the marketing of nickel products in all their various forms.

*Mineral Resources Division

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TABLE 1

Nickel – Production, Trade and Consumption

	1963		1964p	
	Short Tons	$	Short Tons	$
Production				
All forms[1]				
Ontario	149,089	246,252,488	165,254	268,506,035
Manitoba	63,585	106,822,887	63,536	106,628,259
Quebec	2,506	4,209,785	2,330	3,914,025
British Columbia	1,850	3,107,498	1,755	2,948,400
Total	217,030	360,392,658	232,875	381,996,719
Exports				
In ores, concentrates, matte or speiss				
Britain	46,821	76,318,361	44,398	72,302,999
Norway[2]	33,548	47,185,528	27,937	39,364,238
Japan	2,560	2,585,515	1,879	1,807,394
United States	463	643,924	494	710,042
West Germany	–	–	58	64,133
Total	83,392	126,733,328	74,766	114,248,806
In oxide sinter				
United States	9,429	13,858,524	23,485	33,289,679
Britain	2,306	2,771,449	6,490	9,063,987
West Germany	193	303,336	1,873	2,882,335
Australia	555	784,616	1,239	1,737,068
Belgium and Luxembourg	507	800,105	1,013	1,590,676
Italy	1,386	2,181,576	668	1,041,729
France	299	472,590	516	810,274
Sweden	403	630,782	262	408,868
Austria	130	204,142	136	213,545
Japan	–	–	86	138,345
Mexico	...	1,129	29	44,162
Other countries	–	–	3	4,894
Total	15,208	22,008,249	35,800	51,225,562
Nickel and nickel alloy scrap				
United States	760	414,391	959	524,485
West Germany	79	39,825	52	810
Britain	20	20,261	48	29,513
Netherlands	9	6,778	16	2,185
France	10	6,385	4	2,869
Other countries	79	6,698	2	1,336
Total	957	494,338	1,081	561,198

Table 1 (cont.)

	1963		1964p	
	Short Tons	$	Short Tons	$
Anodes, cathodes, ingots, rod and shot				
United States	94,064	145,092,288	92,152	137,252,374
Britain	7,476	11,533,995	26,133	38,569,061
West Germany	2,574	4,160,842	2,842	4,587,418
Japan	473	790,819	2,224	3,701,963
Australia	837	1,486,058	1,050	1,688,340
India	1,088	1,834,419	613	1,020,592
France	–	–	579	968,517
Austria	573	908,466	484	768,638
Italy	398	646,959	436	704,352
Sweden	295	482,412	368	590,374
Brazil	368	619,858	347	580,199
Argentina	194	340,093	321	547,220
Other countries	816	1,340,716	781	1,314,698
Total	109,156	169,236,925	128,330	192,293,746
Nickel and nickel-alloy fabricated materials, not elsewhere specified				
United States	3,725	5,306,821	2,080	3,615,747
India	55	100,485	112	206,681
Britain	85	338,672	81	266,084
New Zealand	21	96,926	42	183,357
Mexico	20	33,850	35	59,344
Japan	11	18,736	26	47,868
Italy	25	99,752	26	90,410
British Guiana	–	–	26	20,200
Republic of South Africa	16	62,447	26	102,721
Other countries	54	73,747	104	259,112
Total	4,012	6,131,436	2,558	4,851,524
Imports[3]				
Nickel anodes, cathodes, ingots, rod and shot				
Norway			10,162	17,373,000
United States			238	522,000
West Germany			7	19,000
Total			10,407	17,914,000

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Table 1 (concl.)

	1963		1964p	
	Short Tons	$	Short Tons	$
Nickel alloy ingots, blocks, rods and wire bars				
United States...........			597	1,480,000
Britain			2	4,000
Total................			599	1,484,000
Nickel and nickel-alloy fabricated materials				
United States...........			1,481	4,353,000
Britain			53	185,000
West Germany			19	50,000
Sweden			15	63,000
France			3	14,000
Norway			2	4,000
Total................			1,572	4,669,000
Consumption[4]				
All forms	5,869		6,899	

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]Due to changes in statistical classification the import classes for 1964 as shown are not comparable with import classes for previous years. [4]Consumption of nickel, all forms (refined metal, oxide and salts), as reported by consumers.

Symbols: p Preliminary; ... Less than one ton.

ONTARIO

The International Nickel Company of Canada, Limited (INCO) operated seven mines in the Sudbury area: the Creighton, Frood-Stobie, Garson, Levack, Murray, Clarabelle and the Crean Hill. The Crean Hill mine, closed in 1919, was reopened in 1964 with production at about 3,000 tons of ore a day. The Clarabelle open pit was operated at about 16,000 tons a day with half of the output going to waste and half to ore. Underground development continued at the Copper Cliff North mine, adjacent to the Clarabelle. Ore mined by INCO during the year in Ontario and Manitoba amounted to 16,439,000 tons compared with 13,566,000 tons in 1963. Year-end ore reserves totalled 303,767,000 tons containing 9,196,000 tons of nickel and copper, slightly higher than a year earlier. In February, INCO recalled some 1,850 workers at Sudbury and Port Colborne, Ontario, who had been released during the production cutback when nickel inventory was high. In New York State, the company officially opened its new Sterling Forest Research Center where about 300 are employed.

TABLE 2

Nickel – Production, Trade and Consumption, 1955–64

(short tons)

	Production[1]	Exports				Imports[2]	Consumption[4]
		In matte etc.	In Oxide Sinter	Refined Metal	Total		
1955	174,928	65,954	1,453	106,473	173,880	2,103	5,020
1956	178,515	70,715	1,767	104,356	176,838	2,554	5,545
1957	187,958	73,694	1,706	103,258	178,658	2,091	4,532
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
1964p	232,875	74,766	35,800	128,330	238,896	10,407[3]	6,899

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]Not completely comparable with previous years. [4]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.

Plans at Sudbury include development of three small mines: the Totten and McLennan in 1965 and the Kirkwood in 1966. Plant construction at Copper Cliff is underway to produce nickel oxide sinter 90. It will supplement nickel oxide sinter 75 and can be used in many applications in place of metallic nickel. Production in 1965 is scheduled at 60 million pounds more nickel than in 1964. Because of plant improvements, INCO's nickel production capacity in Ontario and Manitoba is now some 450 million pounds of nickel a year.

Falconbridge Nickel Mines, Limited operated the Falconbridge, East, Hardy, Onaping and Fecunis mines in the Sudbury district. Development work continued at the Strathcona mine where production is planned for late 1967; construction of a new concentrator will commence in 1966. Falconbridge recalled 200 employees in the first quarter of 1964 because of increased demand for nickel. A new furnace completed in January 1965 along with Strathcona mine production in 1967 will increase Falconbridge's annual nickel production capacity to about 100 million pounds of nickel. A new refinery is planned, although its location is still uncertain.

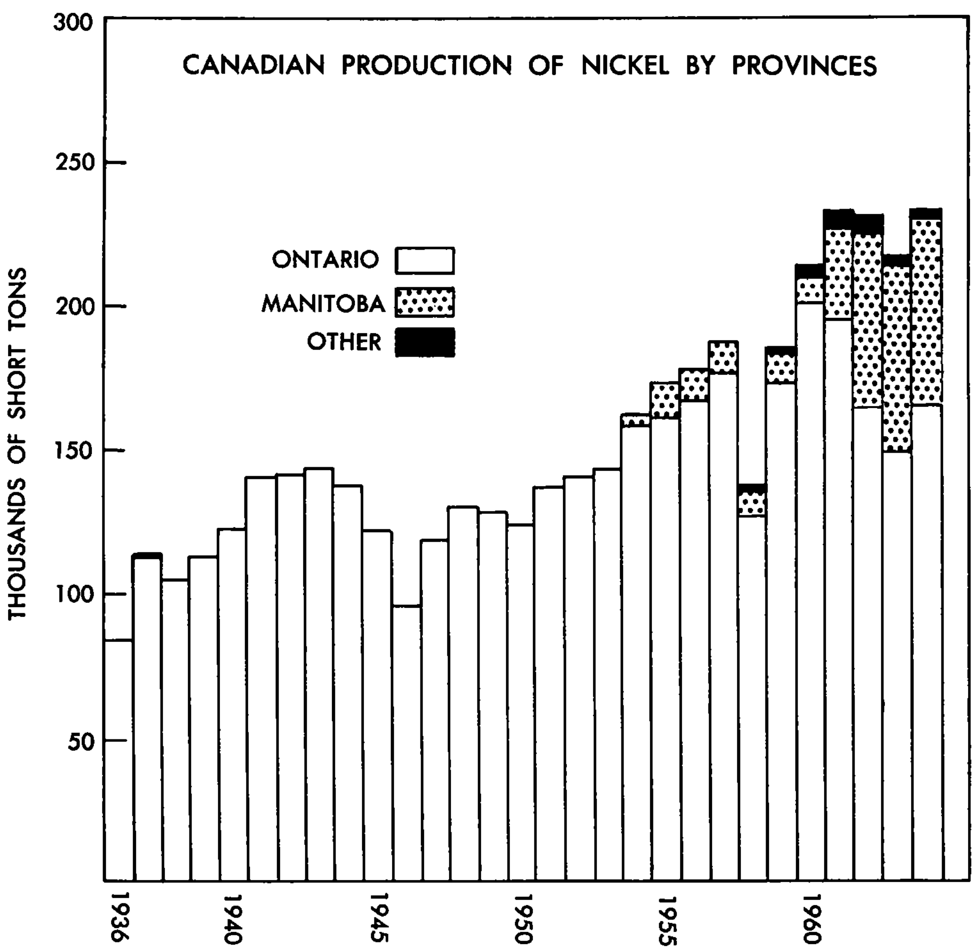
Ore delivery to Falconbridge treatment plants during the year amounted to 1,960,000 tons compared with 2,116,000 in 1963. Proven ore reserves at the year's end were 52,236,250 tons averaging 1.43 per cent nickel and 0.76 per cent copper. Further probable reserves amounted to 17,287,400 tons averaging 1.02 per cent nickel and 0.68 per cent copper.

Metal Mines Limited continued production at about 525 tons of ore a day at its mine in the Gordon Lake area. Nickel-copper concentrates are trucked to Lac du Bonnet, Manitoba, for rail shipment to Copper Cliff, Ontario, for smelting by INCO.

In diamond drilling, McWatters Gold Mines, Limited, intersected grades of better than one per cent nickel in Langmuir Township in the Timmins area.

INCO is diamond drilling claims in the Shebandowan area, some 60 miles northwest of Port Arthur-Fort William.

Texmont Mines Limited, formerly Fatima Mining Company Limited, commenced diamond drilling on claims in Bartlett and Geikie townships in the Timmins area. Previous announced reserves were a minimum of 1.5 million tons averaging 1.07 per cent nickel. Plans include dewatering the shaft and diamond drilling below the bottom level.



MANITOBA

At Thompson, INCO continued sinking a No. 3 service shaft. At the Birchtree mine, 5 miles south of Thompson, two shafts are being sunk. The development shaft was well underway and the collaring of a permanent production shaft was completed at the year's end. Grade is described as good and production is anticipated in 1967. The Birchtree project is considered an auxiliary supply to Thompson. A strike of workers at Thompson curtailed nickel production from mid-August to early September.

Sherritt Gordon Mines, Limited, continued to operate its Lynn Lake mine. Production was in the order of 3,900 tons daily with 2,300 tons coming from the Farley mine and the balance from the A mine. Tonnage milled was 1,362,693 tons. Year-end ore reserves were 11,012,000 tons averaging 0.98 per cent nickel and 0.59 per cent copper compared with reserves of 11,916,000 tons of 0.96 per cent nickel and 0.58 per cent copper a year earlier. Sherritt contracted with Société Le Nickel for the purchase, on a long-term basis, of an annual supply of some 6 million pounds of nickel contained in matte. With Lynn Lake concentrates, this will permit the Fort Saskatchewan, Alberta, refinery to operate at its annual rated capacity of about 28 million pounds of nickel. Nickel production in 1964 was 27,966,936 pounds, an all-time high and 33 per cent more than in 1963. Construction was in progress on the $14 million ammonium phosphate complex and on the $9 million addition to the ammonia and urea production units. Studies on the treatment of nickel laterite ores were completed and ready for demonstration.

Bowden Lake Nickel Mines Limited was formed to consolidate holdings of Consolidated Marbenor Mines Limited, National Malartic Gold Mines Limited and Rio Algom Mines Limited in northern Manitoba. These claims are under option to Falconbridge and development work continues.

QUEBEC

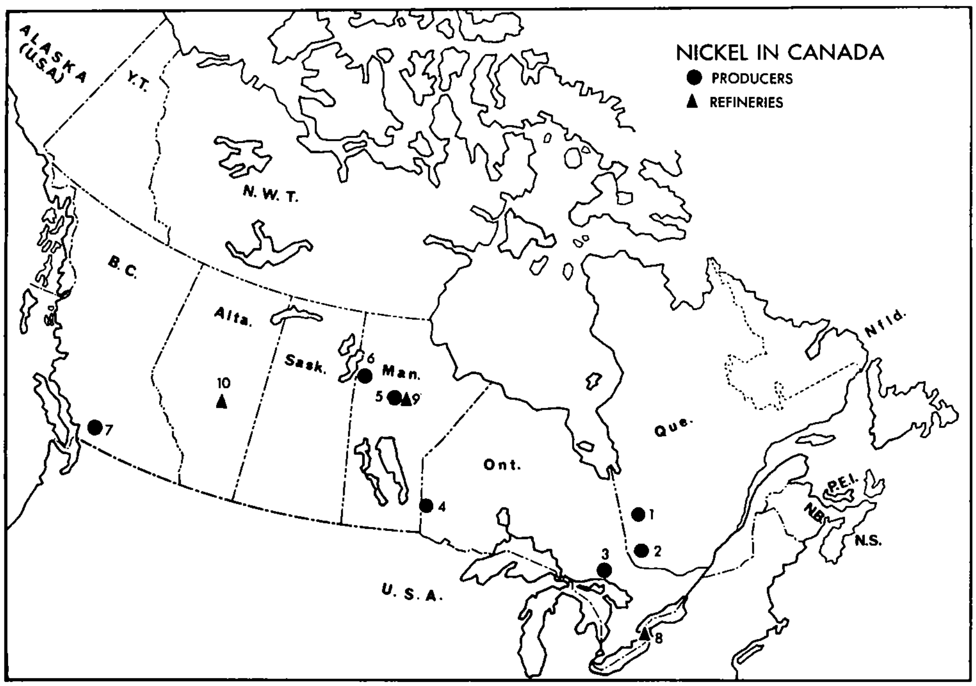
The Marbridge Mines Limited mine near Malartic was sinking a second production shaft to the 650-foot horizon in the area drilled during the summer. Production from this shaft is scheduled in mid-1965 at a daily rate of 200 tons. Ore has been encountered to the 1,250-foot horizon at No. 1 shaft. Concentrates are shipped to Falconbridge for treatment.

Production by Lorraine Mining Company Limited from its property at Belleterre commenced at 400 tons a day early in 1965. Lorraine Mining is Quebec's second nickel producer.

Raglan Nickel Mines Limited did additional diamond drilling on its properties in the Ungava area of far northern Quebec and further drilling is planned in 1965.

BRITISH COLUMBIA

Giant Mascot Mines, Limited, near Hope, continued mine production at a scheduled rate of 1,500 tons daily and treated 324,635 tons. Nickel-copper concentrates are trucked to Vancouver for shipment to Japan. Ore reserves, including a 10-per-cent dilution allowance, are estimated at 1,024,727 tons averaging 0.93 per cent nickel and 0.38 per cent copper. Recent work on the 600 zone on the 3,250-foot level outlined substantial tonnage of ore grading well above mine average.



PRODUCERS

1. Marbridge Mines Limited
2. Lorraine Mining Company Limited
3. Sudbury area
   The International Nickel Company of Canada, Limited (7 mines, 2 smelters), Falconbridge Nickel Mines, Limited (5 mines, 1 smelter)
4. Metal Mines Limited
5. The International Nickel Company of Canada, Limited (Thompson mine and smelter)
6. Sherritt Gordon Mines, Limited
7. Giant Mascot Mines, Limited

REFINERIES

8. The International Nickel Company of Canada, Limited (Port Colborne)
9. The International Nickel Company of Canada, Limited (Thompson)
10. Sherritt Gordon Mines, Limited (Fort Saskatchewan)

WORLD DEVELOPMENTS

INCO announced preliminary plans to bring a Guatemalan nickel laterite deposit into production; negotiations for production were undertaken with the Government of Guatemala. Completion time has been estimated at 2½ to 3 years with the cost of a ferronickel plant and mine development estimated at $70 million. Southern Mining and Development Co. Ltd., an INCO subsidiary, was granted prospecting licences in Australian New Guinea and in the Solomon Islands. Conzinc Rio Tinto of Australia was also prospecting in the Solomons. The modernization of International Nickel's refinery at Clydach, Wales, is scheduled for completion by mid-1966.

Falconbridge Nickel Mines, Limited, commenced diamond drilling a 250-square-mile property in the Republic of South Africa optioned from New Wellington of Africa (Pty) Ltd. Research and development work continued on the laterites of Falconbridge in the Dominican Republic.

The Hanna Mining Company, Riddle, Oregon, treated 16 per cent more ore in 1964 than in 1963. Smelter capacity was increased by adding new ore-drying and smelting equipment.

The Trojan Nickel Mine (Pty) Ltd., Southern Rhodesia, is mining 130 tons a day of nickel ore grading 1.5 per cent nickel. Concentrates, ranging from 15 to 18 per cent nickel, are exported. Increased production of nickel as a byproduct of platinum metals output can be expected in the Republic of South Africa. Rustenburg Platinum Mines Limited plans a 40-per-cent expansion and another group will bring the adjacent Brekspruit property into production. New nickel production capacity will be in the order of 5,000 tons annually.

The Minister of Mines and Hydrocarbons in Venezuela announced nickel reserves of 58.4 million tons containing 634,000 tons of nickel in the Hierro region of the States of Aragua and Miranda.

TABLE 3

World Production of Nickel

(short tons)

	1962	1963
Canada	232,242	217,030
Russia	90,000	90,000
New Caledonia	32,400	32,200
Cuba	16,400	16,200
United States	11,217	11,432
Finland	2,310	3,231
Republic of South Africa	2,700	2,700
Other countries	8,731	207
Total	396,000	373,000

Source: *American Bureau of Metal Statistics Yearbook, 1963* and for Canada, Dominion Bureau of Statistics.

TABLE 4

Free World* Nickel Production Capacity, 1964

(short tons)

International Nickel (including Thompson)	225,000
Falconbridge	35,000
Sherritt Gordon	15,000
Total, Canada	275,000
New Caledonia (French 27,500, Japanese 25,000)	52,500
Hanna Nickel Smelting Company (U.S.A.)	15,000
Others (Finland, South Africa, Brazil, Greece)	12,500
Total, Free World	355,000

Source: Company reports.

*Cuba excluded.

Société Le Nickel, New Caledonia, plans to double its annual output capacity of nickel matte and ferronickel to 55,000 tons contained nickel by 1969.

The Philippines government announced that a foreign firm was interested in bringing the Suriago nickel-iron laterite deposits into production. It later submitted a joint development proposal to Japanese government officials.

The Nippon Mining Company of Japan concluded an agreement for the purchase of 600,000 tons of nickel ore from New Caledonia for the 1965-70 period. The Tokyo Nickel Company Limited was formed with a capitalization of 500 million yen, with 50 per cent taken down by Shimura Kako Kaisha, 10 per cent by Mitsui and Co. and 40 per cent by International Nickel. The company plans to produce nickel oxide and Japanese government approval is sought.

The Chinese People's Republic gave a contract to Le Nickel for 9,300 tons of nickel with delivery over the 4-year period 1965 to 1968.

CONSUMPTION AND USES

Stainless steel has been gaining steadily in its relative importance as a use for nickel and continued as the largest single outlet for nickel. In almost its every use – in utensils, electrical appliances, transportation equipment and structures – nickel's suitability as an alloy is its chief attraction. Nickel, by itself, has qualities of strength, hardness, toughness, ductility and corrosion resistance both at low and high temperatures. When alloyed with iron or other metals it imparts many of these qualities to the alloy. About 62 per cent of the nickel consumed in the Free World is used in the ferrous industry in steel, cast iron and low and high nickel-iron alloys.

TABLE 5
Free World Nickel Consumption 1960–64, by Products
(%)

	1960	1961	1962	1963	1964
Stainless steels	32	33	30	31	34
High-nickel alloys	15	15	16	17	13
Electroplating	16	15	16	14	15
Nickel-alloy steels	13	14	13	13	13
Foundry products	12	11	12	12	11
Copper-nickel alloys	4	4	4	4	4
All other products	8	8	9	9	10

Source: INCO annual reports.

Nickel is finding wider use in coinage because of the silver shortage. In 1964, Sherritt Gordon received a contract for 110 million coin blanks from the Republic of South Africa for 5-, 10- and 50-cent pieces in its conversion from sterling to the decimal system. This contract will involve nearly one million pounds of nickel. Australia specified a cupro-nickel alloy to replace its silver coinage.

INCO announced development of an improved nickel oxide sinter containing 90 per cent nickel that has lower impurities and oxygen content than the company's previous nickel oxide sinter that contained 75 per cent nickel. The new oxide sinter is not yet in commercial production.

Sinclair Refining Co., a subsidiary of Sinclair Oil Corporation, began marketing gasoline containing a nickel additive that is claimed to improve engine performance. Even though the use of a nickel additive to gasoline becomes widely adopted, no appreciable increase in total nickel consumption is anticipated.

PRICES

	Canada (cents a pound)	United States* (cents a pound)
INCO, electrolytic, f.o.b., Port Colborne, Ontario, and Thompson, Manitoba	84	79
Falconbridge, electrolytic, f.o.b., Thorold, Ontario	84	79
Sherritt Gordon, briquettes, f.o.b., Niagara Falls, Ontario, and Fort Saskatchewan, Alberta	84	79

* Includes 1¼ cents-a-pound import duty.

	Canada	United States*
	(cents a pound)	
Nickel oxide sinter (Ni – Co content)		
Points in Ontario (freight allowed)........	81.50	
Points outside Ontario (less freight allowance of 1.25¢ a pound	81.50	
Buffalo, N.Y., or other established U.S. points of entry.....................		75.25

*Includes 1¼ cents-a-pound import duty.

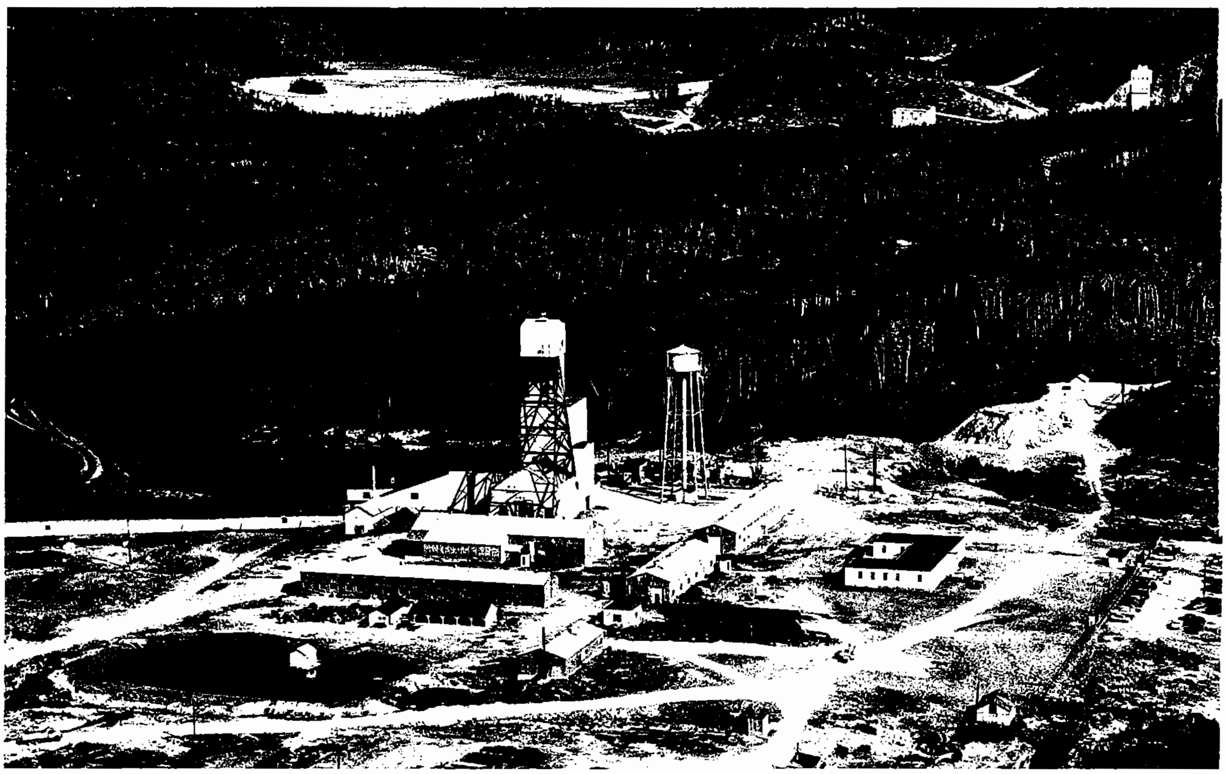
TARIFFS

	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	7½	10

	British Preferential (%)	Most Favored Nation (%)	General (%)
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

Nickel ore, nickel matte and nickel oxide	free
Unwrought nickel; nickel waste and scrap (duty on nickel waste and scrap suspended)	1.25¢ per lb
Bars, plates, sheets and strip, all the foregoing wrought of nickel, whether or not cut, pressed, or stamped to nonrectangular shapes; not cut, not pressed and not stamped to nonrectangular shapes	(% ad valorem)
Plates and sheets, clad	24
Other	
Not cold worked	10
Cold worked	14
Rods, angles, shapes and sections, all the foregoing wrought of nickel; nickel wire	
Rods and wire	
Not cold worked	10
Cold worked	14
Angles, shapes and sections	18
Nickel powders and flakes	
Flakes	10¢ per lb
Powders	1.25¢ per lb.
Pipes and tubes and blanks thereof, pipe and tube fittings all the foregoing of nickel	
Pipes and tubes and blanks thereof	(% ad valorem)
Not cold worked	6.25
Cold worked	8.75
Pipe and tube fittings	18
Electroplating anodes, wrought and cast of nickel	10



Willroy mines property with Geco mines in background.

Niobium (Columbium) and Tantalum

V.B. SCHNEIDER*

St. Lawrence Columbium and Metals Corporation continued to be the only Canadian producer of columbium concentrates. The company reported that mine shipments in 1964 amounted to 2.2 million pounds of contained columbium pentoxide (Cb_2O_5) in pyrochlore concentrates. The company is the world's largest producer of Cb_2O_5 concentrates and prior to 1964 it was the only direct producer of columbium concentrates as a primary product. However, preliminary reports indicate that a Brazilian company, Distribuidora e Exportadora de Minerios e Audbos, S.A. (Dema), exported commercial quantities of pyrochlore concentrates from its Araxa deposits. In all other columbium operations, the concentrate is recovered as a byproduct of tin recovery operations.

Since St. Lawrence Columbium first started operations in 1961 it has expanded production each year, with most of its production being exported. An interesting change in the company's export pattern is shown by the fact that in 1962, 92 per cent of the company's deliveries were made in the United States; 1963 showed an increasing interest by European consumers who took 27 per cent of the company's deliveries with 70 per cent going to the United States and 3 per cent to the domestic market. This trend continued in 1964 when 53 per cent of the company's deliveries were shipped to Europe, 44 per cent to the United States and 3 per cent to the domestic market.

Masterloy Products Limited, Ottawa, Ontario continued to produce standard and self-reducing ferrocolumbium. The self-reducing steel additive is a mixture of pyrochlore and a reductive such as aluminum or ferrosilicon. According to a company report, the company's production capacity is in the order of 12,000 pounds a month of contained Cb in ferrocolumbium and during 1964 the demand for ferrocolumbium taxed the plant's facilities.

*Mineral Resources Division

TABLE 1

Niobium (Columbium) and Tantalum Production, Trade and Consumption

	1963		1964p	
	Pounds	$	Pounds	$
Production (shipments)				
Columbium pentoxide (Cb_2O_5)	1,393,444	1,300,009	2,250,000	2,305,000
Imports[1] from United States			11 Months	
Columbium metal and alloys semifabricated	–	–	20	1,100
Tantalum metal and alloys, crude and scrap	5,456	47,853	4,300	13,330
Tantalum metal, semifabricated	235	19,090	324	18,362
Exports[2] to United States			11 Months	
Columbium ore and concentrates	1,881,704	868,300	1,897,291	897,942
Consumption by steel industry			12 Months	
ferrocolumbium and ferrotantalum columbium (Cb and Ta-Cb content)	34,000		74,000	

Source: Dominion Bureau of Statistics.
[1]From United States Bureau of Commerce EXPORTS OF DOMESTIC AND FOREIGN MERCHANDISE, REPORT FT 410 . [2]From United States Bureau of Commerce IMPORTS OF MERCHANDISE FOR CONSUMPTION, REPORT FT 110, 1963 and REPORT FT 125, 1964.
Symbols: p Preliminary; – Nil.

CANADIAN OCCURRENCES

NORTHWEST TERRITORIES

There are many columbium-tantalum occurrences in the Yellowknife area of Great Slave Lake. The presence of columbite-tantalite has been noted in many pegmatite dikes in association with beryl, spodumene and amblygonite.

BRITISH COLUMBIA

The placer deposits on Bugaboo, Vowell, and Forster creeks, about 45 miles southeast of Golden, consist of columbium-bearing gravel. In 1956, Quebec Metallurgical Industries Ltd.*, at Billings Bridge, Ontario, processed gravity concentrates from these deposits to produce high purity columbium oxide, columbium alloys and columbium sponge. The project was discontinued as uneconomical.

*Name changed March 1963 to Q.M.I. Minerals Ltd.

MANITOBA

Small amounts of Ta_2O_5 are associated with the lithium-bearing pegmatites in the Bernic Lake area. The most significant occurrence at present is that of Chemalloy Minerals Limited. However, Ta_2O_5 would have to be recovered as a byproduct of a cesium-lithium operation.

ONTARIO

The columbium-uranium deposits of Nova Beaucage Mines Limited are six miles west of North Bay in an area covering the Manitou Islands of Lake Nipissing. Estimates of tonnage and grade vary considerably but the reserves in the zone east of Newman Island, on which considerable exploration work has been conducted, are reported to amount to 2.7 million tons averaging 0.69 per cent Cb_2O_5 and 0.042 per cent uranium oxide (U_3O_8). In 1959 and 1960, investigations related to concentration of the company's pyrochlore were conducted at Kimberley, B.C., at the company plant at North Bay, and at the Mines Branch of the Department of Mines and Technical Surveys in Ottawa. The original financing of Nova Beaucage was provided by Inspiration Limited. In 1958, The Consolidated Mining and Smelting Company of Canada Limited (COMINCO) acquired controlling interest in the property and supplied funds for research and management through December 1960. At that time COMINCO decided not to exercise further stock options and the management agreement terminated.

Dominion Gulf Company has outlined two areas of columbium mineralization in Chewett township; one area contains an estimated 20 million tons of material averaging 0.5 to 0.8 per cent Cb_2O_5. Laboratory test-work was conducted in 1960 and 1961 to develop an economical recovery process but no action had been taken to the end of 1964 to bring the property into production. The Chewett ore has so far not proven to be amenable to beneficiation methods for recovery of pyrochlore concentrates. The company has developed two alternative recovery processes that lead directly to good-quality columbium pentachloride, with recoveries of about 90 per cent, that would then have to be reduced to columbium metal. Therefore, it would seem that any development at Chewett must await an adequate market for columbium metal to support a reasonably large-scale operation and the necessary plant investment.

QUEBEC

Large pyrochlore deposits near the town of Oka, 20 miles west of Montreal, are controlled by: Quebec Columbium Limited, jointly owned by Molybdenum Corporation of America and Kennecott Copper Corporation; Columbium Mining Products Ltd., jointly owned by Headway Red Lake Gold Mines, Limited, and Coulee Lead and Zinc Mines Limited; and St. Lawrence Columbium and Metals Corporation.

The mineral deposits associated with and contained in what is referred to as the Oka complex are about two miles east of Oka, at La Trappe. Few outcrops are to be seen as the overburden varies from six to 100 feet in thickness and in places may be as much as 200 feet thick.

St. Lawrence Columbium and Metals Corporation has calculated that there are 62.7 million tons of indicated and proven pyrochlore ore containing 500 million pounds of Cb_2O_5 on the explored part of its property. This calculation concerns only ore containing, as a computed average, a minimum of eight pounds of Cb_2O_5 a ton or an average grade of 0.4 per cent Cb_2O_5. The company conducts an open-pit mining operation with a daily milling rate in 1964 of 1,150 tons a day. The company markets three types of concentrates. Table 2 shows the company's production and shipments since it began operation in 1961.

Columbium Mining Products Ltd. believes it has reserves amounting to 100 million tons assaying 0.3 per cent Cb_2O_5. Quebec Columbium Limited, the largest property holder in the area has not released ore reserve figures.

TABLE 2

Production of Pyrochlore Concentrates by St. Lawrence Columbium and Metals Corporation, 1961–64

(pounds)

	1961	1962	1963	1964
Concentrates	253,885	1,839,319	2,941,303	4,150,388
Contained Cb_2O_5	134,006	971,624	1,521,701	2,163,135
Shipment of concentrates	119,261	1,909,433	2,692,935	4,222,424
Avg. % Cb_2O_5 in concentrates	53	52.82	51.76	52.1

Source: Company report.

WORLD MINE PRODUCTION

World production of columbium-tantalite concentrates amounted to 6,007 tons in 1964; this was made up of 5,632 tons of columbium concentrates and 355 tons of tantalite concentrates. The U.S. Bureau of Mines, COMMODITY DATA SUMMARIES, January 1965, estimates world reserves at 9,172,000 tons of combined Cb_2O_5 and Ta_2O_5 made up of 9.1 million tons of Cb_2O_5 and 72,000 tons of Ta_2O_5.

Columbium is extracted commercially from the minerals columbite and pyrochlore; tantalum is extracted from the mineral tantalite. Tantalite and columbite have the theoretical compositions $(FeMn)O.Ta_2O_5$ and $(FeMn)O.Cb_2O_5$. They are seldom if ever found pure as tantalum and columbium replace one another in widely variable proportions between the theoretical limits. Concentrates from different sources show a range in content of tantalum pentoxide (Ta_2O_5) from 0.8

per cent to 82 per cent, and of columbium pentoxide (Cb_2O_5), from 3.5 per cent to 78 per cent. Combined contents of the two oxides in columbite-tantalite concentrates usually total about 80 per cent. Pyrochlore is essentially $(NaCa)_2 Cb_2O_6F + ThO_2$ and rare-earth elements; Ta_2O_5 can replace Cb_2O_5 in pyrochlore but is seldom present in any appreciable amount.

The Araxa pyrochlore deposit in the State of Minas Gerais, Brazil, is the largest deposit so far discovered, is very high grade containing 3.5 per cent Cb_2O_5, and is known to contain many thousands of tons of columbium with estimates ranging as high as 2.9 million tons. The deposit is owned jointly by the Brazilian government, Molybdenum Corporation of America (Molycorp) and Pato Consolidated Gold Dredging Ltd., a subsidiary of International Mining Corp. Management of the Pato-Molycorp joint venture will be through Niobium Corp., New York, controlled one third by Pato and two thirds by Molycorp. In January 1965, International Mining Corp. bought 118,816 shares of Molybdenum Corporation of America from Kennecott Copper Corporation. Prior to 1964 production at the Araxa deposit was delayed by conditions imposed by the Brazilian government on the export of columbium concentrates.

Nigeria is the perennial leader in the production of columbium concentrates (columbite); in 1964 Brazil was the principal source of tantalum concentrate (tantalite) with the Republic of the Congo (Leopoldville) in second position.

In Norway the Sove mine, in the Fen area, near Ulefoss, which is 72 miles southwest of Oslo, produces a 50 per cent Cb_2O_5 concentrate. This concentrate, with a columbium-tantalum ratio 100:1, is shipped to the European market.

TABLE 3

Non-Communist World Production of Columbium-Tantalum Concentrates, 1963–1964
(short tons)

	1963	1964e
Nigeria	2,270	2,328
Canada	1,471	2,075
Brazil	980	985
Norway	173	175
Congo	155	159
Federation of Malaya	99	100
Mozambique	94	115
Other countries	213	70
Total	5,555*	6,007

Source: Company Reports, U.S. Bureau of Mines MINERALS' YEARBOOK, 1963, U.S. Bureau of Mines COMMODITY DATA SUMMARIES, JANUARY, 1965, and company reports. *Includes 844 tons of pyrochlore concentrates imported by the United States, which represents a portion of 1,764 tons produced in Brazil during 1961–62.
e Estimated.

CONSUMPTION AND USES

The United States is the largest importer of columbium-tantalum ores and the largest consumer of columbium and tantalum products. The United States Bureau of Mines in COMMODITY DATA SUMMARIES of January 1965, estimated that 1964 imports of columbium-tantalum concentrates totalled 2,750 short tons. The metal content of industrial consumption in the United States in 1963 was 1,278 tons. It also reported that metals and alloys are produced in the United States from columbium-tantalum concentrates by 12 companies. Ferrotantalum-columbium alloys are consumed by more than 50 firms. Columbium consumption is proportioned roughly 85 per cent to steelmaking and 15 per cent to nonferrous alloys and minor applications; tantalum consumption is proportioned roughly 60 per cent to electronics applications, 35 per cent to nonferrous applications and 5 per cent to carbide applications.

There are limited applications for columbium in chemical plants and in the electronic industry although tantalum is preferred because of its superior electrical properties. Columbium is resistant to most acids at room temperature, including aqua regia, although it is attacked by hydrofluoric acid. For use in electrolytic capacitors, columbium may be anodized to produce an oxide film of good dielectric properties.

By far the largest tonnage use of columbium is as a minor alloying addition to various grades of steel and superalloys. Columbium reacts with carbon in steels to form columbium carbide, which effects grain refinement and enhances creep properties. In high-chromium steels, columbium prevents chromium carbide formation in the grain boundaries and thus improves resistance to intergranular corrosion, an effect which also causes welded joints to fail. For these applications, purity is not so important and the columbium is usually added as ferrocolumbium.

The future of columbium alloys depends on whether certain properties can be obtained economically. Already they have sufficient high-temperature strength for use in advanced jet engines. But the problem of protecting them from oxidation remains and research is going ahead with coatings of precious and other metals, and other coatings of ceramics and glasses.

In Canada, the need is for ferrocolumbium and ferrotantalum-columbium. In 1964, about 36 tons of contained columbium and tantalum in steel addition agents were consumed by the Canadian iron and steel industry. Indications are that consumption will increase with its wider application in carbon steels to which columbium additions provide higher strengths. This could be important in the fabrication of skelp and plate for use in oil- and gas-transmission piping. Macro Division of Kennametal Inc., Port Coquitlam, B.C., manufactures high-purity tantalum carbide, tantalum-columbium carbide, tantalum-columbium-titanium carbide and tantalum-columbium-tungsten carbide. These materials are further processed as fully prepared powders for the hard metals industry and are also sold as intermediate crystals and powders for use by other carbide manufacturers.

Union Carbide Canada Limited, Metals and Carbon Division; Metallurgical Products Company Limited; Masterloy Products Limited; and Metallurg (Canada) Ltd. are the principal Canadian suppliers of ferrocolumbium.

The more important Canadian consumers of columbium and tantalum products are: Atlas Steels Division of Rio Algom Mines Limited, Welland; The Algoma Steel Corporation, Limited, Sault Ste. Marie; Black Clawson-Kennedy Ltd., Owen Sound; Dominion Foundries and Steel, Limited, Hamilton; Canadian Westinghouse Company Limited, Hamilton, all in Ontario; and Crucible Steel of Canada Ltd., Sorel, Quebec.

PRICES

The following quotations are from E & MJ METAL AND MINERAL MARKETS of December 28, 1964.

Columbium metal, 99 1/2%, per lb	
Roundels	$36.00
Rough ingots	50.00
Tantalum metal, f.o.b. shipping point, per lb	
Powder	30.00 – 49.00
Sheet	47.00 – 60.00
Rod	52.00 – 65.00
Ferrocolumbium, 50–60% Cb, max. 0.4% C, max. 8% Si, ton lots, lump (2 inches), packed, delivered, per lb contained Cb	3.00
Columbite ore, 65% Cb_2O_5 f.o.b. shipping point, per lb	
Ratio 10 to 1	0.80–0.90
Ratio 8½ to 1	0.75–0.80

TARIFFS

	British Preferential (%)	Most Favoured Nation (%)	General (%)
CANADA			
Columbium and tantalum ores and concentrates	free	free	free
Ferrocolumbium, ferrotantalum, ferrotantalum-columbium	free	5	5
Columbium metal or tantalum metal in pure form, in lumps, powder, blocks, ingots	free	15	15
Columbium metal or tantalum metal if in alloy form, in rods, sheet or any semi-process form	15	20	25

UNITED STATES

	(%)
Columbium and tantalum ores and concentrates	free
Columbium metal	
Unwrought, other than alloys; waste and scrap*	10
Unwrought, alloys	15
Wrought	18
Tantalum	
Unwrought, waste and scrap*	10
Wrought	18
Ferrocolumbium and ferrotantalum	10

* Duty on scrap suspended to June 30, 1965.

Petroleum

D.W. RUTLEDGE*

New records were established in several sectors of the Canadian petroleum industry in 1964. Production of crude oil and natural gas liquids averaged an all-time high of 855,000 barrels a day, surpassing the production target of 850,000 barrels set by the federal government for 1964. Cash expenditures in development drilling and exploration were the highest on record. However, capital investment in the oil pipeline, petroleum refining and marketing sectors was in each case less than in some years of the 1950 decade. Total drilling, in terms of footage, reached its highest level since 1956 and the increase in crude oil reserves was the greatest in the history of the industry. Important changes in provincial legislation were announced during the year. The Alberta government outlined a completely revised proration plan that will base production primarily on reserves rather than on the existing 'economic allowance' system, which will be phased out beginning in 1965. In Saskatchewan, legislative changes will allow more lenient land selection and royalty savings on certain oil production.

PRODUCTION

Production of all liquid hydrocarbons – crude oil plus natural gas liquids – increased by 8.8 per cent in 1964 and was substantially above all previous levels. Total output of liquid hydrocarbons was 313.1 million barrels, an average of 855,000 barrels a day. Crude oil output alone amounted to 750,000 barrels daily. Field and gas-plant production of natural gas liquids totalled 102,000 barrels a day, comprising 69,000 barrels of pentanes plus and condensate, and 33,000 barrels of propane and butane.

*Mineral Resources Division

TABLE 1

Production of Crude Oil by Province and Field

(Numbers in parentheses give locations of fields on the accompanying maps)

		1963		1964p	
		Barrels	Bbl/day	Barrels	Bbl/day
Alberta					
Pembina	(1)	39,720,059	108,822	40,607,165	110,949
Swan Hills	(4)	13,213,766	36,202	16,056,458	43,870
Redwater	(3)	16,415,660	44,974	15,523,634	42,414
Leduc-Woodbend	(2)	11,911,158	32,633	11,530,595	31,504
Judy Creek	(4)	6,411,309	17,565	7,524,835	20,560
Bonnie Glen	(2)	7,605,760	20,838	6,752,175	18,449
Fenn-Big Valley	(8)	5,632,103	15,430	5,257,932	14,366
Wizard Lake	(2)	4,248,397	11,639	3,642,090	9,951
Joffre	(5)	3,912,709	10,720	3,613,941	9,874
Virginia Hills	(4)	2,883,745	7,901	3,176,287	8,678
Golden Spike	(2)	3,702,036	10,143	3,074,138	8,399
Joarcam	(7)	2,979,331	8,162	2,899,322	7,921
Sturgeon Lake South	(9)	2,956,533	8,100	2,812,349	7,684
Kaybob	(10)	2,672,011	7,321	2,712,038	7,410
Innisfail	(6)	2,723,940	7,463	2,706,995	7,397
Harmattan East	(6)	2,499,937	6,849	2,485,951	6,792
Acheson	(2)	2,428,617	6,654	2,207,308	6,031
Willesden Green	(1)	1,907,131	5,225	2,188,736	5,980
Snipe Lake	(12)	613,721	1,681	1,872,210	5,115
Gilby	(5)	1,758,551	4,818	1,852,795	5,062
Deer Mountain	(4)	484,171	1,326	1,629,086	4,451
Crossfield	(6)	1,965,516	5,385	1,618,423	4,422
Medicine River	(13)	903,945	2,477	1,543,689	4,218
Garrington	(13)	913,942	2,504	1,504,495	4,111
Harmattan-Elkton	(6)	2,226,952	6,101	1,501,800	4,103
Westerose	(2)	1,727,816	4,733	1,481,448	4,048
Stettler	(8)	1,522,706	4,172	1,481,264	4,047
Kaybob South	(14)	329,292	902	1,405,266	3,840
Carson Creek North	(4)	1,394,240	3,820	1,383,894	3,781
Turner Valley	(11)	1,187,920	3,255	1,195,970	3,268
West Drumheller	(8)	1,006,664	2,758	1,001,385	2,736
Other fields and pools		18,354,416	50,287	21,197,915	57,918
Total		168,214,054	460,860	175,441,589	479,349
Total Value		$416,844,350		$452,184,663	

Table 1 (Cont.)

	1963		1964p	
	Barrels	Bbl/day	Barrels	Bbl/day
Saskatchewan				
Weyburn .... (15)	14,787,621	40,514	13,444,840	36,735
Steelman.......................... (16)	10,205,972	27,962	13,288,246	36,307
Midale............................ (15)	5,781,189	15,839	6,044,834	16,515
Dollard .... (17)	4,740,241	12,987	4,772,249	13,039
Fosterton .... (18)	3,206,509	8,785	4,202,793	11,483
Nottingham........................ (19)	2,881,793	7,895	3,135,311	8,566
Success .... (18)	2,095,391	5,741	3,069,236	8,384
Instow............................ (17)	2,776,452	7,607	3,012,075	8,230
Battrum........................... (18)	1,311,215	3,592	2,879,990	7,869
Hastings.......................... (19)	1,674,957	4,589	1,918,871	5,243
Coleville-Smiley .... (20)	1,828,464	5,009	1,874,848	5,123
Carnduff .... (21)	1,491,187	4,085	1,671,262	4,566
Dodsland .... (20)	1,507,232	4,129	1,519,976	4,153
Parkman .... (22)	1,534,751	4,204	1,473,400	4,026
Willmar .... (16)	994,306	2,724	1,385,895	3,787
Workman .... (21)	1,328,122	3,639	1,334,528	3,646
Queensdale .... (19)	1,190,314	3,261	1,294,512	3,537
Alida............................. (19)	969,375	2,656	1,054,303	2,881
Other fields and pools	10,998,802	30,134	14,000,472	38,253
Total..............................	71,303,893	195,352	81,377,641	222,343
Total Value	$160,226,978		$185,171,355	
British Columbia				
Boundary Lake .... (23)	7,726,776	21,169	5,911,797	16,152
Blueberry .... (24)	1,279,318	3,505	1,149,787	3,141
Other fields and pools	3,522,587	9,651	4,462,527	12,193
Total..............................	12,528,681	34,325	11,524,111	31,486
Total Value	$24,841,518		$23,340,101	
Manitoba				
Virden-Roselea .... (25)	1,022,102	2,800	1,034,745	2,827
North Virden-Scallion .... (25)	1,347,590	3,692	1,583,226	4,326
Other fields and pools	1,401,471	3,840	1,799,253	4,916
Total..............................	3,771,163	10,332	4,417,224	12,069
Total Value	$9,188,635		$10,734,764	
Ontario	1,205,376	3,302	1,243,784	3,398
Total Value	$3,459,429		$3,548,876	

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Table 1 (Cont.)

	1963		1964p	
	Barrels	Bbl/day	Barrels	Bbl/day
Northwest Territories......................	631,229*	1,729	586,296*	1,602
Total Value...........................	$633,754		$438,608	
New Brunswick..........................	7,381	20	4,688	13
Total Value...........................	$10,333		$6,563	
Total, Canada.........................	257,661,777	705,920	274,595,333	750,260
Total Value...........................	$615,204,997		$675,424,930	

Sources: Dominion Bureau of Statistics and provincial government reports.
*Excludes base stock reinjected into the reservoir.
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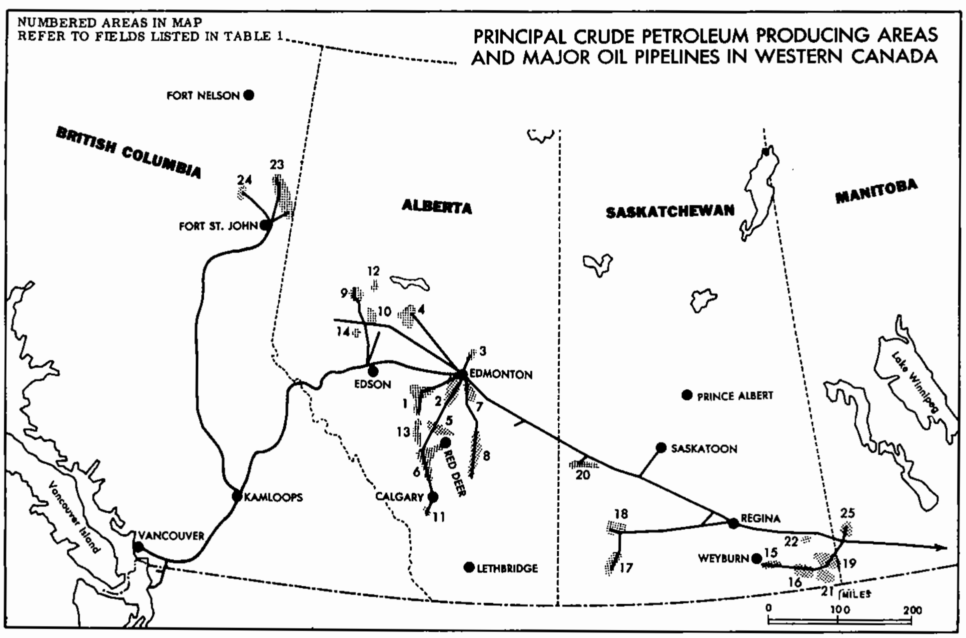

PRINCIPAL CRUDE PETROLEUM PRODUCING AREAS AND MAJOR OIL PIPELINES IN WESTERN CANADA

Total liquid hydrocarbon production increased 8.3 per cent in Alberta, 14.0 per cent in Saskatchewan, 17.1 per cent in Manitoba and 3.2 per cent in Ontario. Production in British Columbia declined 6.0 per cent following several years of large increases.

Alberta production accounted for 67.4 per cent of total Canadian output, a slightly smaller proportion than in 1963. Saskatchewan supplied 26.4 per cent of output, British Columbia 4.2 per cent, Manitoba 1.4 per cent and Ontario, the Northwest Territories and New Brunswick together 0.6 per cent.

The Pembina field remained, by a wide margin, the largest oil-producing field in Canada, yielding nearly 111,000 barrels of crude oil daily and 5,700 barrels of natural gas liquids. The Swan Hills field displaced the Redwater field as the second largest producer of crude oil. A moderate decline in production occurred in Saskatchewan's Weyburn field, the fourth largest producer in the country, as many former oil wells were converted to water injection as part of the new pressure maintenance project.

The first major revision of Alberta's prorationing system was outlined by Alberta the Oil and Gas Convervation Board in 1964. The new system will gradually be brought into effect in the 1965-69 period. The present system, in use

TABLE 2

Production of Natural Gas Liquids by Province

	1963		1964p	
	Barrels	Bbl/day	Barrels	Bbl/day
Alberta				
Propane....................	3,551,726	9,731	6,724,314	18,372
Butane.....................	2,528,330	6,927	4,828,093	13,192
Pentanes plus	17,462,924	47,843	23,298,914	63,658
Condensate.................	3,167,939	8,679	742,169	2,028
Total	26,710,919	73,180	35,593,490	97,250
Saskatchewan				
Propane....................	596,983	1,636	646,003	1,765
Butane.....................	336,208	921	367,036	1,003
Pentanes plus	273,252	748	285,624	780
Total	1,206,443	3,305	1,298,663	3,548
British Columbia				
Propane....................	205,162r	562	240,410	657
Butane.....................	409,087r	1,121	459,668	1,256
Pentanes plus	841,740	2,306	909,934	2,486
Condensate.................	13,671	37	26,367	72
Total	1,469,660r	4,026	1,636,379	4,471
Canada				
Propane....................	4,353,871r	11,929	7,610,727	20,794
Butane.....................	3,273,625r	8,969	5,654,797	15,450
Pentanes plus	18,577,916	50,897	24,494,472	66,925
Condensate.................	3,181,610	8,716	768,536	2,100
Total	29,387,022r	80,511	38,528,532	105,269
Returned to Formation	338,370	927	1,227,332	3,363
Total Net Production	29,048,652r	79,584	37,301,200	101,906

Source: Dominion Bureau of Statistics and provincial government reports.
Symbols: p Preliminary; r Revised.

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since 1950, is operated in the following manner: purchasers' nominations are used to calculate the monthly available market and a basic share of production is allotted to every producing well by the economic allowance rule; the residual share of the market is divided among fields on the basis of maximum efficient rates of production calculated by a complex formula. The economic allowance rule ensures that each oil well is allowed to produce at a rate which will return to the owner in relatively few years the cost of drilling and completing the well. Many of these marginal wells, by best engineering standards, should not be produced at this high level. The regulations were set up to help the producer recover at least his investment. However, as more marginal wells are drilled and given the economic allowance, their production allowances are taken not from the other marginal wells but from the residual share of oil allotted to the better wells. Hence it is argued that the economic allowance encouraged the drilling of wells which should never have been drilled. It can often be shown that the reservoir can be produced much more economically and under best engineering practices through the more productive wells. Under the economic allowance system, an increasing proportion of low-productivity wells has been gaining a greater proportion of actual production at the expense of the better wells. Thus in 1951, 62 per cent of Alberta production was allocated on the basis of the economic allowance; this proportion increased to 73 per cent in 1957 and 85 per cent in 1963. Under the new system production will be based predominantly on ultimate and remaining reserves although a small proportion of production will be allocated through a 'floor allowance' to certain wells to prevent their premature abondonment.

RESERVES

The increase in Canada's crude oil reserves in 1964 was the largest in the history of the industry. According to the estimates of the Canadian Petroleum Association, reserves of crude oil and natural gas liquids at the end of the year were 7,065 million barrels, or 26 per cent more than in the preceding year. The major portion of the increase was because of extensions and revisions of known oil occurrences. The revisions came largely from widespread waterflood recovery projects, which will increase the proportion of recoverable oil from oil in place. Newly discovered oil constituted only 6 per cent of gross additions to estimated recoverable reserves but, as is normally the case, much larger volumes of oil will eventually be accorded the new discoveries after further drilling and production experience. The Alberta Oil and Gas Conservation Board estimated the recoverable reserves at the Mitsue oil field, the year's most important discovery, at 58 million barrels – a very conservative initial estimate. The Conservation Board's estimate of remaining recoverable crude oil in the Pembina, Canada's largest oil field, increased from 845 million barrels to 1,435 million. The nature of the Pembina Cardium reservoir and the various recovery mechanisms makes calculation of its oil reserves extremely difficult. The board's estimate is inter-

TABLE 3

Value of Natural Gas Liquids by Province
('000 dollars)

	1963	1964p
Alberta*	66,680	70,500
Saskatchewan	1,876	2,154
British Columbia	2,442	2,442
Total, Canada	70,998	75,096
Volume ('000 bbl)	28,904	35,370

Source: Dominion Bureau of Statistics.

*The Alberta Oil and Gas Conservation Board shows a breakdown of natural gas liquid sales for Alberta as follows:

	1963	1964
	('000 dollars)	
Propane	4,469	5,901
Butane	3,078	5,938
Pentanes plus	50,972	60,209

Because of the few plants in operation in British Columbia and Saskatchewan it is not possible do divulge the volumes of natural gas liquids entering marketing channels in these provinces. However, the value of production of condensates and pentanes plus and the value of sales of propane and butane is shown in Table 3 as totals of all natural gas liquids by province. The total volume is also shown.

mediate between widely divergent estimates by two oil industry groups. Accurate estimates of reserves within individual oil pools in Alberta have become especially important because the new proration plan bases production predominantly on oil reserves. The Redwater field remains the second largest with 495 million barrels. Reserves in the third largest field, Swan Hills, were substantially increased by a new waterflood project.

Huge volumes of low-gravity, viscous oils extending in a broad arcuate belt from the Lloydminster district through Cold Lake and the Athabasca oil sands to the Peace River heavy-oil occurrences are excluded from the estimates of recoverable reserves published by the Canadian Petroleum Association and the Alberta Oil and Gas Conservation Board. The board estimates that the oil sands of northern Alberta contain in excess of 700,000 million barrels of oil in place, of which about 90 per cent are in the Athabasca sands. The prospects that large volumes of this oil can eventually be recovered by *in situ* methods as well as by mining, are now more encouraging because of recent successful experimental and commercial thermal extraction of heavy oil from oil sands in the United States.

TABLE 4

Crude Oil – Production, Trade and Consumption, 1954-63

(barrels)

	Production[1]	Imports[2]	Exports[2]	Consumption[3]		
				Domestic	Imported	Total
1954	96,080,345	78,771,914	2,344,948	92,679,819	76,773,031	169,452,850
1955	129,440,247	86,678,057	14,833,971	105,050,563	86,751,128	191,801,691
1956	171,981,413	106,469,685	42,908,086	125,592,074	106,305,532	231,897,606
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
1964p	274,595,333	143,531,233	101,258,926	199,456,553	143,946,481	343,403,034

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).
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TABLE 5

Reserves of Crude Oil

	At End of 1964	Per Cent of Total		Net Change Since 1963
	('000 barrels)	1963	1964	('000 barrels)
Alberta	5,279,146	84.8	85.4	+1,138,299
Saskatchewan	602,352	10.7	9.8	+ 78,895
British Columbia	204,040	2.8	3.3	+ 67,613
Northwest Territories	49,164	1.0	0.8	– 635
Manitoba	33,637	0.5	0.5	+ 9,840
Eastern Canada	9,307	0.2	0.2	2,142
Total	6,177,646	100.0	100.0	+1,296,154

Source: Canadian Petroleum Association.

TABLE 6

Reserves of Liquid Hydrocarbons at End of 1964

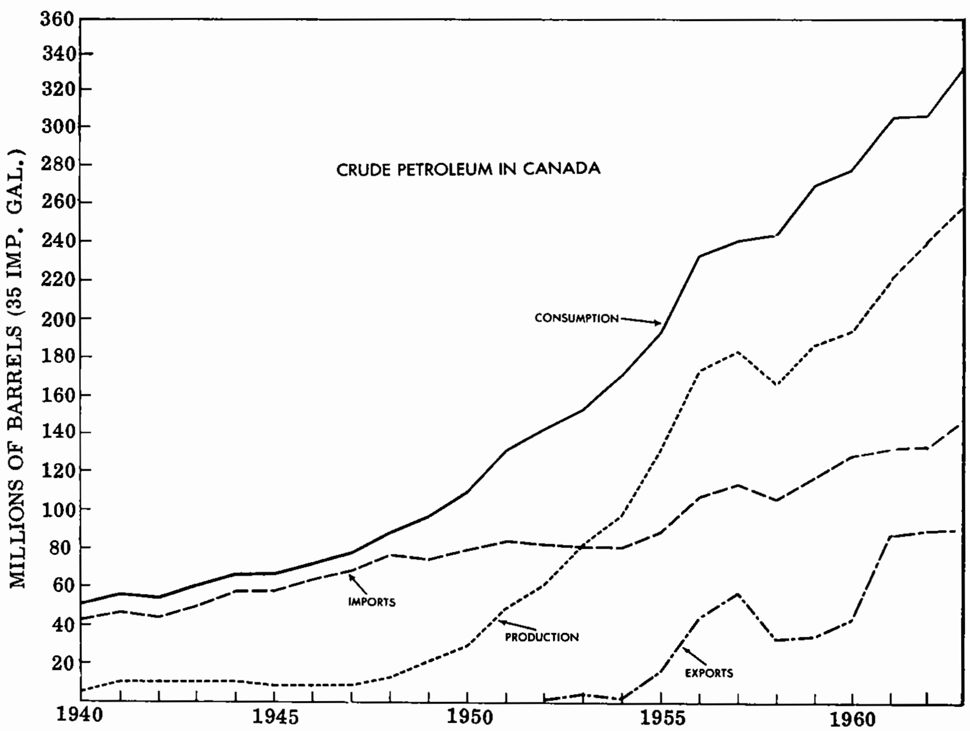
	Natural Gas Liquids (N.G.L.) ('000 barrels)	Crude Oil plus N.G.L. ('000 barrels)	Per Cent of Total
Alberta	834,683	6,113,829	86.5
Saskatchewan..............	8,111	610,463	8.7
British Columbia	44,956	248,996	3.5
Other areas................	–	92,108	1.3
Total	887,750	7,065,396	100.0

Source: Canadian Petroleum Association.
– Nil.

EXPLORATION AND DEVELOPMENT

GENERAL

Exploration and development drilling for oil and gas totalled 16.1 million feet in 1964, of which 15.6 million was in western Canada. Total footage drilled in western Canada was 10 per cent greater than the 1963 total, and only slightly less than the all-time record established in 1956. Exploratory drilling increased



sharply but development drilling only moderately. Sixty-two per cent of the drilling in western Canada was for developing known oil and gas pools and the remainder was of an exploratory nature. Discovery of a large oil field just southeast of Lesser Slave Lake early in 1964 was a major factor in the increased exploratory activity. Evidence of important new natural gas reserves in north central and central west Alberta also contributed toward greater interest in exploration.

The gradual year-by-year decline in geophysical field work evident during the past decade continued in 1964, although the decline was slight. However, more time and money are being devoted to interpretation of old and new field data. Geophysical methods of exploration are considered only of limited value in the search for certain types of oil reservoirs such as the stratigraphic traps of the Gilwood sand in the Lesser Slave Lake region. In contrast, geophysics have been indispensable in some areas of recent exploratory activity such as in the Cutbank River region south of Grande Prairie where deep Devonian gas and condensate-bearing reefs were delineated by seismic methods. In terms of crew-months, seismic work in Canada was as follows: Alberta, 406; British Columbia, 89; Saskatchewan, 53; Yukon and Northwest Territories, 61; Manitoba, 1; and Eastern Canada, 17, for a total of 627 crew-months.

Petroleum and natural gas land holdings in western Canada and offshore areas at the end of 1964 totalled 397 million acres, about 154 million acres more than a year earlier. The main reason for this greatest increase in many years was the acquisition of extensive acreages of offshore areas by several large oil companies. Largest of these permit blocks was a 45-million-acre tract in Hudson Bay held by Richfield Oil Corporation. On the Grand Banks of Newfoundland, Pan American Petroleum Corporation acquired 31 million acres. Shell Canada Limited held 22 million acres off Nova Scotia, most of it acquired in 1963. Smaller offshore acreages were acquired by other companies. Some east and west coast offshore areas were held simultaneously under both federal and provincial government permits because of the problem of which governments have jurisdiction. The federal government has referred the question to the Supreme Court of Canada for legal opinion.

ALBERTA

A total of 1,807 wells, including service wells, were completed in 1964, of which 708 were exploratory. Total drilling, on a footage basis, reached on all-time high. Aggregate footage was 10.3 million feet, surpassing the previous records of 10.1 million feet drilled in both 1956 and 1960. Exploratory drilling, which comprised 38 per cent of the total footage, increased considerably whereas development drilling declined slightly.

One region of exploratory activity stands out above all others: the Sylvia-Hondo area immediately southeast of Lesser Slave Lake. Two excellent oil discoveries 17 miles apart were made almost simultaneously in February. These were SOBC Calstan Hondo 2-1-71-4-W5 and IOE Sylvia 10-8-73-5-W5. The productive horizon was the Devonian Gilwood sandstone, a common formation in Alberta not previously commercially productive. Rapid expansion of the productive area, eventually named the Mitsue field, indicated a pool 26 miles long and up to 7 miles wide. About 40 oil wells were completed within the field during the year. Another Gilwood oil occurrence was discovered in December 6 miles northwest of the Mitsue field.

The region between Grande Prairie and Simonette was also an important exploration area. Drilling resulted in several significant discoveries of condensate-bearing natural gas and an oil discovery. The latter, Shell et al Simonette 12-28-63-25-W5, located 4 miles northwest of the Simonette D-3 oil field, was the first important D-1 oil find made in Alberta. A successful follow-up well was completed one-half mile to the north. A Devonian oil discovery was made east of Zama Lake in the far northwestern corner of Alberta by IOE Atlantic Sousa 6-12-112-5-W6. This was the most northerly oil well drilled in Alberta and was considered significant because the whole region had generally been considered mainly 'gas-prone' on the basis of the very limited number of wells previously drilled.

Exploration and development of heavy oil occurrences in southeastern Alberta increased markedly principally because of the construction of a new oil pipeline from the Bantry-Taber area to the Interprovincial Pipe Line Company's pipeline at Hardisty. Several new oil fields were designated in the southeastern sector: Bantry East, Bantry West, Matziwin and Retlaw.

Some of the main areas of oil field development elsewhere in Alberta were in those districts where new fields were designated by the Oil and Gas Conservation Board. In north-central Alberta, the Mitsue, House Mountain, Goose River and Utikuma Lake fields were designated. The House Mountain field later was merged with the Deer Mountain field because of rapid expansion of the productive areas. Development of the Swan Hills field added 98 oil wells, mainly in the northeastern sector adjacent Deer Mountain. One of the most important discoveries of 1963 was developed as the Goose River field in 1964. This field had 20 oil wells at the end of the year. The Kaybob South oil field, the only important area of Triassic production in Alberta, was enlarged from 47 to 86 wells. In west-central Alberta, a Cardium oil pool along the Trans Mountain Oil Pipe Line Company's pipeline east of Edson was designated as the Edson field and later the field limits were extended to include the huge Mississippian Elkton gas pool. The Edson Cardium pool had 16 oil wells at year's end. In central Alberta, the principal district of development drilling was at the Medicine River oil field where the number of wells capable of production was increased from 87 to 157. Other main development areas in central Alberta included the Pembina, Sylvan Lake and Bashaw fields.

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TABLE 7

Wells Completed*

	Oil Wells		Gas Wells		Dry Holes		Total	
	1963	1964	1963	1964	1963	1964	1963	1964
Alberta.............	869	861	275	266	560	663	1,704	1,790
Saskatchewan	572	636	41	30	338	588	951	1,254
British Columbia	31	45	70	37	82	60	183	142
Manitoba	29	63	–	–	15	37	44	100
Yukon and Northwest Territories........	–	–	–	3**	6	15	6	18
Total, western Canada.........	1,501	1,605	386	336	1,001	1,363	2,888	3,304
Ontario.............	32	33	57	55	113	128	202	216
Quebec.............	–	–	–	–	14	10	14	10
Maritimes...........	–	–	–	–	1	1	1	1
Total, eastern Canada.........	32	33	57	55	128	139	217	227
Total, Canada.....	1,533	1,638	443	391	1,129	1,502	3,105	3,531

Sources: Provincial and federal government reports.
*Service wells excluded. **Suspended wells.
– Nil.

TABLE 8

Oil Wells in Western Canada at End of Year

	Producing Wells		Wells Capable of Producing	
	1963	1964	1963	1964
Alberta..........................	9,217	9,613	11,437	12,114
Saskatchewan	4,653	4,837	5,291	5,640
Manitoba.........................	683	745	839	892
British Columbia.................	350	310	389	401
Northwest Territories	31	31	60	60
Total	14,934	15,536	18,016	19,107

Sources: Provincial government reports and Department of Northern Arrairs and National Resources.

Water injection pressure maintenance programs were started in three more fields in the Swan Hills region: Deer Mountain, Carson Creek North and Kaybob. Four wells were utilized for water injection in each case. Water injection experiments for enhanced recovery of viscous, asphaltic crude were continued at Lloydminster. Imperial Oil Limited received Conservation Board permission to carry out enhanced recovery experiments in the heavy oil area at Cold Lake, 90 miles north of Lloydminster. Plans for major pressure maintenance projects announced in 1964 included the Snipe Lake waterflood and the Golden Spike miscible flood. The latter operation is expected to provide 95 per cent recovery of the original oil in place, by a wide margin the largest recovery factor of any oil field in Canada

The Conservation Board granted permission in February for Great Canadian Oil Sands Limited to produce light synthetic crude oil at a rate of 45,000 barrels a day from the Athabasca oil sands. Production facilities at Mildred Lake were being constructed by summer. Full-scale production is scheduled for the fall of 1967. Experimental recovery projects by several other companies were continued in the Athabasca sands.

SASKATCHEWAN

Drilling increased sharply for the second successive year. A total of 4.2 million feet was drilled, 31 per cent more than in 1963. The increase was mainly in the exploratory category but no major oil discoveries were made. While deep drilling in the Saskatchewan part of the Williston basin provided little encouragement, several significant oil discoveries were made in deep strata, particularly Devonian, in adjacent Montana and North Dakota.

The results of step-out drilling in known areas of production were generally good. The drilling of hitherto marginally economic oil accumulations was promoted by higher crude oil prices and capacity demand for Saskatchewan crude. Some of the main areas of oil field development were close to the United States boundary in southeastern Saskatchewan. Forty-one oil wells were added to the Pinto field. The Northgate field, discovered in 1963 12 miles east of the Pinto field, was enlarged to a total of 16 wells. The other main development districts in the southeastern corner of the province were Willmar, Lost Horse Hills and Midale fields. In the chain of Jurassic medium-gravity fields in southwestern Saskatchewan nearly 100 oil wells were completed. Drilling was concentrated principally at the northern end of the trend, especially in the Battrum field where 71 additional wells expanded the field total to 134. In the Coleville region of western Saskatchewan, the Dodsland field was, as in the preceding three years, the main development area. The recent revival of development in the Lloydminster heavy oil region continued as the result of the successful operation of the new dual pipeline system. The number of wells capable of production in the fields and pools of the Lloydminster area increased from 513 to 609. Drilling was concentrated mainly in the Aberfeldy and Lone Rock fields.

The water injection pressure maintenance project in the Weyburn field, the largest such project in Saskatchewan, reached full-scale operation by mid-1964. Water-flood programs were initiated in the Dodsland and Pinto fields. At the end of the year, 29 water-flood projects were in progress in the province. These ranged in size from test projects involving one water injection well to the large Weyburn project utilizing 131 injection wells. An *in situ* combustion method of secondary recovery is to be tested in the Battrum field and an experimental secondary recovery operation involving steam injection is planned in the Lloydminster

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field. The present recovery factor of Lloydminster crude by primary methods is very low, 5 to 10 per cent. Generally speaking, thermal methods have been found to be more successful than water flooding in the recovery of low-gravity, viscous oil. As yet, no commercial project utilizing thermal recovery is in use in Canada.

BRITISH COLUMBIA

Drilling declined for the second successive year. The decrease is attributable mainly to the lack of major oil discoveries in recent years and the virtual completion of development drilling in most of the existing oil fields. Total drilling amounted to 674,800 feet, 25 per cent less than in 1963. Drilling consisted of 43 per cent exploratory and 57 per cent development.

The most important oil discovery in 1964 was Pacific Candel Peejay d-85-H-94-A-15, three miles west of the Peejay field. Subsequent exploration and development was concentrated in this area and a very productive medium-sized oil reservoir, known as the Nancy pool, was developed at the discovery site.

Until 1964, pressure maintenance operations had not played an important part in oil field development in British Columbia. At the beginning of the year, three small water-injection projects were in operation: in the Boundary Lake, Beatton River and Milligan Creek fields. During 1964, water-flood operations were expanded to large scale in the Boundary Lake and Milligan Creek fields, and small pilot-size programs were initiated in the Peejay and Beatton River West fields.

MANITOBA

The low point in drilling activity in Manitoba during the past decade was reached in 1962. Since then, drilling has increased substantially each year. Total footage drilled in 1964 was the greatest since 1957. Sixty-seven per cent of the total 256,700 feet drilled was development and the remainder was exploratory. No important oil discoveries were made. Drilling was predominantly in the vicinity of the Daly, Virden-Roselea and West Routledge fields.

One interesting aspect of petroleum exploration in Manitoba was the acquisition of oil shale exploratory permits by several oil companies covering several million acres along the Manitoba Escarpment of western Manitoba and the adjacent Pasquia Hills region of Saskatchewan. A relatively limited program of surface sampling and laboratory testing of the shales in 1921 indicated the dedeposits were of no economic value at that time. However, recent advances in technology pertaining to the recovery of petroleum from oil shales in the southwestern United States has led to renewed interest in occurrences of oil-bearing shales.

YUKON AND NORTHWEST TERRITORIES

Exploration increased markedly and 18 wells were drilled compared to six in 1963. The footage drilled amounted to 113,100 feet, all of an exploratory nature. Three wells discovered natural gas but none found oil. The third Arctic islands well, on Bathurst Island, was completed as a dry hole in February 1964, after reaching a depth of 10,000 feet.

EASTERN CANADA

In Ontario, aggregate footage drilled (excluding service wells) was 431,100 feet. Exploratory drilling constituted 54 per cent of the total. Although four exploratory wells found oil, apparently none of the discoveries were comparable in importance to the 1962 find at Clearville. Two of the oil discoveries were in Cambrian strata and two were in Silurian. Twenty-nine oil wells were completed in established fields and pools. The development of secondary recovery facilities resulted in increased production in the Rodney field.

An offshore 'play' developed in Hudson Bay where several companies took out federal exploratory permits covering most of the southwestern quarter of the bay, or 55 million acres. Offshore aeromagnetic and seismic surveys were performed by combined federal and provincial government parties. At least one company plans extensive geophysical testing of its offshore holdings in 1965.

In Quebec 10 exploratory wells were drilled, all dry. In the Atlantic Provinces, only one well was drilled. This was completed as a dry hole at a depth of 9,853 feet near Pugwash, Nova Scotia. Exploration permits covering huge areas of the continental shelf were taken out by several companies. Two main areas are held: the shelf off Nova Scotia extending to just beyond Sable Island, and the Grand Banks off Newfoundland. A federal government survey recorded a negative gravity anomaly near Cape Breton Island and permits covering the area were issued to an oil company. During the summer of 1964, considerable seismic reconnaissance was done off Nova Scotia.

TRANSPORTATION

The total of operational oil pipelines in Canada increased in 1964 to nearly 12,000 miles. Although this was predominantly crude oil pipeline, approximately 1,300 miles was used exclusively to transport natural gas liquids and nearly 900 miles was limited to carrying refined petroleum products.

A total of 1,383 miles of new pipeline came into operation in 1964, although some of this pipeline was laid in 1963—notably most of the 577-mile, 6-inch natural gas liquids pipeline from the Alberta-Saskatchewan boundary to Winnipeg. This natural gas liquids pipeline, owned by Pacific Petroleums, Ltd., transports propane, butane and pentanes plus extracted from the Trans-Canada pipeline stream at a new gas reprocessing plant near Empress, Alberta.

The second longest new pipeline completed in 1964 was constructed by Bow River Pipe Lines Ltd. from the Taber area of southeastern Alberta to the Interprovincial pipeline at Hardisty. The system consists of 210 miles of mainly

TABLE 9

Mileage in Canada of Pipelines for Crude Oil, Natural Gas Liquids and Products

Year's End	Miles	Year's End	Miles
1954	4,656	1959	7,945
1955	5,079	1960	8,435
1956	6,051	1961	9,554
1957	6,873	1962	10,037
1958	7,148	1963	10,607
		1964	11,744

Source: Dominion Bureau of Statistics.

TABLE 10

Deliveries of Crude Oil
(millions of barrels)

Company	Destination	1963	1964
Interprovincial Pipe Line	Western Canada	32.3	33.1
	United States	41.8	46.9
	Superior (for tankers)	—	—
	Ontario....................	97.8	104.5
	Total	171.8	184.5
Trans Mountain Oil Pipe Line	British Columbia	23.6	26.4
	State of Washington	46.4	53.3
	Total	70.0	79.7

Source: Annual reports of companies.
— Nil.

8- and 10-inch pipe, and 65 miles of laterals. It makespipeline transport available for the first time to heavy oil of the Bantry-Taber region. Gibson Petroleum Company Limited laid an 8-mile lateral connecting the Hamilton Lake field to the Bow River system. Interprovincial Pipe Line Company added 53 miles of 34-inch loops in Manitoba. This marked the third successive year 34-inch loops were added to the system, and increased to three the number of parallel pipelines in certain sections of the system.

Mitsue Pipeline Ltd. began laying a 100-mile, 10-inch pipeline from the new oil field near Lesser Slave Lake to Redwater but wet weather delayed completion of the line until early in 1965. Gathering systems in the Mitsue field were started. Peace River Oil Pipe Line Co. Ltd. completed a 120-mile pipeline from Snipe Lake to the Red Earth field. This is the most northerly oil pipeline in Alberta. The same company also completed short laterals to the Ante Creek and Goose River fields. Pembina Pipe Line Ltd. built 21 miles of trunk and gathering lines at the Edson Cardium pool and joined the system to the Trans Mountain pipeline at Edson. The same company connected the Rocky Mountain House field to the Willesden Green field with a 3-mile line. It also added 5 miles of crude gathering lines and 7 miles of propane-butane miscible flood lines in the Pembina field. The Cremona Pipe Line Division of Home Oil Company Limited laid two short condensate lines from the Crossfield East and the Olds gas processing plants to the existing system. Federated Pipe Lines Ltd. joined the House Mountain field to the Deer Mountain field with a 6-inch line. Hudson's Bay Oil and Gas Company Limited added 27 miles of gathering lines, mainly in the Garrington field.

In southeastern Saskatchewan, Producers Pipelines Ltd. constructed a total of 37 miles of extensions to join the Northgate, Lake Alma, Ratcliffe and Sherwood pools to its network, and 22 miles of gathering lines within fields.

Reductions in pipeline gathering and transportation charges, particularly in southeastern Saskatchewan and Manitoba, were reflected by corresponding increases in wellhead prices of crude oil. Minor changes were made in tariffs on the Interprovincial pipeline but the Edmonton to Toronto tariff remained at 51 cents a barrel.

The use of jumbo-size railway tank cars, holding up to three times the volume of conventional tank cars, became more common, especially for moving liquified petroleum gases. Reduced railway rates applicable to jumbo tank cars were introduced in October, resulting in a significant extension of the economic range of Canadian liquified petroleum gases. It was found that Canadian LPG was suddenly competitive in greater areas of the United States Pacific northwest and as a result plans were announced to ship large quantities of propane and butane to that area from the Pembina field.

PETROLEUM REFINING

A 4-per-cent increase in Canada's crude oil refining capacity was recorded in 1964 as the result of the opening of one new refinery and the enlargement of several others. At the end of the year, total refining capacity was 1,052,510 barrels per calendar day.

The new refinery, a 13,500-barrel-a-day plant near Halifax, owned by Texaco Canada Limited, came on stream early in the year. Imperial Oil Enterprises Ltd. increased the crude oil capacity of its Halifax refinery to 58,500 barrels a day and of its Montreal refinery to 84,700 barrels. Imperial Oil has nearly 34 per cent of Canada's operative refining capacity. Shell Canada Limited is the second largest refiner with nearly 17 per cent of the total capacity. The British American Oil Company Limited, holding just over 16 per cent of Canada's refining capability, increased the Kamloops refinery capacity to 6,000 barrels a day and the Brandon plant to 3,600 barrels. BP Refinery Canada Limited expanded its Montreal plant to 38,000 barrels a day and acquired the Oakville refinery of Cities Service Refining (Canada) Limited. Pacific Petroleums, Ltd., expanded the capacity of the refinery at Taylor in northeastern British Columbia to 6,500 barrels a day.

TABLE 11

Crude Oil Refining Capacity by Regions

	1963		1964	
	Bbl/day	%	Bbl/day	%
Atlantic Provinces	103,800	10.2	125,500	11.9
Quebec	305,000	30.1	318,700	30.3
Ontario	305,470	30.2	306,900	29.2
Prairie Provinces and Northwest Territories	201,130	19.9	199,910	19.0
British Columbia	97,300	9.6	101,500	9.6
Total	1,012,700	100.0	1,052,510	100.0

Source: Department of Mines and Technical Surveys, PETROLEUM REFINERS IN CANADA (OPERATORS LIST 5), January 1965.

TABLE 12

Crude Oil Received at Canadian Refineries, 1964p
(barrels)

Location of Refineries	Country of Origin				Total Received
	Canada	Middle East	Trinidad	Venezuela	
Atlantic Provinces	9,832	14,756,034	–	24,555,622	39,321,488
Quebec	–	21,242,833	4,788,559	78,127,457	104,158,849
Ontario	103,014,110	–	–	475,976	103,490,086
Prairie Provinces	65,798,029	–	–	–	65,798,029
British Columbia	30,049,443	–	–	–	30,049,443
Northwest Territories and Yukon	585,139	–	–	–	585,139
Total	199,456,553	35,998,867	4,788,559	103,159,055	343,403,034

Source: Dominion Bureau of Statistics, REFINED PETROLEUM PRODUCTS, monthly reports, 1963.
Symbols: p Preliminary; – Nil.

The competitive position of some of the smaller refineries continued to decline and three were closed down in 1964. Husky Oil Canada Ltd. shut down its 3,600-barrel-a-day plant at Fort William, Ontario, and moved some of the equipment to the Lloydminster refinery. The 2,100-barrel-a-day refinery of Shell Canada Limited at Grande Prairie, Alberta, was closed. The small, 300-barrel-a-day plant of New Brunswick Oilfields Limited near Moncton, New Brunswick, operated for only short periods during the year.

MARKETING AND TRADE

Consumption of crude oil in Canada, as measured by receipts at refineries, amounted to 938,000 barrels a day in 1964, or 3.2 per cent more than in 1963. This rate of increase was the smallest in many years. Domestic crude made up 56.2 per cent of the total crude received at refineries, a slightly higher proportion than in 1963. Refinery receipts of domestic crude increased 6.6 per cent. Receipts increased 8.5 per cent in Ontario, 13.6 per cent in British Columbia and a mere 1.6 per cent in the Prairie Provinces. Part of the increase in Ontario consumption of Canadian crude was the result of increased refinery capacity near Toronto and a continuing 'backing out' of products refined from foreign crude in the Montreal area. Less than 0.5 per cent of the crude oil used in Ontario refineries was imported.

TABLE 13

Regional Consumption of Petroleum Products – Net Sales, 1964

('000 barrels)

	Motor Gasoline	Kerosene, Stove Oil, Tractor Fuel	Diesel Fuel Oil	Light Fuel Oils No. 2 and 3	Heavy Fuel Oils No. 4, 5 and 6
Newfoundland	1,434	1,021	1,497	1,496	2,489
Maritimes	7,466	2,736	2,863	6,487	9,310
Quebec	27,712	6,181	6,912	23,865	28,005
Ontario	45,227	3,741	6,384	32,902	21,253
Manitoba	6,436	770	2,391	2,327	1,282
Saskatchewan	8,645	1,251	3,070	1,659	868
Alberta	13,589	506	4,863	1,062	417
British Columbia	11,492	1,844	5,055	4,767	7,250
Northwest Territories and Yukon	207	100	305	293	105
Total	122,208	18,150	33,340	74,858	70,979

Source: Dominion Bureau of Statistics, REFINED PETROLEUM PRODUCTS, monthly reports, 1964.

Quebec and the Atlantic Provinces continued to use only imported crude oil with the exception of the negligible output of New Brunswick crude. Receipts of imported crude averaged 393,000 barrels daily, 2.8 per cent less than in 1963. The decline resulted from the 'backing out' of Montreal-refined products. Thus, while receipts of imported crude at Quebec refineries decreased by nearly 17,000 barrels a day, Ontario receipts of domestic crude increased by 22,000 barrels daily. Consumption of foreign crude in the Atlantic Provinces increased 10 per cent. A significantly greater proportion of the imported crude used in eastern

Canada in 1964 came from Venezuela. Substantial decreases of imports from the Middle East and Trinidad were evident.

TABLE 14

Imports of Refined Petroleum Products
(millions of barrels)

	1963	1964p
Heavy fuel oil	14.74	22.04
Light fuel oil	6.55	7.67
Stove oil	2.16	1.39
Motor gasoline	2.12	1.97
Aviation gasoline	0.35	0.26
Diesel fuel	2.80	3.25
Lubricating oil	1.12	1.36
Petroleum coke	1.17	2.09

Source: Dominion Bureau of Statistics.
p Preliminary: 1964 figures are totals of monthly imports from REFINED PETROLEUM PRODUCTS.

Imports of petroleum products averaged 115,000 barrels daily, about 23,000 barrels more than in 1963. This increase in imports of refined products more than offset the 11,000-barrel-a-day decrease in imports of crude oil. Late in the year, independent gasoline marketers imported several shipments of 'distress price' motor gasoline into Ontario from West Germany. Although the volumes imported were not great in the over-all trade picture – a yearly average of about 500 barrels a day – the fact that much of this gasoline entered the Toronto area retail market over a short period of time at relatively low prices caused considerable consternation among other gasoline marketers. To counteract a continuation of this type of trade the federal government passed an Order in Council which will permit the Minister of National Revenue to apply appropriate tariffs to any unreasonably low cost imported products.

Exports of crude oil and equivalent to the United States increased in 1964, following the temporary levelling off of 1963. Crude oil exports averaged 278,000 barrels daily, an 11.4-per-cent increase. As in 1963, 51 per cent of the exports was shipped to refineries in the Puget Sound region of the west coast, and the remainder went to refineries along the northern perimeter of the United States between western Montana and Buffalo, New York. Exports of refined petroleum products increased by 61 per cent to 24,000 barrels a day. Most of the exported products, mainly butane, propane, heavy fuel oil and gasoline, were shipped to the United States. Sweden and West Germany were the second and third largest markets for exported petroleum products but volumes involved were very small.

TABLE 15

Supply and Demand – All Oils

('000 barrels)

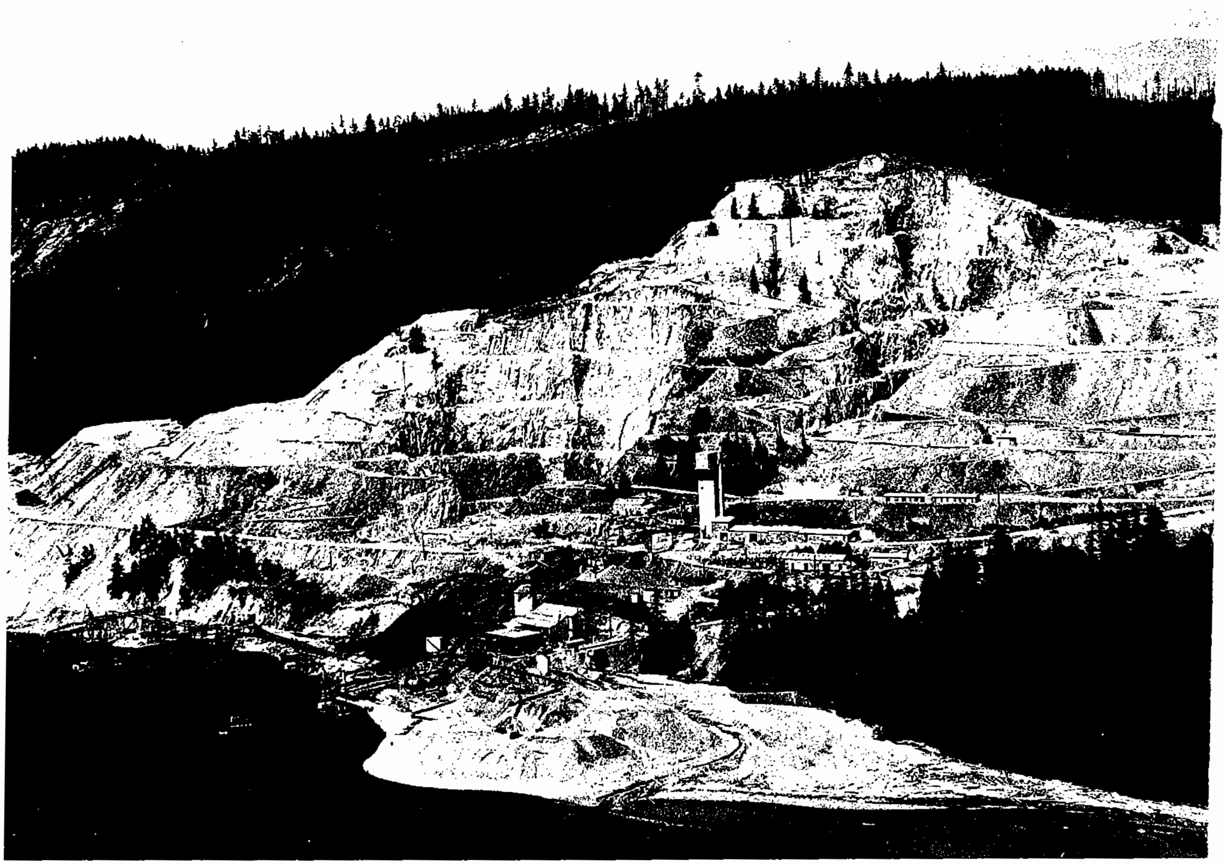
	1963	1964p
Supply		
Production		
Crude oil, excluding condensate	257,662	274,595
Natural gas liquids, including condensate	29,049r	37,301
Total, Canada	286,711r	311,896
Total, Canada ('000 barrels per day)	786r	855
Imports		
Crude oil	147,721	143,531
Refined-petroleum products	33,844	42,307
Total	181,565	185,838
Change in stock		
Crude oil	+193	+1,015
Refined-petroleum products	−2,398	+8,378
Net changes in stock	−2,205	+9,393
Oils not accounted for	−2,805r	+714
Total supply	463,266	507,841
Demand		
Exports		
Crude oil	90,876	101,259
Products	5,509	8,879
Total	96,385	110,138
Domestic sales		
Motor gasoline	115,124	122,207
Middle distillates	126,127	134,007
Heavy fuel oil	60,624	70,979
Other products	36,815	40,724
Total	338,690	367,917
Uses and losses		
Refinery	25,145	26,250
Field and pipeline	3,046	3,536
Total	28,191	29,786
Total demand	463,266	507,841

Source: Dominion Bureau of Statistics and provincial government reports.
Symbols: p Preliminary; r Revised.

PRICES

The average wellhead price of Canadian crude oil increased by $0.07 in 1964 to $2.46 a barrel. The average price in Alberta was $2.58 a barrel, but posted prices varied considerably from field to field, depending on factors such as the gravity and quality of the crude and the field location. Posted Alberta prices were as low as $1.63 for low-gravity crude in the Taber area to as high as $2.83 for high-gravity crude at the Bonnie Glen field. Average crude oil prices in other provinces were: Saskatchewan, $2.28 a barrel; British Columbia, $2.03; Manitoba, $2.43; and Ontario, $2.85.

Texada Mines Ltd. in British Columbia. The mine is now operated by underground mining methods.



Phosphate

J.E. REEVES*

Canada's relatively large share in the world's rapidly growing phosphate fertilizer industry is reflected in the continuing expansion of fertilizer production facilities and in the steadily increasing imports of phosphate rock.

In 1964, 1,406,424 short tons valued at $11,719,401 were imported. About 97 per cent was phosphate rock from the United States, mainly Montana and Florida, worth between $7 and $8 a ton. The balance consisted of much higher-priced defluorinated phosphate rock from the United States, phosphate rock from Morocco and naturally low-fluorine phosphate rock from the island of Curaçao in the Netherlands Antilles. This is the largest quantity of phosphate rock ever imported into Canada in one year.

A comparison between statistics of phosphate rock imports in 1964 and those of previous years is affected by changes in import trade classifications for 1964. The classification 'phosphate rock' no longer includes imports of high-priced dicalcium phosphate from the United States, Belgium and Japan; these imports are tabulated separately under 'calcium phosphates' in 1964. By subtracting about 20,000 tons of dicalcium phosphate worth about $1.8 million, adjusted statistics comparable with those for 1964 are obtained for imports of phosphate rock in 1963. These indicate an increase in imports of phosphate rock in 1964 of about 10 per cent in volume and 13 per cent in value.

There is considerable trade in fertilizers between Canada and the United States. In 1964 Canada imported 112,590 short tons of normal superphosphate and 63,258 short tons of triple superphosphate, in each case reversing the declining trend in these imports over the last few years.

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Canada's capacity for producing phosphate fertilizer exceeds domestic demand and for many years has resulted in significant exports, particularly of ammonium phosphate. In 1964 a little more than $10 million worth of 'nitrogen phosphate' fertilizers was exported, virtually all to the United States. The decline from more than $13 million worth in 1962 apparently is because of the rapidly increasing demand for ammonium phosphate in western Canada.

TABLE 1

Phosphate – Trade and Consumption

	1963		1964	
	Short Tons	$	Short Tons	$
Imports[1]				
Phosphate rock				
United States	1,266,043	11,432,139	1,368,768	11,144,630
Morocco	22,815	320,349	35,733	487,846
Netherlands Antilles	4,290	206,183	1,923	86,925
Belgium and Luxembourg	3,397	177,544	...[2]	...[2]
Japan	882	61,513	...[2]	...[2]
Total	1,297,427	12,203,728	1,406,424	11,719,401
Adjusted total[3]	1,280,000	10,400,000	...	...
Calcium phosphates[4]				
United States	..	..	16,950	1,619,686
Belgium and Luxembourg	...[5]	...[5]	1,353	75,541
Japan	...[5]	...[5]	843	57,026
Others	–	–	13	4,129
Total	..	..	19,159	1,756,382
Phosphate fertilizers				
Normal superphosphate				
United States	83,938	1,596,744	112,590	2,141,725
Triple superphosphate				
United States	41,946	2,068,325	63,258	3,685,283
Phosphate chemicals				
Potassium phosphates				
United States	..	..	1,793	573,794
Sodium phosphate, tribasic				
United States	894	148,994	823	141,495
Sodium phosphates, n.e.s.				
United States	3,576	1,007,038	3,522	861,851
West Germany	46	15,890	70	24,648
Others	7	9,535	–	–
Total	3,629	1,032,463	3,592	886,499
Exports				
Nitrogen phosphate fertilizers				
United States		13,058,269		10,243,635
Cuba		–		12,052
Thailand		16,072		–
Bermuda		569		–
Total		13,074,910		10,255,687

Table 1 (cont.)

	1962		1963	
	Short tons	$	Short tons	$
Consumption of phosphate rock (available data)				
Fertilizers[6]....................	957,195		1,002,920	
Chemicals[7]....................	159,412		163,653	
Total.......................	1,116,607		1,166,573	

Source: Dominion Bureau of Statistics.

[1]Because of changes in import trade classifications, import statistics for 1964 are not completely comparable with previous years. [2]Listed below under 'calcium phosphates'. [3]Calculated by subtracting the imports, dicalcium phosphate, from Belgium and Japan, and the estimated imports of dicalcium phosphate from the United States, from the totals for 1963. [4]New class previously included under 'phosphate rock'. [5]Listed above under 'phosphate rock'. [6]Includes small amount used for making animal feed supplements. [7]Includes small amount used in production of pig iron.

Symbols: — Nil; .. Not available; ... Not applicable.

TABLE 2

Phosphate Rock – Imports and Consumption, 1955-64

(short tons)

	Imports	Consumption
1955	588,209	585,326
1956	627,648	552,646
1957	723,220	772,715
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	

Source: Dominion Bureau of Statistics.

DEVELOPMENTS

For nearly three years Canada has been experiencing a dramatic growth of its phosphate fertilizer industry. Fertilizer producers are expanding their plants and building new ones; several companies with limited or no experience in fertilizers are joining the industry. In western Canada the availability of sulphur and byproduct sulphuric acid and the spiralling demands of the Prairie farmers are important stimuli; in eastern Canada, byproduct sulphuric acid from the smelting of sulphides is the main reason. For all this growth phosphate rock must be imported.

In early 1964 The Consolidated Mining and Smelting Company of Canada Limited completed a 100,000-ton-a-year extension of its ammonium phosphate plant at Kimberley, British Columbia, and its subsidiary, Montana Phosphate Products Company, completed the development of the Douglas Creek mine and construction of a 300,000-ton-a-year phosphate rock concentrator near Maxwell in southwestern Montana. In addition, it began construction of a 100,000-ton-a-year ammonium phosphate plant at Regina, Saskatchewan, and an extension of the phosphoric acid plant at Kimberley to feed the Regina plant – both to be completed in 1965.

At Fort Saskatchewan, Alberta, Sherritt Gordon Mines, Limited, started construction of a plant capable of producing 125,000 tons of ammonium phosphate a year. Completion is scheduled for the latter part of 1965. Phosphate rock will be imported from Florida via Vancouver.

Late in 1964 Border Fertilizer Limited began producing ammonium phosphate at Transcona, Manitoba, from a new plant with a capacity of 80,000 tons a year. Phosphate rock is imported from Wyoming.

During the year construction was begun on an expansion of the ammonium phosphate plant of Northwest Nitro-Chemicals Ltd. at Medicine Hat, Alberta, and on a new fertilizer plant at Calgary, Alberta, to be operated by Western Co-Operative Fertilizers Limited. The latter plant is being financed jointly by three large co-operatives – the Alberta Wheat Pool, the Saskatchewan Wheat Pool and Federated Co-operatives Limited – and will include in its production 520 tons of ammonium phosphate a day.

Plans for several new phosphate fertilizer plants have been announced. Brunswick Fertilizer Corporation Limited, owned jointly by Brunswick Mining and Smelting Corporation and the British parent company of Electric Reduction Company of Canada, Ltd., Albright & Wilson Limited, will build a plant for the production of 680,000 tons of ammonium phosphate a year, mainly for export. The plant, which will be located near Belledune, north of Bathurst, New Brunswick, will consume byproduct sulphuric acid from the proposed nearby iron ore (pyrite) plant and imported phosphate rock. St. Lawrence Fertilizers Limited was incorporated to operate a wet-process phosphoric acid plant and related fertilizer plants at Valleyfield, Quebec, using byproduct sulphuric acid from the smelter of Canadian Electrolytic Zinc Limited and phosphate rock imported probably from Morocco. The acid plant will reportedly have a capacity of about 300 tons a day. Canadian Industries Limited will build a large fertilizer complex, including units for making phosphoric acid and ammonium phosphate, at Courtright, south of Sarnia, Ontario. J.R. Simplot Company will build a fertilizer complex at Winnipeg, including an ammonium phosphate plant with a capacity of 225,000 tons a year. It will import the necessary phosphoric acid from its expanded facilities in Pocatello, Idaho.

PRODUCTION AND OCCURRENCES

There has been no significant domestic production of phosphatic raw material since low-cost Florida sedimentary phosphate rock became readily available during the early 1890s. For a few years before that period, a flourishing apatite-mining industry existed, particularly in the Buckingham area of Quebec. The source of this production was a number of relatively small, irregular, coarse-grained deposits of a type that is common in southwestern Quebec and south-eastern Ontario. Typically, the deposits also contain phlogopite mica and pink calcite and are found in association with pyroxenite.

Apatite is relatively abundant in some of the alkaline-rock complexes that occur in parts of Ontario and Quebec. Near Nemegos, about 150 miles northwest of Sudbury, extensive zones contain more than 20 per cent apatite, large quantities of titaniferous magnetite and minor amounts of the niobium mineral pyrochlore. The niobium-mineral deposits in the Oka area, near Montreal, contain small amounts of apatite, which may prove to be recoverable as a byproduct of the niobium-mineral production.

Some of the ilmenite-magnetite deposits associated with anorthosite in eastern Quebec contain sufficient apatite to make them potential sources of by-product apatite.

Sedimentary phosphate rock occurs between Banff, Alberta, and the Crowsnest-Fernie area of southeastern British Columbia, but is probably too low-grade to be currently commercial.

WORLD PRODUCTION

World output of phosphate in 1964 was reportedly about 59 million short tons, of which the United States produced about 23 million, marking the continuing growth of world production of phosphatic raw material. Production statistics for 1963 are shown in Table 3.

Sedimentary phosphate rock is the dominant phosphatic raw material, apatite concentrate makes up about 17 per cent of the total, and guano is a minor source. The U.S.S.R., North Viet Nam, Brazil and North Korea are the main producers of apatite. Peru is the largest guano producer. The Netherlands Antilles markets a naturally low-fluorine phosphate rock for use as an additive to stock and poultry feeds.

TABLE 3

World Production of Phosphate, 1963
('000 short tons)

United States	22,215
U.S.S.R.	12,230e
Morocco	9,423
Tunisia	2,610
Nauru Island	1,733
North Viet Nam	885e
China	784e
Christmas Island	729
Egypt	674
Senegal	656
Togo	647
Brazil	622e
Republic of South Africa	502
Jordan	448e
Makatea Island	448e
Ocean Island	399
Israel	330
Algeria	273
North Korea	224
Netherlands Antilles	123
Other countries	493
Total	56,448

Source: U.S. Bureau of Mines, MINERALS YEARBOOK, 1963
e Estimated.

TECHNOLOGY

Phosphorus, an essential constituent of life, is mainly derived from sedimentary phosphate rock or apatite, which are essentially calcium phosphate. These raw materials are graded chemically in terms of the content of $Ca_3(PO_4)_2$ (bone phosphate of lime or B.P.L.) or of P_2O_5 – 1.0 B.P.L. = 0.458 P_2O_5.

The phosphorus can be made readily assimilable by plants by converting the raw material to a fertilizer. Normal superphosphate, with an 18- to 22-per-cent content of available P_2O_5, is manufactured by treating phosphate rock with sulphuric acid. Triple superphosphate contains 45 to 48 per cent available P_2O_5 and is produced by treating phosphate rock with phosphoric acid. These fertilizers are used mostly with compounds of nitrogen and potassium to produce mixed fertilizers, but are also applied directly to the soil. Ammonium phosphates, which are manufactured by reacting ammonia with phosphoric acid, provide two essential ingredients, phosphorus and nitrogen. Generally, wet-process phosphoric acid is used, produced by acidulating phosphate rock with sulphuric acid and usually concentrated to about 54 per cent P_2O_5. Diammonium phosphate, a fairly highly concentrated plant food with about the same amount of available phosphorus as triple superphosphate plus 11 to 18 per cent nitrogen, has become the most common variety.

Increasing interest in fertilizers with a higher, more suitable or more complete plant food content has led to numerous developments in products and methods of processing and marketing. The ability to produce and transport superphosphoric acid, having approximately 70 per cent P_2O_5 and a very low fluorine content, offers a cost advantage to the farmer; the growing acceptance of liquid fertilizers, generally containing nitrogen and phosphorus, has meant a readily available source of plant nutrients; and the building of a system of small bulk-blending plants has provided fertilizers geared to local needs.

Almost all phosphate rock contains 3 to 4 per cent fluorine; before a supplement for stock and poultry feed can be produced, the fluorine content must be reduced significantly. This is accomplished by calcining the rock, which substantially defluorinates it, or by manufacturing wet-process phosphoric acid and reacting this with limestone to produce dicalcium phosphate, which contains less than 0.2 per cent fluorine.

Elemental phosphorus is manufactured by fusing a mixture of phosphate rock, silica and coke in an electric furnace. The phosphorus is converted to high-purity phosphoric acid and numerous industrial chemicals.

USES AND SPECIFICATIONS

Phosphate rock is used mainly for fertilizer. Although a minor amount is fine-ground and applied directly to the soil, most is processed to make the phosphorus more readily available. Smaller amounts of phosphate rock are used for making phosphorus and phosphorous chemicals, and feed supplements for livestock and poultry.

Phosphorous chemicals are consumed by a wide variety of industries. The main application is in the manufacture of soaps and detergents. The food-processing industry uses considerable amounts as a leavening agent in baking powders, cake mixes, etc., and in food preservatives. They are also used in water-conditioning, metal treatment, plastic- and paper-manufacturing, the synthesis of organic phosphates, and the manufacture of chemical reagents and pharmaceutical preparations, as well as in paints, stock-feed supplements, munitions and fireworks and many other products.

For the manufacture of fertilizer, phosphate rock should contain at least 68 per cent B.P.L., and may contain as high as 77 per cent B.P.L. depending on the process. For electric furnace use, a lower B.P.L. content is acceptable but the rocks must have no excess calcium, a maximum of 3 per cent Fe_2O_3 plus Al_2O_3, and be mostly coarser than 5 mesh.

PRICES

The rapidly growing demand for phosphate rock has resulted in price increases. The price of phosphate rock from several sources, including Florida and Morocco, increased during the year.

According to OIL, PAINT AND DRUG REPORTER of December 28, 1964, the following prices apply:

Phosphate rock, Florida land pebble, run of mine, washed, dried, unground, bulk car load, f.o.b. mines, per short ton	
66-68% B.P.L.	$5.84
68-70	6.76
70-72	7.38
73-75	8.34
76-77	9.30
Phosphate rock, Curaçao, bulk, f.o.b. Atlantic and Gulf ports, per ton	46.75
Defluorinated phosphate, feed grade, various U.S. sources, 14-19% P, per ton	54.00-73.35

Phosphate rock enters Canada duty free.

Platinum Metals

C.C. ALLEN*

The platinum group of metals consists of platinum, palladium, rhodium, ruthenium, iridium and osmium. With the exception of osmium. all are produced in Canada. Production in 1964 amounted to 374,988 ounces valued at $25,196,159, slightly higher than in 1963. These metals are recovered in Canada as byproducts from the refining of nickel ores and the increase in production in 1964 resulted from a higher nickel output.

In the past several years, Russia has produced about half the world production. Canada and the Republic of South Africa have supplied most of the remainder with minor amounts produced in the United States and Colombia Prior to 1964, Russia exported at least one third of its production of platinum metals to Europe and the United States. In 1964, Russian exports to the Free World, which had been curtailed in late 1963, virtually ceased and decreased supply brought about partial rationing by the two major distributors: Engelhard Industries, Inc., and Johnson, Matthey & Co., Limited, whose official price for platinum was $87 to $90 an ounce. The price for platinum on the 'dealers' or free market was $137 to $140 an ounce.

The United States Bureau of Mines estimates Russian production of platinum metals at 1 million ounces in 1964. The curtailment of exports to the western world would greatly increase the amount of these metals available to industry in the Sino-Soviet bloc. It is possible that some production was stockpiled but a great deal of the increased production could have been used in new oil refineries, which require large initial quantities of platinum for catalysts, and in the fertilizer and chemical industries, which require much smaller amounts. Platinum for these uses is not actually 'consumed' but acts only as a catalyst; therefore, Russian supplies, including stockpiled material, could re-enter tne western market in the future when immediate needs for new plants are not so great.

*Mineral Resources Division

TABLE 1

Platinum Metals – Production and Trade

	1963		1964p	
	Troy Ounces	$	Troy Ounces	$
Production[1]				
Platinum, palladium, rhodium, ruthenium, iridium	357,651	22,585,205	374,988	25,196,159
Exports				
Domestic origin				
Platinum metals in ores and concentrates				
Britain	479,838	20,536,696	383,315	19,314,889
Norway	19,444	937,395	19,962	1,295,599
United States	7,500	133,856	1,614	37,772
Total	506,782	21,607,947	404,891	20,648,260
Platinum metals				
Japan	31,499	2,159,037	3,495	125,977
United States	9,424	638,854	275	27,075
Britain	1,137	108,805	95	10,018
Jamaica	56	7,023	36	1,184
Cuba	729	34,150	–	–
Total	42,845	2,947,869	3,901	164,254
Foreign origin[2]				
Platinum metals, refined and semiprocessed	386,941	10,144,484	581,779	20,888,749
Imports[3]				
Platinum lumps, ingots, powder and sponge[4]				
United Kingdom	..	..	125,000	12,110,789
United States	..	..	858	78,854
Norway	..	..	200	23,760
Total	..	..	126,058	12,213,403
Other platinum group metals in lumps, ingots, powder and sponge[4]				
United Kingdom	..	..	85,814	4,701,857
United States	..	..	9,685	454,031
Total	..	..	95,499	5,155,888
Total platinum and platinum group metals				
United Kingdom	..	13,093,491	210,814	16,812,646
United States	..	497,084	10,543	532,885
Norway	–	–	200	23,760
Total	..	13,590,575	221,557	17,369,291

Table 1 (cont.)

	1963		1964p	
	Troy ounces	$	Troy Ounces	$
Imports[3] (cont.)				
Platinum crucibles				
United States	..	1,731,558	30,747	2,788,810
United Kingdom	..	34,874	2	249
Total	..	1,766,432	30,749	2,789,059
Platinum metals, fabricated material n.e.s.[4]				
United Kingdom	..	..	3,107	307,172
United States	..	..	1,353	115,795
Total	..	..	4,460	422,967

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 with change or alteration. [3]Classification changes effective 1964 result in 1964 classes not being completely comparable with previous years. [4]Class not available prior to 1964.
Symbols: p Preliminary; — Nil; .. Not available.

TABLE 2

World Production of Platinum Metals
(troy ounces)

	1962	1963
U.S.S.R.	800,000e	800,000e
Canada	470,787	357,649
Republic of South Africa	306,000e	305,500e
United States	28,742	49,750
Colombia	22,052	28,592
Other countries	2,419	1,509
Total	1,630,000	1,543,000

Source: U.S. Bureau of Mines MINERALS YEARBOOK, 1963; for Canada, Dominion Bureau of Statistics.
e Estimate.

TABLE 3

Platinum Metals – Production and Trade, 1955-64

	Production[1]			Exports			Imports[4]
	Platinum (troy oz)	Other Platinum Metals (troy oz)	Total (troy oz)	Domestic[2] ($)	Foreign[3] ($)	Total ($)	($)
1955	170,494	214,252	384,746	14,605,539	11,697,861	26,303,400	15,723,099
1956	151,357	163,451	314,808	20,571,623	14,814,488	35,386,111	19,579,826
1957	199,565	216,582	416,147	17,638,093	10,081,412	27,719,505	15,430,931
1958	146,092	154,366	300,458	15,014,321	4,893,616	19,907,937	8,641,360
1959	150,382	177,713	328,095	12,497,221	8,676,998	21,174,219	6,466,280
1960	..	..	483,604	16,068,728	8,404,563	24,473,291	12,951,420
1961	..	..	418,278	26,331,101	9,820,374	36,151,475	11,242,328
1962	..	..	470,787	24,340,175	8,644,781	32,984,956	12,925,466
1963	..	..	357,651	24,555,816	10,144,484	34,700,300	13,590,575
1964p	..	..	374,988	20,812,514	20,888,749	41,701,263	17,369,291

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 in concentrates exported for treatment. [3]Exports of platinum metals refined and semiprocessed. Re-exports of platinum metals from Britain considered exports of foreign produce. [4]Imports mainly from Britain of refined and semiprocessed platinum metals derived from Canadian concentrates and residues.

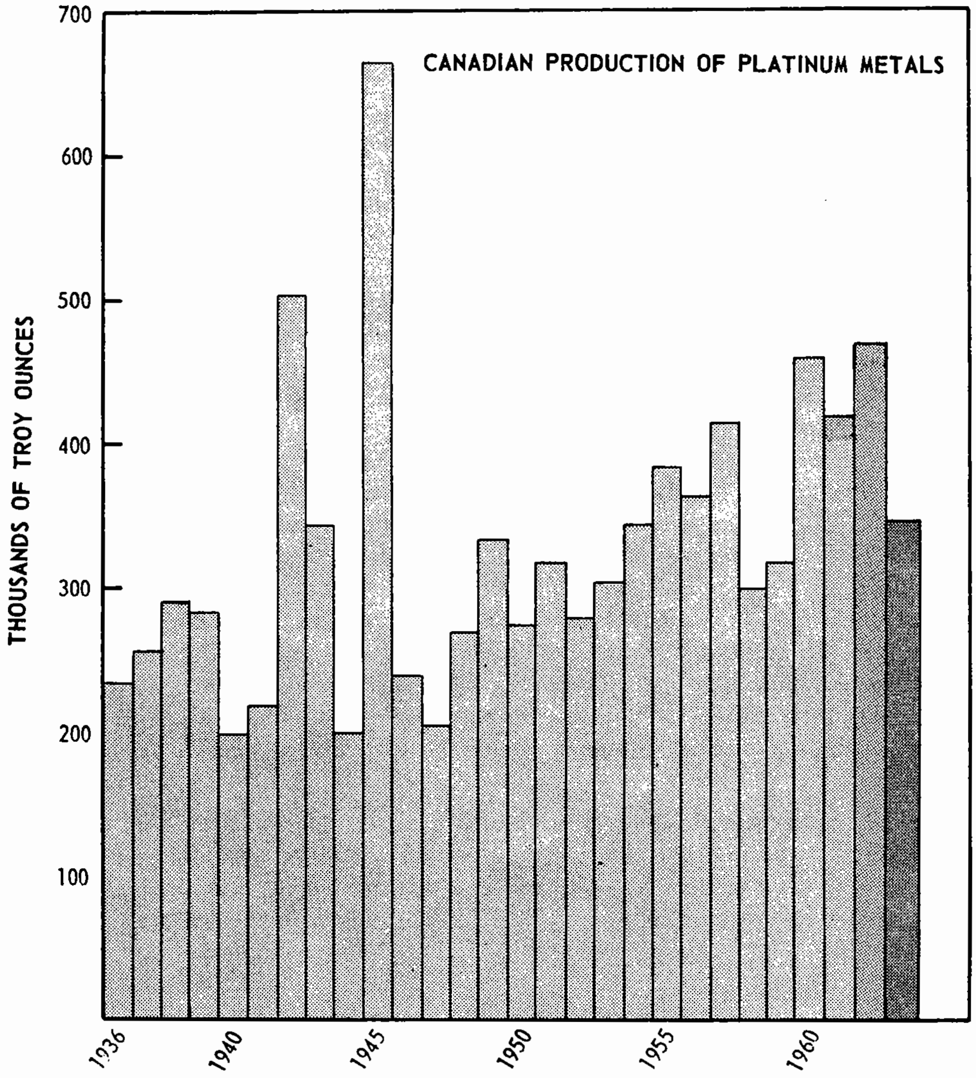
Symbols; p Preliminary; .. Not available for publication.

South African producers have announced plans to increase production to meet the rise in demand for platinum metals. Rustenburg Platinum Mines Limited, plans a 40-per-cent increase in capacity from the present estimated 625,000 ounces obtained from 2.5 million tons of ore. Plant and mine capacity will be increased in stages in 1965; the expansion program is scheduled to be completed in early 1966. The adjoining Brakspruit property will be developed by a consortium of four companies, including Anglo American Corporation of South Africa Limited, and General Mining and Finance Corporation Limited.

PRODUCTION

Canadian nickel ores average about 0.025 ounce of platinum metals per ton. In the smelting process the platinum metals are collected in the nickel-copper sulphide matte, which is cast into anodes and subsequently purified by electrolysis. During electrolysis, the platinum metals are released and collect as a sludge in the bottom of the tanks. The impure sludge is removed, purified and shipped to refineries in Britain and the United States for recovery of the individual metals.

Canadian production of platinum metals comes from the treatment of nickel ores of the Sudbury, Ontario, area, Thompson, Manitoba, and the smaller mines



at Malartic and Belleterre in Quebec and at Gordon Lake, Ontario. At Sudbury, The International Nickel Company of Canada, Limited (INCO), operated seven mines and Falconbridge Nickel Mines, Limited, operated five mines. INCO operated the Creighton, Frood-Stobie, Garson, Levack, Murray, Clarabelle and the new Crean Hill mine. The latter, closed in 1919, was reopened at a production rate of 3,000 tons of ore a day. Falconbridge operated the Falconbridge, East, Hardy, Onaping and Fecunis mines. Mine production in the Sudbury area is more than 50 thousand tons of ore a day. The Thompson, Manitoba, mine of INCO has an output of about 6,000 tons of ore a day.

Ore mined by INCO during the year amounted to 16,439,000 tons compared with 13,566,000 tons in 1963. Year-end ore reserves totalled 303,767,000 tons containing 9,196,000 tons of nickel and copper, slightly higher than the 1963 reserves. Development plans at Sudbury include three small mines with production at the Totten and McLennan planned for 1965 and at the Kirkwood for 1966. Five miles south of Thompson, Manitoba, development work was under way at the Birchtree mine that included sinking of two shafts; production is expected in 1967. INCO plans to produce in 1965 some 60 million more pounds of nickel than it did in 1964. Through plant improvements in Ontario and Manitoba the company's production capacity is now 450 million pounds of nickel a year, up from the previous year's 400 million pounds.

Falconbridge ore deliveries to treatment plants during the year were 1,960,000 tons compared with 2,116,000 tons in 1963. Proven ore reserves at the year's end were 52,236,250 tons averaging 1.43 per cent nickel and 0.76 per cent copper. Probable ore reserves amounted to 17,287,000 tons averaging 1.02 per cent nickel and 0.68 per cent copper. Development work continued at the Strathcona mine where production is planned for late 1967 and where construction of a new concentrator will begin in 1966. A new blast furnace was completed in January 1965. The furnace, coupled with Strathcona mine production in 1967, will increase Falconbridge's annual nickel production capacity to about 100 million pounds from 70 million pounds. Platinum metals production should be correspondingly greater.

The smaller mines – Metal Mines Limited at Gordon Lake, Ontario (500 tons of ore a day); Marbridge Mines Limited, Malartic, Quebec (400 tons a day); and Lorraine Mining Company Limited, Belleterre, Quebec (400 tons a day) – ship their nickel-copper concentrates to Sudbury for treatment by INCO and Falconbridge.

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 also used in plating.

The chemical industry is a large user of platinum, which serves mainly as a catalyst in the manufacture of sulphuric and nitric acid and in the hydrogenation of organic chemicals, gas purification and the production of high-octane gasoline. Palladium is used principally in the electrical industry. Its main application is in low-amperage circuits where it provides contacts that are noncorrosive and highly reliable under all operating conditions. Platinum-gold and platinum-rhodium alloys are used in spinnerets for the manufacture of synthetic fibres and as extrusion nozzles for making fiberglass. Platinum metals are used in dental alloys and in jewellery where their ease of working, strength and hardness are valuable properties.

PRICES

The prices of platinum metals per troy ounce in the United States, according to E & MJ METAL AND MINERAL MARKETS on December 30, 1963, and on December 30, 1964, were:

	December 30, 1963	December 30, 1964
Platinum	$82–85	$87–90
Palladium	24–26	32–34
Osmium	60–70	190–200
Iridium	70–75	90–95
Rhodium	137–140	182–185
Ruthenium	55–60	55–60

The prices listed by E & MJ METAL AND MINERAL MARKETS are official prices and not free market prices.

TARIFFS

CANADA	British Preferential	Most Favoured Nation	General
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

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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 valorem

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 valorem

Potash

C.M. BARTLEY*

POTASH MINERALS AND THEIR SOURCES

The term 'potash', applied to materials containing potassium in useful amounts, is derived from 'pot ashes'. In early days, solutions leached from wood ashes in iron pots served as a source of potassium. Soluble potash minerals found in German salt deposits were recognized as valuable for fertilizer in 1857, and minerals have since been the source for fertilizer and for chemical use. The potassium content of the minerals is stated in terms of K_2O because it was originally thought that potassium was effective as fertilizer only in this form. The present trend to high-analysis fertilizers makes traditional practice cumbersome in that plant nutrient values sometimes total more than 100 per cent. However, consideration is being given to stating nutrient values of potash and phosphate in terms of per cent potassium (K) and phosphorus (P), as is done with nitrogen, rather than as K_2O and P_2O_5.

The common and most useful potassium-bearing minerals, with chemical formulae and potassium content expressed as percentages of K_2O and K, are as follows:

Mineral	Formula	Percentages Equivalent K_2O	K
Sylvite	KCl	63.3	52
Carnallite	$KCl.MgCl_26H_2O$	17.0	14
Langbeinite	$K_2SO_42MgSO_4$	22.0	19
Kainite	$KCl.MgSO_43H_2O$	18.9	13
Nitre	KNO_3	46.5	39

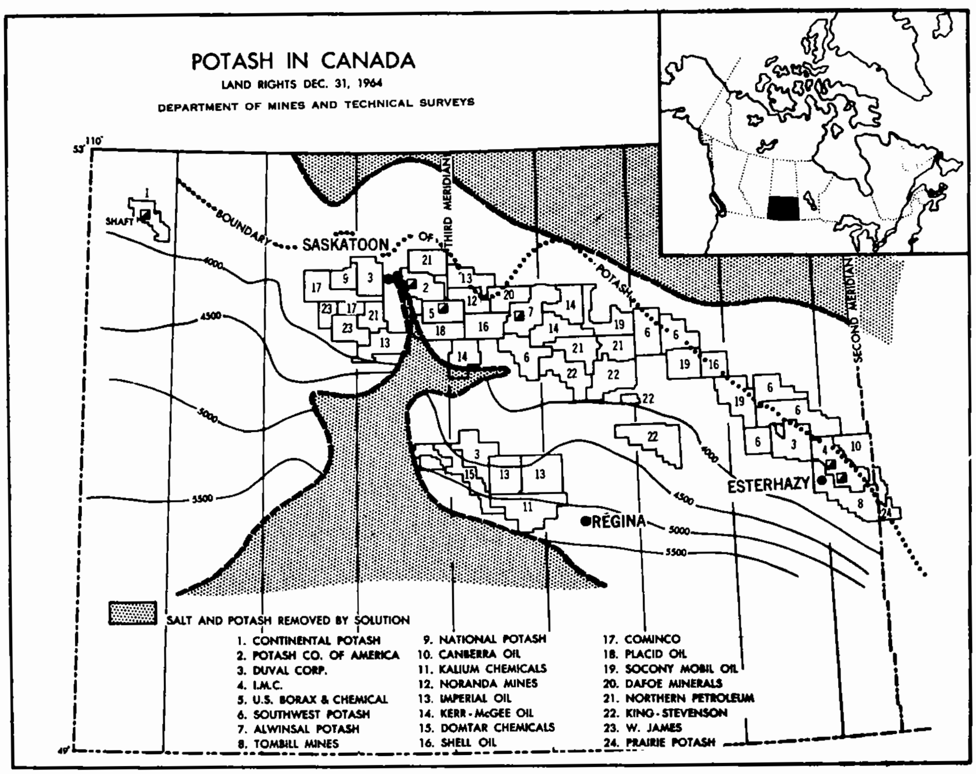
Minerals valued for their potassium content occur almost entirely as bedded evaporite deposits associated with salt (NaCl) or as natural brines (as in the Dead Sea) where soluble salts are being concentrated by high rates of evaporation. The main sources of potash are evaporites that after deposition have been buried by overlying sediments and thus protected from solution by surface water. Major deposits of potash minerals have been found in Germany, France, the U.S.S.R., Spain, the United States and, more recently, in Saskatchewan.

*Mineral Processing Division, Mines Branch

Potash is recovered from brines at Searles Lake in California. It is also recovered by Israel from brines drawn from the Dead Sea. Similar recovery is planned by Jordan at the Dead Sea. Brine occurrences in the Sechura desert of Peru have been investigated as a source of potash.

POTASH – CANADA AND GENERAL

From the first attempt to recover potash in Saskatchewan, near Unity in 1951, interest and activity have fluctuated as problems have been encountered and solved and as fertilizer demand and output have varied from year to year. Initial production was achieved in 1958 at the Potash Company of America, Saskatoon project, but in 1959 the operation was closed to repair water leaks through the shaft wall. In 1962 International Minerals & Chemical Corporation (Canada) Limited started to produce at Esterhazy and with subsequent expansions now operates at a capacity of 1.6 million tons a year. The successful completion and operation of the Kalium Chemicals Limited solution mining plant at Belle Plaine, in 1964, and the resumption of production at Potash Company of America's Saskatoon area plant in early 1965 raised production capacity in Canada to 2.8 million tons of product a year.



These projects are the first of a large number which will soon make Canada the world's leading producer of potash. Two projects are under construction, two more will start development in 1965 and several others are expected to announce active development within the next two years. By 1970 Canada is expected to have a potash production capacity of 10 million tons of product per year.

Such rapid development of a major industry cannot be justified on the basis of past potash consumption trends. There are, none the less, real needs for vast amounts of fertilizer as the world population continues to grow at unprecedented rates. In addition, there is now both the realization of the serious food problems inherent in such rapid population growth and also the ability, as demonstrated in the food surpluses of industrialized countries, to take corrective measures. Agencies of the United Nations have shown by controlled field tests that food production can be expanded substantially by the increased use of chemical fertilizers even without modern equipment. The vast reserves of high-grade potash now under development in Saskatchewan will thus serve a basic and pressing need – the production of food for the world's expanding population.

PRODUCTION, TRADE AND CONSUMPTION

Full scale production at the International Minerals & Chemical Corporation (Canada) Limited (IMC) Esterhazy plant, and last quarter output by Kalium Chemicals Limited, brought total Canadian potash production to 862,440 tons in terms of K_2O in 1964. Expansions during the year raised annual capacity to 720,000 tons and then to 960,000 tons by year-end. The increased capacity at IMC, full-scale production from Kalium Chemicals Limited and resumed production at Potash Company of America will provide substantially greater potash production in 1965.

TABLE 1

Potash – Production and Imports

	1963		1964p	
	Short Tons	$	Short Tons	$
Production (shipments) K_2O content	626,860	22,500,000	862,440	30,660,000
Imports*				
Potash fertilizers				
Potassium chloride				
United States	37,572	1,002,474	43,450	1,184,838
France	14,009	388,623	9,126	284,405
West Germany	9,593	300,588	7,850	245,783
U.S.S.R.	12,899	404,734	6,612	239,920
Total	74,073	2,096,419	67,038	1,954,946

Table 1 (cont.)

	1963		1964p	
	Short Tons	$	Short Tons	$
Potassium sulphate				
United States	13,808	567,396	12,050	485,410
France.....................	5,106	190,893	4,408	170,127
Italy.......................	—	—	3,100	169,161
Total	18,914	758,289	19,558	824,698
Potash fertilizer, not elsewhere specified				
United States	4,748	83,332	6,203	105,522
Total, potash fertilizers....	97,735	2,938,040	92,799	2,885,166
Potash chemicals				
Potassium carbonate..........	531	95,394	659	116,698
Potassium hydroxide..........	2,168	298,345	1,825	337,305
Potassium nitrates...........	851	135,219	884	133,272
Total, potash chemicals....	3,550	528,958	3,368	587,275

Source: Dominion Bureau of Statistics.

*Due to classification changes, effective 1964, 1964 import statistics are not completely comparable with those of previous years.

Symbols: p Preliminary; — Nil; .. Not available.

TABLE 2

Potash Consumption
(short tons)

	1962	1963	1964
Muriate of potash			
Fertilizers and chemicals	158,608	158,261	..
Other..................................	947	702	..
Total..................................	159,555	158,963	180,256

Source: Dominion Bureau of Statistics.
.. Not available.

Exports were not reported during 1964 because only two companies were shipping, but possibly 700,000 tons of K_2O were exported, mainly to the United States but also to Japan and several other countries.

Potash imports for agricultural fertilizer totalled 92,799 tons, down about five per cent from that of 1963. Potash chemical imports, mainly potassium hydroxide, were down slightly from 1963 at 3,368 tons.

Consumption of potash in Canada increased substantially from 158,963 tons in 1963 to 180,256 tons in 1964.

TABLE 3

World Potash Production, Consumption and Trade by Continents, 1962–63

	Production %	Consumption %	Exports ('000 metric tons)	Imports
Europe	61.1	53.6	2,897	2,313
U.S.S.R.	12.7	9.0	365	–
North & Central America	24.9	26.1	450	590
South America	0.2	1.4	8	103
Asia	1.1	7.7	84	713
Africa	–	1.2	–	110
Oceania	–	1.0	–	89
Total	100.0	100.0	3,804	3,818

Source: FERTILIZERS 1963, Tables 2 and 4, United Nations, Food and Agricultural Organization.

– Nil.

WESTERN CANADA DEPOSITS

In Saskatchewan, potash was first noted in the early 1940's in cores from oil-well drilling. Subsequent discoveries indicated the extent and richness of the occurrences and attracted wide interest in their development. Attempts to recover potash from these occurrences began in 1951 near Unity.

Potash is found in three or more fairly continuous and consistent layers in the upper part of the vast Prairie Evaporites Formation of Middle Devonian age. The formation has the shape of a huge platter underlying southern Saskatchewan and adjacent parts of Manitoba and Alberta. It is tilted slightly to the southwest, the shallow northern edge lying from 3,000 to 3,500 feet below the surface. Southward the depth increases to 5,000 feet at Regina and 7,000 feet at the International Boundary. The Prairie Evaporites consist largely of salt concentrated by the evaporation of an ancient sea; the potash zones are the final precipitation of the most soluble materials. Thus, the potash occurs with salt and is overlain by various sedimentary rocks ranging from glacial drift to limestone.

CANADIAN POTASH ACTIVITIES

INTERNATIONAL MINERALS & CHEMICAL CORPORATION (CANADA) LIMITED

Capacity of the mine and refinery at Esterhazy was increased to 1.2 million tons of product annually in April, 1964, and expanded to 1.6 million tons at the

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end of 1964. Further expansion now underway will raise capacity to 2.0 million tons by late 1965.

At the end of July, 1964, the plant had produced 2 million tons of product and at year-end 128 linear miles of underground openings had been excavated, 11 mining machines were in operation and more than 5 miles of conveyors were being used. The No. 2 shaft, at Gerald, had reached a depth of 1,310 feet at year-end and progress was much faster than in the first shaft.

Completion of the No. 2 shaft and a second refinery by mid-1967 will increase productive capacity to 4.5 million tons of product annually. IMC has predicted a 50 per cent increase in world potash consumption to a total of 28.7 million tons by 1970. Continued expansion at the Esterhazy facility is thus considered necessary to maintain the company's position in the industry.

KALIUM CHEMICALS LIMITED

The world's first potash solution mine commenced production in August, 1964, and output in 1965 is expected to be 600,000 tons of product. The plant at Belle Plaine, about 30 miles west of Regina, pumps a carefully adjusted hot lean solution of salts in water into the potash formation, some 5,200 feet below the prairies, and recovers a more concentrated solution of salts. The pregnant solution is concentrated by evaporation, the salt ($NaCl$) separated from the sylvite (KCl) and the latter crystallized in three grain sizes to conform to trade specifications. The crystals are creamy white in colour and somewhat higher in purity than the product from potash shaft mines. The higher purity is not a significant advantage for agricultural fertilizer use but may be important in other applications.

The successful development and operation of this potash solution mining project in Saskatchewan is immensely important in that it permits the recovery of vast reserves at depths beyond the reach of shaft mines. With operating experience it is expected that improvements in techniques and economics will be achieved and that other companies will develop successful solution mining processes.

POTASH COMPANY OF AMERICA

Rehabilitation and re-equipment of the mine and refinery near Saskatoon was nearly complete at the end of 1964 and production was resumed in April 1965. The plant has a productive capacity of 600,000 tons of product annually and total cost has been estimated at more than $40 million. Limited initial production in 1958–59 had to be stopped to seal leaks through the shaft wall.

The fact that underground workings at the mine have been open and under observation for the past seven years provides a basis for confidence in the stability of the potash formations in Saskatchewan and probably has been an important factor in encouraging development by other companies.

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TABLE 4

Summary of Potash Projects in Saskatchewan, 1964–65

No.	Company	Location	Start Constru-ction	Approx. Capital Cost in $ million	Start Production (Scheduled)	Type of Mining	Production Capacity Million short tons K_2O/year	Present Status
1	Western Potash Corp.	Unity	1951	na		solution	— —	test abandoned
2	Potash Company of America	Saskatoon	1952	40	1965	shaft	0.36	in production
3	Continental Potash Corp. (name changed from Western Potash Corp. 1955)	Unity	1953	3		shaft	0.30	feasibility studies
4	International Minerals & Chemical	Esterhazy	1957	52	1962	No. 1 shaft	0.96	in production
5	International Minerals & Chemical	Gerald	1963	10	1968	No. 2 shaft	na	const. on schedule
6	Kalium Chemicals Ltd.	Belle Plaine	1960	50	1964	solution mine	0.36	in production
7	Imperial Oil Ltd.	Findlater	1962		na	solution test	—	stopped 1964
8	Southwest Potash Corp.	Boulder Lake	1963		na	solution test	—	stopped 1964
9	Alwinsal Potash of Canada	Lanigan	1964	60	1968	shaft	0.60	shaft sinking
10	United States Borax & Chemical	Allan	1964	60	1968	2 shafts	0.90	shaft sinking
			(Major Projects Announced Early 1965)					
11	Consolidated M & S	Delisle	1965	65	1969	shaft	0.60	preparing
12	Noranda Mines Ltd. (Consolidated Morrison property)	Viscount	1965	73	1969	2 shafts	0.72	preparing
13	Duval Corp.	Saskatoon	1965	63	1969–70	2 shafts	0.60	preparing

Symbols: — Nil; na Not available.

ALWINSAL POTASH OF CANADA LIMITED

This Canadian company, formed by two West German and one French potash-producing companies, holds a large block of potash rights in the Lanigan area 75 miles east of Saskatoon. In June, 1963, the company announced that a major potash project would be constructed and in mid-1964 a shaft was started. The 18-foot diameter shaft will be sunk to 3,300 feet by AMC-Harrison Ltd. of Regina. Water-bearing formations will be frozen and a double steel cylindrical wall installed (with concrete in the anulus). In sections where water is not a problem a normal reinforced concrete wall lining will be used.

The Alwinsal project is scheduled for completion by 1968. The mine and refinery will have a capacity of 1 million tons of product per year. Total cost has been estimated at $50 million. The site is in a rural area some distance from any large town which might serve as a centre for services and homes for construction and operating personnel. To avoid problems inherent in the uncontrolled growth near industrial sites, and to provide for adequate services and an attractive community for personnel, Lanigan has become the first to accept the planning assistance offered by the new Industrial Towns Act of the Government of Saskatchewan of 1964. The success of this planned and controlled community will be followed with interest.

UNITED STATES BORAX & CHEMICAL CORPORATION

This company announced in May 1964 that a major potash project would be established near Allan, some 40 miles east of Saskatoon. Two closely spaced shafts will be sunk simultaneously and a refinery, to be built in 1966, will have a production capacity of 1.5 million tons of product by early 1968. At the end of 1964 the two shaft areas had been drilled and were being frozen in preparation for sinking operations. The cost of the project has been estimated at $70 million and will be shared by U.S. Borax, Homestake Mining Company and Swift Canadian Company.

THE CONSOLIDATED MINING AND SMELTING COMPANY OF CANADA LIMITED

The company announced in January 1965 that a large potash mining operation would be established at Delisle, 20 miles southwest of Saskatoon. Production will be 1 million tons of product per year and cost has been estimated at $65 million. Shaft sinking will start in 1965 and production is scheduled for 1970. COMINCO is a major fertilizer producer based on phosphate and nitrogen output, and the use of byproduct sulphur from the base-metal smelting operations at Trail, B.C. It is the first Canadian company to become basic in all the main fertilizer ingredients.

NORANDA MINES LIMITED

Early in 1964 Noranda entered an option agreement covering Tombill Mines Limited potash property straddling the Saskatchewan-Manitoba boundary. Addittional drilling was conducted in 1964 and marketing and metallurgical studies were underway. The option is in force until late in 1965.

In October 1964 Noranda purchased the potash property of Consolidated Morrison Explorations Limited, some 40 miles east of Saskatoon. Additional drilling was done and in February 1965 it was announced that a potash mine and refinery would be constructed at a cost of $73 million to produce 1.2 million tons of product per year. Shaft sinking will start in the latter half of 1965 with production scheduled for 1968. Reserves have been reported at 800 million tons grading about 30 per cent K_2O, indicating one of the most valuable potash deposits in the world.

As listed in Table 4, potash productive capacity in Canada at the end of 1964 was 2.8 million tons of product or 1.68 million tons of K_2O. With the addition of capacity now under construction by Alwinsal and U.S. Borax, output in 1968 could be as much as 8.0 million tons of product or 5.0 million tons K_2O, and in 1970, on the completion of the COMINCO and Noranda projects, 10.0 million tons of product or 6.0 million tons K_2O.

These large-scale rapid developments do not exhaust the productive potential of Saskatchewan potash and have not discouraged other prospective producers. It is expected that at least two other companies will announce potash projects before the end of 1965.

In addition to the projects mentioned above, fourteen other companies hold potash rights in Saskatchewan and two have properties in Manitoba. Several of these have conducted drilling, technical and economic studies and could be in a position to start development within a year or two. Four or five others have varying amounts of exploration work completed and, assuming continuing demand for potash, could start active development before 1970. Brief references to several of these potential producers follow.

DUVAL CORPORATION

This corporation operated a solution mining test plant at a property just west of Saskatoon from 1962 to 1965. Another property, northwest of Esterhazy, is well located for shaft mining and considerable drilling has been completed. Development of a shaft mine in the Saskatoon area was announced in July, 1965.

SOUTHWEST POTASH CORPORATION

This company, a subsidiary of American Metals Climax, Inc., operated a solution mining test from 1963 to late in 1964 at Boulder Lake near Watrous. The company holds other property north and west of Esterhazy in an area reputed to contain attractive deposits for shaft mining. Drill exploration was conducted near Yorkton during 1964. There has been no report as to which method of mining would be used.

THE TOMBILL MINES LIMITED

This property on the Saskatchewan-Manitoba boundary, near Esterhazy is under option to Noranda Mines Limited until November, 1965. Based on results at the nearby IMC operation, potash in this area is known to be at relatively shallow depths and to contain little insoluble material. Work by Noranda has shown increased reserves and improved average grade.

CONTINENTAL POTASH CORPORATION LIMITED

This company, near Unity, sank a shaft to the Blairmore formation but it was flooded in 1962. The shaft was recovered and repaired but shortage of funds delayed completion and in 1964 negotiations were being carried on to refinance and resume development. Early in 1965 a feasibility study was underway on the property and the means of bringing it to production.

SIFTO SALT (DOMTAR CHEMICALS LIMITED)

Sifto Salt holds land rights northwest of Moose Jaw and has been investigating methods of solution mining potash. Pilot plant operations were being conducted in early 1965 at the Unity salt brining property.

KERR–McGEE OIL INDUSTRIES, INC.

This company holds a property northeast of Lanigan on which considerable drilling was completed in 1964. It is currently developing a potash project in Carlsbad, New Mexico, and has described its Saskatchewan property as having improved vast reserves of high-grade ore. Development would be based on the planned townsite at Lanigan.

SOCONY MOBIL OIL OF CANADA, LTD.

Socony obtained Saskatchewan potash holdings in 1964. Early in 1965 exploration by drilling was underway. The United States based company has acquired a source of phosphate and is constructing an ammonia plant in Texas. A Saskatchewan potash development would make the company basic in fertilizers.

PRAIRIE POTASH MINES LIMITED

This is the only company holding land rights entirely in Manitoba. Drilling conducted in 1964 indicated potash ore and additional drilling is planned for 1965. The company is controlled by Metal Mines Limited. Canadian Nickel Company Limited , a subsidiary of The International Nickel Company of Canada, Limited, has an interest in the potash project and is providing finances.

IMPERIAL OIL LIMITED

In the early part of 1964 Imperial operated a solution mining test plant at Findlater. The test was stopped about mid-year and, in August, Esso Chemical

Company, a subsidiary of Standard Oil of New Jersey, made an offer to purchase Potash Company of America (PCA). The purchase would include PCA potash mining and refining facilities in New Mexico and the new plant at Saskatoon which resumed production early in 1965. Before the transaction reached completion the United States Justice Department entered a suit to prevent the purchase on the grounds that it would tend to reduce competition in potash sales and was therefore unlawful. The trial was held in February 1965 with the decision to be given later. It is not yet clear how this decision would influence potash development by Imperial Oil in Saskatchewan.

SHELL CANADA LIMITED

Shell retains two permit areas for potash and has drilled on one of these. No development plans have been announced.

NOVA SCOTIA

Early in 1965 the Nova Scotia Department of Mines and the Atlantic Development Board were preparing an exploration program to search for commercial deposits of potash associated with salt deposits of the Malagash peninsula of Nova Scotia. Geophysical surveys and drilling are planned. Small occurrences of potash have been found in two salt deposits and the possibility of commercial deposits being discovered is considered to be favourable.

During 1964 two projects involving the transportation of potash by pipelines were proposed . One proposal would move potash to the Chicago area and the other to the west coast for export. Assuming long-term large-volume shipments, considerable savings in freight costs are forecast.

WORLD REVIEW

Potash exploration, expansion of present facilities and development of new projects have been active throughout the world for the past several years. Although much of the interest and the most significant development has been in western Canada, new projects are planned, under construction and in operation in the United States, U.S.S.R., Spain, Italy, Israel, Ethiopia and Congo. Investigations of potash resources have been conducted in England, Jordan, Morocco, Libya, Poland, Brazil and Peru.

In the United States the most significant development of 1964 was the completion and start of production at Texas Gulf Sulphur Company Cane Creek potash property near Moab, Utah. The plant was planned to produce 1.1 million tons of product but initial production, started December 1964, will be at the rate of 4,000 tons of ore per day with later increases.

At Carlsbad, New Mexico, Duval Corporation expanded output by starting the production of potassium sulphate, Southwest Potash announced an increase in output, and National Potash Company also increased capacity. Kermac Potash Company expects its new 1,500 ton per day plant to be in operation by September 1965. Other investigations were underway for potash in Navajo County, Arizona, in Imperial Valley, California, where the potash potential of deep seated hot brines is being studied, and at Great Salt Lake, where Lithium Corporation of America and associates plan to recover potash, sodium sulphate and magnesium chloride.

TABLE 5

Estimated World Potash Resources and Production 1964

Country	Reserves in Millions of Metric Tons	% K_2O	Production 1964 Million Metric Tons K_2O
United States	400	18 to 25	2.727
New Mexico		(18)	(2.502)
Utah		(25)	
West Germany	2,000 to 20,000	12	2.201
East Germany	9,000	20	1.750
France	400	17	1.749
U.S.S.R.	17,000 to 20,300	15	1.900
Canada	50,000	25	.782
Spain	270 to 500	16	0.293
Italy	155	12	0.134
Israel and Jordan (in Dead Sea brines)	2,000	3	.111
Poland	165	8	
Ethiopia	50	25	
Gabon	40	20	
Britain			
England	350	16	
Scotland (shales)	100	10	
Chile (KNO_3)	na	1	
Peru (in brines)	na	3	
Morocco	na	12	
Libya	9	na	
Brazil	na	na	
China	na	na	.250
	110,000	15	11.647

Sources: PHOSPHORUS AND POTASSIUM, U.S. Bureau of Mines and others.
Note: 1000 kilograms = 1 metric ton = 1.1023 short tons.
na Not available.

Substantial increases in potash production are planned in the U.S.S.R. as new projects are brought into operation and others developed. Current production, estimated at 1.9 million metric tons in 1964, is drawn mainly from established mines in the Ukraine and western Urals, with small but growing amounts coming from new mines in Byelorussia. Other deposits are being investigated on the north shore of the Caspian Sea, and north of the City of Kamsk, in western Siberia. The U.S.S.R. plans to increase potash output to 6.4 million tons K_2O by 1970.

The main potash sources in western Europe, West Germany and France, have produced at near capacity rates in recent years but, because these deposits have been worked for many years, it is unlikely that any significant increase in production will take place. European production will serve European markets for many years to come but some export markets may be lost to the new sources now coming into operation.

East Germany, a major producer for many years, is reported to have opened one new mine and rehabilitated several older mines but major increases in production are not expected.

Spain and Italy, smaller producers in Europe, are expanding output. These additions are important to domestic markets but have only a small influence on the world situation.

Production of potash from Dead Sea brines by Israel has increased in recent years and additional expansion is planned to raise production to 600,000 tons by 1970. It is reported that sales contracts covering total production for 1965 and 1966 have been obtained.

Two projects in Africa are active and are expected to reach production within two or three years. A potash deposite in the Holle-St. Paul area of the Republic of Congo, about 50 kilometers (31 miles) from the sea, is under development. The ore is sylvite, at a depth of 300 metres. Production, expected to start within five years at 350,000 metric tons a year, will be increased to 900,000 tons later. American Potash and Chemical Corporation and Mines Dominciales de Potasses d'Alsace hold large interests and the Republic of Congo a smaller share. Total cost of the development has been estimated at $49 million.

In Ethiopia, the Ralph M. Parsons Company of the United States has potash concessions in the Danakil Depression near the Red Sea. Potash was produced in this area by an Italian company between 1915 and 1925. Exploration by Parsons has indicated a substantial deposit of sylvite ore reported to grade 25% K_2O, at relatively shallow depths. Development is underway and production is expected to start in a year or so at 300,000 tons per year.

Armour Chemical Industries Ltd., a subsidiary of Armour & Company of U.S.A., holds potash rights in Yorkshire, England, and has been investigating deep-seated deposits with the intent to produce potash by solution mining methods. Work continues but no development plans have been announced.

Potash deposits have been discovered in Sergipe State, Brazil, near the Atlantic coast. Found in the course of oil exploration, the discovery is important because only limited amounts of potash are produced in South America, as potassium nitrate, in Chile.

Potash occurrences have been reported in Morocco and Libya and some exploration has been carried out.

In Roumania, investigations have been carried out to find satisfactory methods of treating low grade potash ores from the Galean area.

Potash production in mainland China has been estimated at 250,000 tons per year, a small fraction of the amount needed.

OUTLOOK

The outlook for potash, and indeed all fertilizer materials, is bright and appears promising for many years to come. Recent increases in demand have been attributed to crop failures and poor crop responses to some agricultural programs, but, although these have contributed, the basic cause is the population explosion. World population, totalling one billion in 1850, had increased to two billion in 1930 and to three billion in 1960. It is projected to six or seven billion by 2000.

The major increases in population and the resulting serious food shortages will occur in the less developed and poorly industrialized parts of the world. Because per capita food supplies in these areas are even now marginal to deficient and show little evidence of improvement, the problems of expanding the food supply in the face of rapidly growing populations are formidable and cause for acute alarm. The present trends indicate widespread famine in some areas by the early 1970s and the social and political consequences of such a disaster are beyond prediction.

Against this background the quickening pace of Canadian potash development becomes realistic as a necessary response to a serious and growing need.

USES AND SPECIFICATIONS

Potash is one of the three basic ingredients in mixed chemical fertilizers, the others being phosphorus and nitrogen. The familiar grade notations on packaged fertilizers, such as 5–10–15, indicate the percentage content of nitrogen, phosphate and potash in that order. As fertilizer, potash contributes to healthy plant growth and assures the maximum of balanced development by regulating the intake of other fertilizer ingredients.

About 95 per cent of the potash produced is used as fertilizer, five per cent is used in the form of various chemicals of which potassium hydroxide has the widest application. Most fertilizer potash is used as concentrates of muriate (KCl) in various strengths, mixed with other ingredients. Smaller amounts are used as potassium sulphate for particular soils and crops.

PRICES

CANADA

Commencing July 1964 the following Canadian potash prices were issued by the Canadian producer for bulk material:

Period	Price in cents per short ton unit, f.o.b. plant			
	Muriate 60% K_2O			Sulphate of Potash 50% K_2O
	Standard	Coarse	Granular	
July-Aug.	38.9	40.5	43.2	75.6
Sept-Oct.	41.0	42.7	45.4	78.8
Nov.-Jan./65	43.2	44.8	47.5	82.1
Feb.-June	46.4	48.1	50.8	85.3

UNITED STATES

The OIL, PAINT AND DRUG REPORTER of December 1964 quoted the following United States prices:

	$
Potassium muriate, standard	
bulk, car lots, f.o.b. works, unit ton	0.40
bagged 60% min. K_2O, per s.t.	29.50
granular, bulk, car lots, unit ton	.44
granular, bagged, 60% min. K_2O, s.t.	31.90
Potassium chloride, chemical	
99–95% KCl, bulk, car lots, per ton	33.00
" " bags, car lots " "	38.50
Potassium sulphate, min. 50% K_2O,	
agricultural, bulk, car lots, unit ton	0.76

TARIFFS

CANADA

Potash, muriate and sulphate of, crude; saltpetre or nitrate of potash .... free

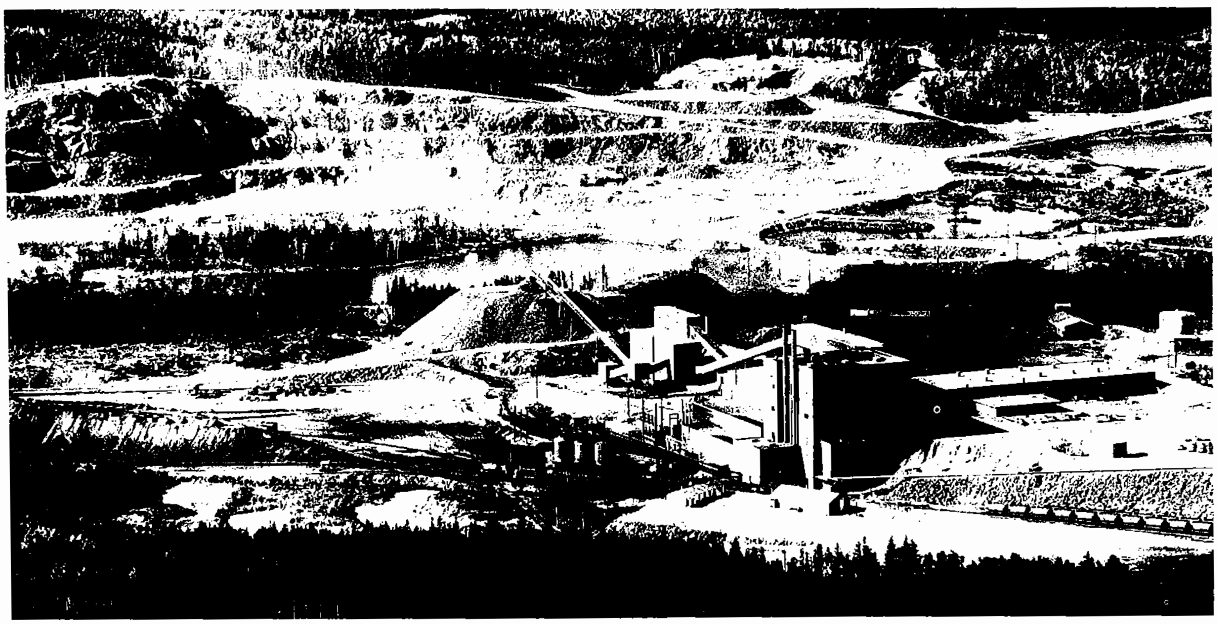
German potash salts and German mineral potash .... free

	British Preferential	Most Favoured Nation	General
Potash, chlorate of, not further processed than ground	free	15%	20%
Potash, chloride	free	free	25%

TARIFFS (cont'd)

UNITED STATES

Potassium chloride or muriate of potash,
potassium sulphate, potassium nitrate. . . . . free



Concentrator and sinter plant operated by Algoma Ore Properties Div. at Wawa, Ontario.

Roofing Granules

H.S. Wilson*

The 1964 consumption of roofing granules increased 11.9 per cent in volume and 13.6 per cent in value over that of 1963, amounting to 140,890 short tons valued at more than $3.8 million. The quantity consumed in 1964 was close to the record quantity of 1955, which amounted to 147,877 short tons, while the value was well below the record $4.5 million of 1958.

Table 1 shows consumption in 1963 and 1964 by kind and colour, and imports by kind. The colours are arranged in decreasing order of preference by volume in 1964. Table 2 shows the granule consumption for the period 1954 to 1964, the total values, the average price per ton for each year and the percentage of consumption produced in Canada. In all tables prices are f.o.b. consumer plants.

During 1964, the consumption of Canadian-produced natural and artificially coloured granules, and imported natural coloured granules, increased over that of 1963. The consumption of imported artificially coloured granules decreased in the same period. Although the quantity of Canadian-made natural coloured granles consumed in 1964 was 5.4 per cent higher than in 1963, the Canadian share of the total quantity of natural coloured granules consumed decreased from 77.3 per cent in 1963 to 72.3 per cent in 1964. Canadian-made, artificially coloured granules consumed in 1964 were 32.2 per cent higher in quantity than in 1963, while the share of the total quantity consumed increased from 63.2 per cent in 1963 to 75.0 per cent in 1964. The Canadian-produced black slag granule shared about the same proportion of the market as it did in 1963. Table 3 shows the average prices of the natural and artificially coloured granules, both imported and domestically produced, for 1963 and 1964.

CANADIAN PRODUCERS

Manufacturers of granules in Canada are located at Havelock, Ont., Montreal, Que., and Vancouver, B.C.

*Mineral Processing Division, Mines Branch

TABLE 1
Consumption and Imports*

	1963		1964	
	Short Tons	$	Short Tons	$
Consumption				
By Kind				
Natural coloured	50,115	1,015,112	56,457	1,130,645
Artificially coloured	75,794	2,377,242	84,433	2,722,059
Total	125,909	3,392,354	140,890	3,852,704
By colour				
Black and grey-black	40,032	899,564	55,804	1,207,202
White	19,817	736,940	22,623	874,769
Grey	28,147	534,933	20,947	432,042
Green	19,069	610,861	18,829	619,640
Red	7,694	218,181	7,762	214,798
Brown and tan	5,112	147,961	6,914	197,233
Blue	3,713	151,696	3,703	154,611
Turquoise	716	33,371	1,840	60,288
Buff	716	25,526	1,514	56,182
Coral, cream and yellow	893	33,321	916	34,799
Not differentiated	–	–	38	1,140
Total	125,909	3,392,354	140,890	3,852,704
Imports				
United States				
Natural coloured	11,367	263,190	15,618	360,726
Artificially coloured	27,910	1,066,901	21,114	831,157
Total	39,277	1,330,091	36,732	1,191,883

*Values calculated from figures supplied directly by the consumers.
–Nil.

TABLES 2
Roofing Granules – Consumption, 1954-64

	Total Tons	Total Dollars	Average Price/Ton	Canadian Percentage
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

Roofing Granules – Average Prices*

($ per short ton)

	Imported		Canadian	
	1963	1964	1963	1964
Natural coloured				
Rock	21.03	21.71	14.85	14.72
Slag	24.49	24.47	22.25	21.44
Slate	–	–	17.84	21.41
Artificially coloured				
Black and grey-black	30.87	32.86	20.57	22.90
White	41.09	41.69	32.69	37.15
Grey	28.89	30.08	26.08	28.16
Green	37.33	40.37	29.06	30.60
Red	43.14	34.86	24.90	24.89
Brown and tan	36.21	36.59	25.82	26.25
Blue	46.43	47.40	37.79	39.29
Turquoise	49.86	51.21	39.22	26.32
Buff	37.68	38.21	39.38	36.94
Coral, cream, yellow	45.53	45.51	28.31	28.07
Not differentiated	–	–	–	30.00
Average	38.23	39.37	27.36	29.86

*F.o.b. consumer's plant.
–Nil.

Minnesota Minerals Limited at Havelock crushes a trap rock for granules and operates a colouring plant, which produces a wide range of artificially coloured granules. The basalt is also crushed in sizes suitable for other uses, principally for road building and concrete aggregate applications.

Industrial Granules Ltd. of Montreal, the producer of the black-slag granule, obtains its raw material, a waste slag, from a steam-generating plant in Halifax, N.S. Other sources of waste slag are constantly being investigated for their ability to granulate with a minimum of acicular-shaped fragments when quenched. The slag must be free from deleterious materials; its composition has much to do with the success of the granule product. A low iron content is necessary to assure freedom from staining of the granule surface when exposed to the weather.

G.W. Richmond of Vancouver, B.C., produces slate granules.

ROOFING AND SIDING PLANTS

There are seven companies manufacturing roofing shingles and wall siding in 17 plants in Canada. These plants rely wholly on the manufactured granule for their production of shingles. The built-up roof, on the other hand, can be constructed with aggregate ranging in size from the smallest sand sizes for filler material, to gravel and rock fragments up to 8 inches long. Roofing granules used to make shingles and siding usually fall within the – 8+35 mesh range, mainly between the 10- and 20-mesh sizes.

The seven companies and plants manufacturing these products are:

COMPANY	LOCATION
Allied Chemical Canada,Ltd.*	Montreal, Que. Vancouver, B.C. St. Boniface, Man.
Building Products Limited	Montreal, Que. Hamilton, Ont. Winnipeg, Man. Edmonton, Alta.
Canadian Gypsum Company, Limited	Mount Dennis, Ont.
Canadian Johns-Manville Company, Limited	Asbestos, Que.
Iko Asphalt Roofing Products Limited	Calgary, Alta. Brampton, Ont.
Domtar Construction Materials Ltd.	Brantford, Ont. Saint John, N.B. Lachine, Que. Lloydminster, Alta. Burnaby, B.C.
The Philip Carey Company Ltd.	Lennoxville, Que.

*Formerly The Barrett Company, Limited.

DEVELOPMENT IN THE INDUSTRY

Construction in Canada reached a value of $8.6 billion in 1964, an increase of 12.1 per cent over that of 1963. Consumption of roofing granules is related directly to house construction. In 1964, residential construction was valued at $2.6 billion, 30.1 per cent of the construction industry. This compares with $2.3 billion, 29.2 per cent of total construction in 1963. Table 4 shows the values of residential construction in 1963 (actual), 1964 (preliminary) and 1965 (intention).

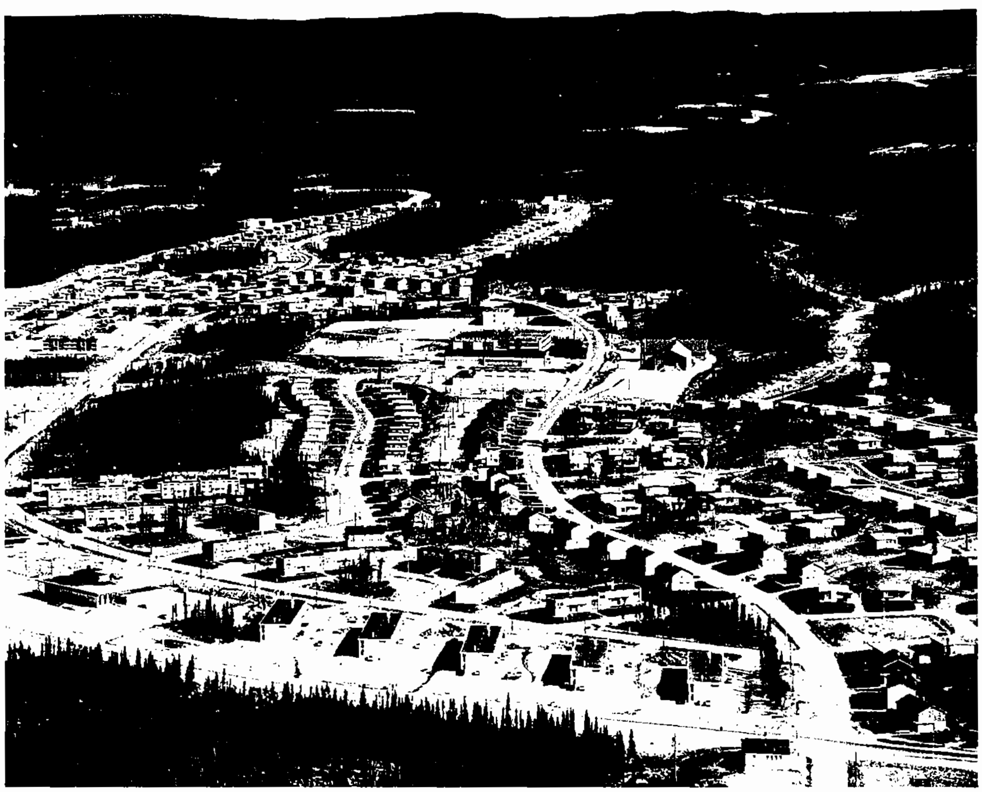
TABLE 4
Residential Construction*
(value × $000,000)

	1963	1964	1965
New	1,713	2,028	2,244
Repair	544	577	612
Total	2,257	2,605	2,856

*Source: Dominion Bureau of Statistics.

New residential construction increased by 18.4 per cent and total residential construction by 15.4 per cent in 1964. An increase in new construction of 10.7 per cent and in total residential construction of 9.6 per cent is anticipated in 1965. A similar increase in the consumption of roofing granules should occur in 1965.

Gagnon townsite.



Salt

R.K. COLLINGS*

The spectacular growth of the domestic salt industry during the last decade, from just under 1 million tons in 1954 to close to 4 million tons in 1964, is directly attributed to the establishment of three rock salt mines, two in Ontario and one in Nova Scotia, and to the initiation of brine exports from southern Ontario to the United States during that period.

Production in 1964, at a record 3.9 million tons, was 4.6 per cent greater than in the previous year. Approximately half was rock salt; the balance was largely brine for use by the chemical industry. Production of fine evaporator salt represented less than 15 per cent of the total production. Value of production was nearly $23.1 million.

Imports, mostly consisting of rock salt from the United States and solar salt from the United States, Mexico and Spain, amounted to 405,574 tons valued at $1.9 million. British Columbia, having no production of its own, was the chief importing province.

Exports, mostly composed of rock salt and salt in brine form to the United States, were valued at $3.6 million, slightly less than the 1963 value of $3.7 million. Minor exports of fine evaporated salt from plants in Nova Scotia were made to various countries, including New Zealand, as shown in Table 1.

*Mineral Processing Division, Mines Branch

TABLE 1

Production and Trade

	1963		1964p	
	Short tons	$	Short tons	$
Production, shipments				
By type				
Fine vacuum salt	486,940	10,166,591	518,930	..
Mined rock salt	1,771,242	10,074,331	1,873,799	..
Salt recovered in chemical operations	25,192	122,295	27,176	..
Salt content of brines used and shipped	1,438,620	1,953,348	1,562,731	..
Total	3,721,994	22,316,565	3,892,636	23,075,518
By province				
Ontario	3,187,491	14,793,161	3,265,909	14,481,663
Nova Scotia	356,902	4,043,804	430,633	4,739,620
Alberta	96,417	1,496,577	101,400	1,665,000
Saskatchewan	56,301	1,364,490	70,094	1,569,235
Manitoba	24,883	618,533	24,600	620,000
Total	3,721,994	22,316,565	3,892,636	23,075,518
Imports				
Salt for sea or gulf fisheries				
Spain	39,970	143,800	34,449	163,641
Bahamas	18,985	128,136	10,516	58,815
Jamaica	5,578	22,090	350	1,512
United States	2,212	8,411	350	1,512
Netherlands	90	1,817	–	–
Total	66,835	304,254	45,665	225,480
Salt and brine, not elsewhere specified				
United States	166,147	1,150,816	199,595	1,500,542
Mexico	99,263	119,621	160,110	200,502
Britain	336	7,215	204	4,889
Total	265,746	1,277,652	359,909	1,705,933
By province				
Newfoundland	50,683	252,743		
Nova Scotia	16,510	69,672		
New Brunswick	8	331		
Quebec	56,019	355,324		
Ontario	73,727	546,316		
Manitoba	552	12,149		
Saskatchewan	1,793	36,166		
Alberta	50	437		
British Columbia	133,239	308,768		
Total	332,581	1,581,906	405,574	1,931,413

Table 1 (Cont.)

	1963		1964p	
	Short tons	$	Short tons	$
Exports*				
United States		3,510,854		3,404,853
Trinidad		39,311		56,750
Jamaica..........................		37,811		56,521
British Guiana		21,206		35,894
Leeward and Windward Islands		10,889		15,706
New Zealand		55,121		10,554
Cuba.............................		—		8,695
Bermuda..........................		5,693		7,874
Nigeria		901		5,627
Other countries..................		19,570		16,095
Total......................		3,701,356		3,618,569

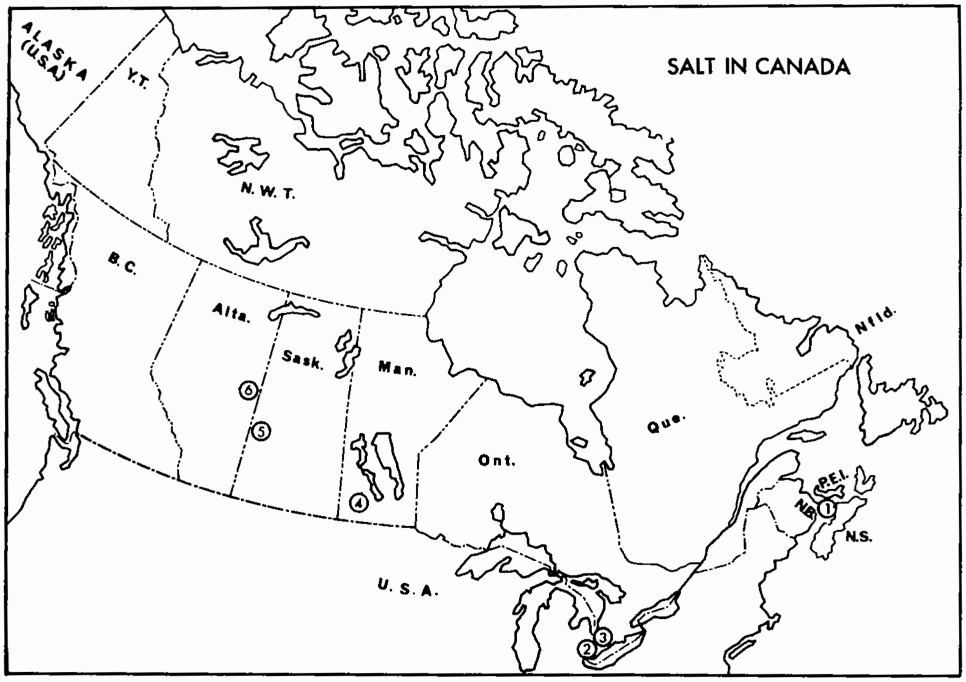
Source: Dominion Bureau of Statistics.
*Quantities not available.
Symbols: p Preliminary; — Nil; .. Not available.

TABLE 2

Production and Trade, 1955-1964
(short tons)

	Production[1]	Imports	Exports[3]	
			Tons	$
1955	1,244,761	365,255	146,472	
1956	1,590,804	319,124	333,935	
1957	1,771,559	367,483	457,888	
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
1964p	3,892,636	405,574	..	3,618,569

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. [3]Tonnages not available after 1959.
Symbols: p Preliminary; .. Not available.



EVAPORATOR PLANTS

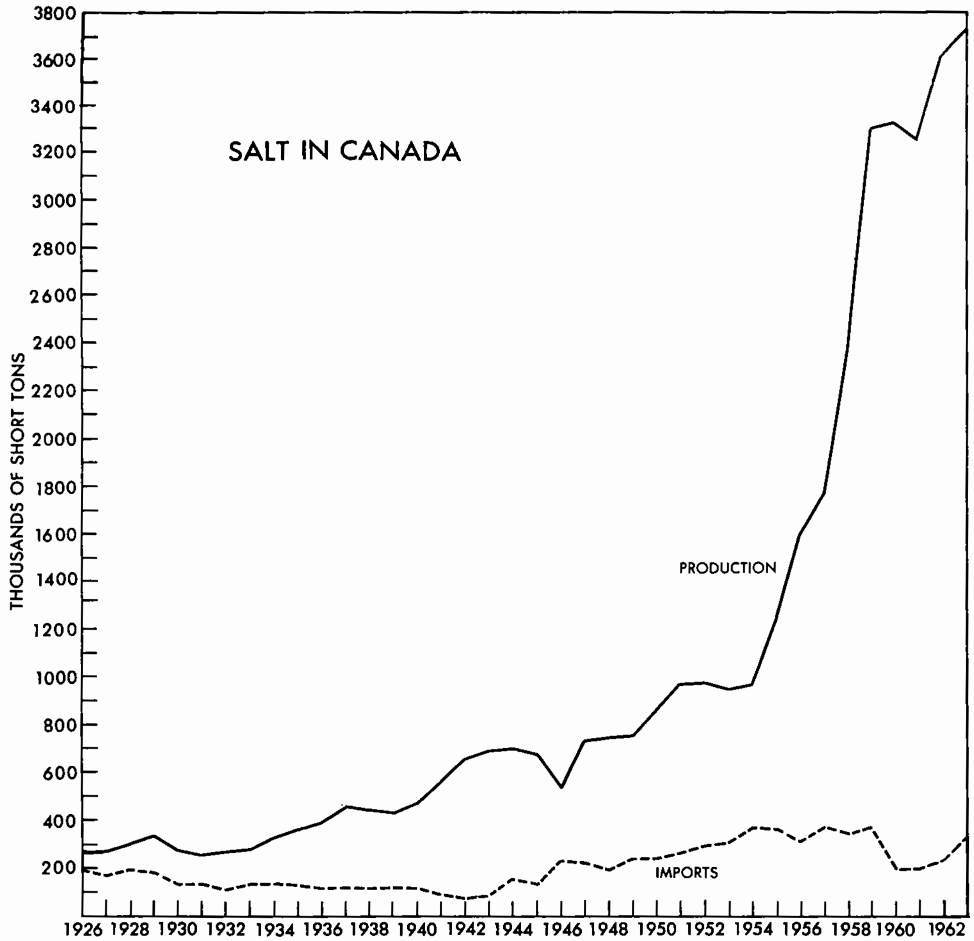
1. Domtar Chemicals Limited, Sifto Salt Division, Nappan, N.S.
1. The Canadian Rock Salt Company Limited, Pugwash, N.S.
2. The Canadian Salt Company Limited, Sandwich, Ont.
2. Brunner Mond Canada, Limited, Amherstburg, Ont.
3. Domtar Chemicals Limited, Sifto Salt Division, Goderich, Ont.
4. The Canadian 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.



PRODUCERS

ONTARIO

Ontario, the chief producing province in 1964, accounted for 84 per cent of the total Canadian salt production. This salt is obtained from thick beds that underlie the area between Kincardine and Amherstburg, in the southwestern section of the province. It occurs at depths of from 800 to 1,800 feet.

Two rock salt mines are in this area, one at Ojibway, operated by The Canadian Rock Salt Company Limited and the other at Goderich, operated by Sifto Salt Division of Domtar Chemicals Limited. At Ojibway an 18-foot section of salt is mined at a depth of 980 feet; at Goderich a 45-foot section is mined at 1,760 feet.

Salt brining operations are conducted at Sandwich, a suburb of Windsor, Amherstburg, Sarnia and Goderich. The Canadian Salt Company Limited produces

TABLE 3

World Production, 1963

('000 short tons)

United States	30,652
China	11,600
U.S.S.R	9,650
Britain	7,159
West Germany	6,160
India	5,000
France	4,543
Canada	3,721
Other	26,415
Total	104,900

Source: U.S. Bureau of Mines, MINERALS YEARBOOK, 1963.

fine evaporated salt from brine at Sandwich. A subsidiary, Canadian Brine Limited, also produces brine at Sandwich, exporting it to a chemical plant in Detroit. At Amherstburg, Brunner Mond Canada, Limited, produces industrial salt, soda-ash, calcium chloride and other chemicals. Brine from company wells at Sarnia is used by Dow Chemical of Canada, Limited, for caustic soda and chlorine manufacture. Domtar Chemicals Limited operates brine wells at Goderich for the production of fine evaporated salt. Domtar's brine recovery and salt evaporator plants at Sarnia were closed during the year after many years of operation. All of the company's future production in Ontario is expected to come from the Goderich plant. Fused salt is made from fine evaporated salt by The Canadian Salt Company Limited at Sandwich.

NOVA SCOTIA

Canada's third rock salt mine is at Pugwash where The Canadian Rock Salt Company Limited obtains salt from a 20-foot seam lying 630 feet underground. Waste fines from this operation are used at an adjacent evaporator plant for the production of refined salt. A second shaft at Pugwash, now at 930 feet, is nearing completion. This deeper shaft will permit mining from lower, higher-grade salt horizons. Fine evaporator salt is produced at Nappan by Domtar Chemicals Limited using natural brine from depths of 1,100 to 1,800 feet.

PRAIRIE PROVINCES

The Canadian Salt Company Limited produces fine salt at Neepawa, Manitoba, using natural brine that occurs at a depth of 1,400 feet, and at Lindbergh, Alberta, using artificial brine from salt beds that are 3,600 feet below the surface. Domtar Chemicals Limited produces fine salt at Unity, Saskatchewan, using brine from salt beds at 3,000 feet.Fusion plants for the production of high-purity coarse salt are operated at Lindbergh and Unity. Western Chemicals Ltd. of Calgary produces caustic soda, chlorine, and hydrochloric acid at Duvernay, Alberta, using brine from company wells.

OTHER OCCURRENCES

In addition to the salt deposits that underlie the Nappan-Pugwash area of Nova Scotia, the western portion of southern Ontario and the Unity-Lindbergh area of Saskatchewan-Alberta, rock salt deposits occur at depth in the Mabou-Port Hood area of Cape Breton Island; under Hillsborough Bay, Prince Edward Island; in the area south of Moncton, New Brunswick; under large sections of southwestern Manitoba, central Saskatchewan and the northeastern portion of Alberta; in the area to the north of Great Slave Lake and in the vicinity of Norman Wells in the District of Mackenzie.

Although no definite evidence of rock salt deposits has yet been uncovered, brine springs, indicative of salt, are plentiful in the southwestern section of Newfoundland, north-central Nova Scotia, the Sussex area of New Brunswick, in 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 important chiefly as a raw material for the chemical industry where it is used, as brine, for the production of sodium hydroxide, chlorine and hydrochloric acid. These, in turn, are used to manufacture many other chemicals.

The second largest use of salt in Canada is as an ice- and snow-control agent on streets and highways. Salt is also used in dust-control and road-stabilization programmes, in the dairy and food processing industries, in stock feed, in the curing of meat and fish, in curing and tanning hides and skins, in textile dyeing, as a glazing agent in sewer pipe and drain tile, as a drilling mud ingredient, in water softeners for the regeneration of calcium and magnesium zeolites, and in refrigeration.

TECHNOLOGY

In Canada, salt is obtained from underground deposits by mining or brining. Mining is by the room and pillar method with rooms being 50 to 60 feet and pillars 50 feet or more square. Thicknesses mined in Canada vary from 18 feet at Ojibway to 45 feet at Goderich, Ontario. In brining, the salt is dissolved by water pumped down a well to the salt horizon. The brine formed is brought to the surface and evaporated in vacuum pans. The resulting slurry is dried to yield high-purity, fine salt. Natural underground brines also occur and are utilized in some areas.

98115—34

Coarser grades of salt are derived from mined rock salt by crushing and sizing and, from fine evaporated salt, by briquetting or fusion followed by crushing. Rock salt fines are also made into coarser grades by briquetting or by forming into a thin ribbon of salt by smooth-faced rolls followed by crushing. Rock salt fines are used at one Canadian operation to produce brine which in turn is processed by vacuum pan evaporation.

Mined rock salt, although usually relatively pure, sometimes contains gypsum, anhydrite, limestone and dolomite. These impurities may be partly eleminated by crushing followed by selective screening, by electronic scanning devices, and by the 'thermoadhesive' beneficiation method developed by International Salt Company of Cleveland, Ohio. Electronic scanning techniques, although not yet widely used by industry, are becoming increasingly popular in mineral beneficiation, particularly in the nonmetallic mineral field. Electronic scanners are capable of differentiating between translucent, light-coloured grains such as salt, and opaque, darker mineral impurities, as well as between mineral of different colours. One Canadian plant now uses an electronic sorter to upgrade sized rock salt for water softeners. The 'thermoadhesive' method for upgrading salt is based on the fact that pure salt crystals transmit infrared rays whereas gangue minerals such as gypsum and dolomite will absorb these rays and thus become heated. Separation is accomplished on a conveyor belt coated with a heat-sensitive polystyrene resin. The impurities adhere to the belt whereas the salt particles do not.

TABLE 4

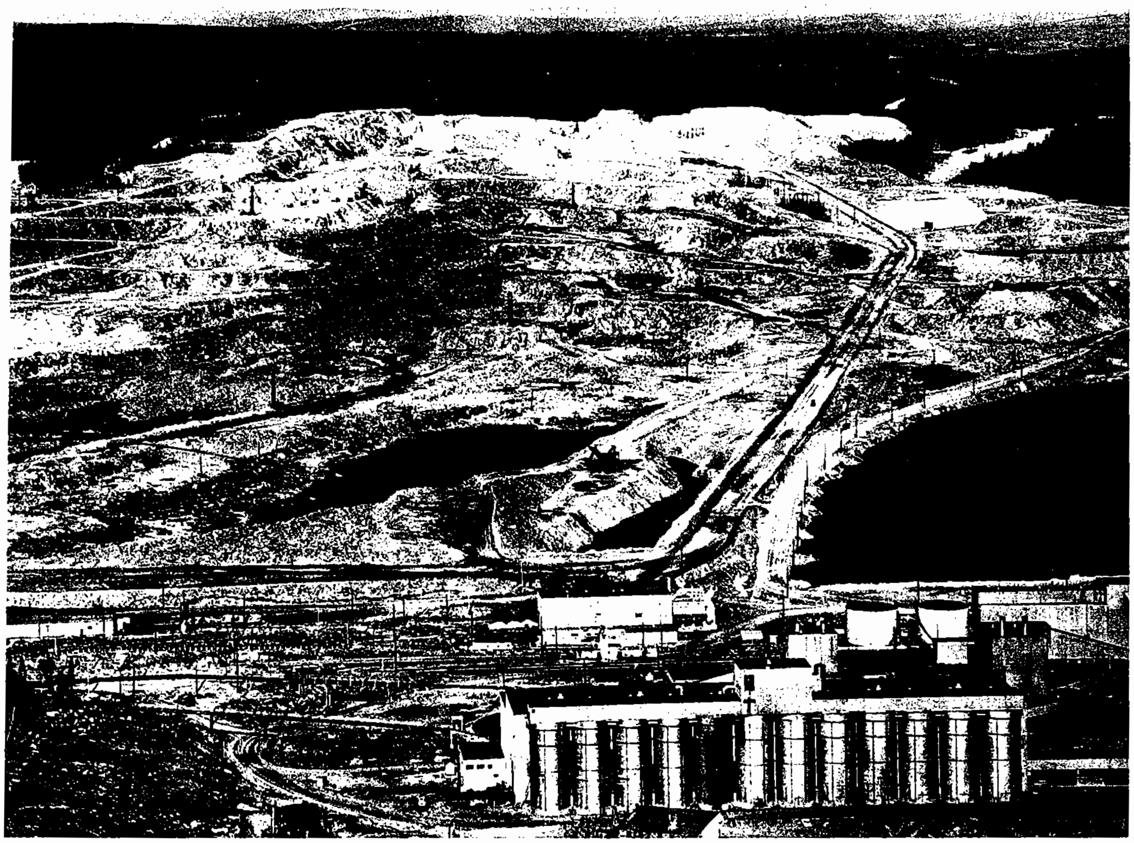
Available Data on Consumption of Salt in Specified Canadian Industries, 1962*
(short tons)

Chemical products (dry salt and salt content of brine)	1,187,243
Snow and ice control	650,000**
Food preparation	57,376
Slaughtering and meat packing	56,243
Pulp and paper mills	51,948
Fish processing	75,000**
Leather tanneries	8,061
Soap and cleaning preparations	2,317
Dyeing and finishing textiles	1,075
Breweries	552

Source: Dominion Bureau of Statistics.
*The latest year for which all data are available. **Estimated.

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%	10%	15%
UNITED STATES			
Bulk salt	1.7¢ per 100 lb		
Salt in bags, barrels, etc.	3.5¢ per 100 lb		
Salt in brine	10% ad valorem		



Mine and concentrator at Quebec Cartier Mining Co.'s Lac Jeannine operation near Gagnon, Quebec.

Sand, Gravel and Crushed Stone

F.E. HANES*

The estimated** production of sand, gravel and crushed stone in 1964 was 236,150,000 short tons valued at $181,600,000 which is a 1.4 per cent increase in volume and a 1.8 per cent increase in value compared with the 1963 final statistics.

The estimated sand and gravel production for 1964 is 176,000,000 short tons for a value of $116,600,000, a slight increase in volume with no perceptible change in value. The estimated production of crushed stone in 1964 was 60,150,000 short tons, for a value of $65,000,000.

SAND AND GRAVEL

Sand and gravel referred to in this review include those materials used in construction for road building, concrete construction, asphalt mixes, railroad ballast and mortar mixes. It also includes crushed gravel which is used in road and railroad construction, in asphalt and concrete mixes and other unclassified applications

These sand and gravel products make up approximately 93 and 94 per cent (volume and value, respectively) of the total sand and gravel product reported by the Dominion Bureau of Statistics. The estimated product of sand and gravel used for construction in 1964 was obtained by applying the above percentages to the estimates reported by DBS for total sand and gravel.

* Mineral Processing Division, Mines Branch

** Values estimated by the author based on values for construction supplied by the Dominion Bureau of Statistics.

TABLE 1

Production of Sand, Gravel and Crushed Stone

	1963		1964p	
	Short Tons	$	Short Tons	$
By Province				
Sand and gravel				
Newfoundland	4,410,019	4,149,035		
Prince Edward Island	600,315	563,595		
Nova Scotia	6,385,404	4,034,453		
New Brunswick	4,348,579	2,689,312		
Quebec	39,727,568	18,993,940		
Ontario	72,962,314	52,446,217		
Manitoba	8,509,371	6,353,883		
Saskatchewan	6,895,498	3,764,897		
Alberta	15,294,850	14,287,421		
British Columbia	16,579,649	9,320,474		
Total	175,713,567	116,603,227	176,000,000	116,600,000
Crushed stone				
Newfoundland	84, 653	252,373		
Prince Edward Island	225,000	225,000		
Nova Scotia	362,035	674,078		
New Brunswick	4,298,758	3,652,178		
Quebec	28,774,645	31,982,709		
Ontario	18,185,865	19,525,608		
Manitoba	3,347,153	3,381,856		
Saskatchewan	–	–		
Alberta	200	450		
British Columbia	2,024,009	2,105,913		
Total	57,302,318	61,800,165	60,150,000	65,000,000
By Type				
Sand and Gravel				
For roads (roadbed surface)	109,629,266	59,235,209		
Concrete aggregate	18,846,947	19,264,554		
Asphalt aggregate	5,652,576	5,558,856		
Railroad ballast	5,828,341	2,965,073		
Mortar sand	1,483,351	1,214,287		
Total	141,440,481	88,237,979		
Crushed gravel				
For roads (roadbed surface)	22,179,744	17,414,249		
Concrete aggregate	4,915,010	4,682,227		
Asphalt aggregate	2,116,764	2,585,290		
Railroad ballast	2,884,331	1,868,912		
Other uses	2,177,237	1,814,570		
Total	34,273,086	28,365,248		

Table 1 (cont.)

	1963		1964p	
	Short Tons	$	Short Tons	$
Crushed stone				
Concrete aggregate	12,740,453	15,637,117		
Railway ballast	1,796,159	1,807,334		
Road metal	32,883,077	33,352,259		
Rubble and riprap........	4,205,755	4,358,033		
Terrazzo, stucco and artificial stone	59,647	809,690		
Other uses..............	5,617,227	5,835,732		
Total	57,302,318	61,800,165	60,150,000	65,000,000
Total sand and gravel and crushed stone	233,015,885	178,403,392	236,150,000	181,600,000

Source: Dominion Bureau of Statistics.

p Preliminary estimates projected from available information by the author. Further information unavailable.

CRUSHED STONE

The crushed stone product estimate was obtained by increasing the 1963 final statistics shown in Table 1 by 5 per cent in volume and value. This estimated increase is an approximation closely in line with the 5.7 per cent increase shown by the statistics for the group of building construction materials composed of stone, sand and gravel, cement and lime in 1964 compared with 1963. A volume increase in the crushed stone product is expected because of the rising trend in total construction in 1964, estimated to be a record $8.6 billion. This rising trend is predicted to continue in 1965 and should rise to a new record $9.8 billion. Production for over-all construction increased by 8.3 per cent in 1964.

Estimates for a breakdown by province and by types in crushed stone and sand and gravel is not justified because of insufficient statistics.

On the basis of 1963 final figures Ontario was the principal producer of sand and gravel with 41.5 and 45.0 per cent, volume and value respectively, of the total Canadian production. Quebec was next with 22.6 and 16.3 per cent while Alberta and British Columbia each had approximately 10 per cent of the product and value.

Approximately 7,680 pits were operated in 1963. Of the total production from these, including the crushed gravel product, almost 75 per cent is used for road construction. Concrete products used over 13 per cent while asphalt and railroad ballast used approximately 5 per cent; the remainder is used in mortar mixes and other unclassified products.

Quebec has approximately 50 per cent of the crushed stone production and 52 per cent of the total value. Ontario has approximately 31 per cent both in volume and value. New Brunswick, Manitoba and British Columbia follow with 7.5, 5.4 and 3.5 per cent of the production.

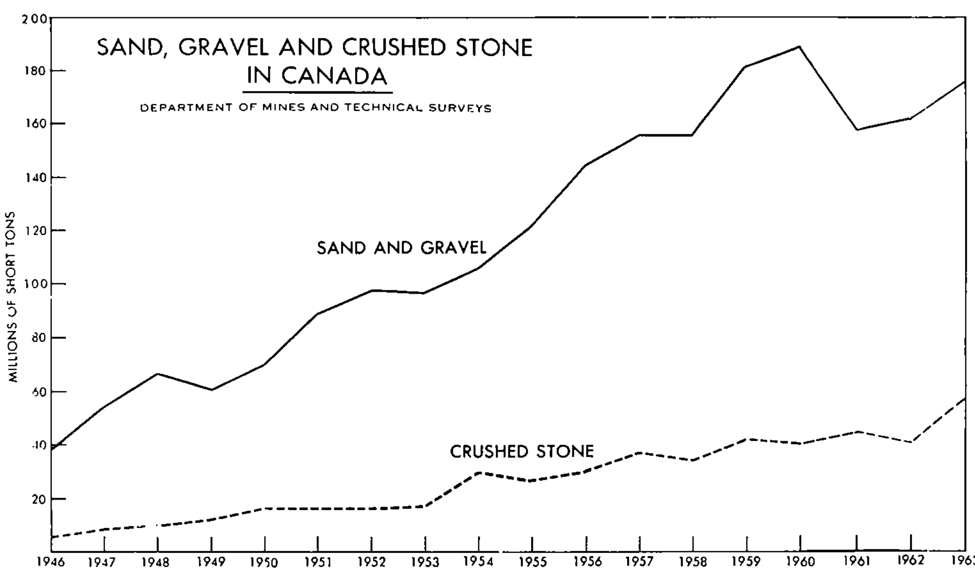
TABLE 2*

Types of Construction in Canada, 1964

Type of Construction	Percentage change 1963–1964	Percentage of Total value 1963	Percentage of Total value 1964
Engineering	+16.6	39.2	40.7
Residential.................	+15.4	29.2	30.1
Institutional	−11.7	11.1	8.7
Commercial.................	+ 7.6	9.6	9.2
Industrial	+24.0	6.9	7.7
Other building	+ 1.3	4.0	3.6

*Dominion Bureau of Statistics, Catalogue 64-201, CONSTRUCTION IN CANADA 1963 – 1965

Road building is the major construction utilizing crushed stone, absorbing 57.4 and 54 per cent of the total production and value of this aggregate. Concrete construction is second with 22.2 per cent of the total for a value of 25.3 per cent. Terrazzo, stucco and artificial stone materials (undifferentiated) make up slightly more than one per cent of the volume and value. Approximately 10 per cent of the product is unclassified.



The value of total construction amounting to $8,653 million is divided approximately 60 to 40 per cent between building and engineering. Table 2 shows the relationship (in per cent of the total value) of each, as well as the divisions of building construction for 1964 compared with 1963.

Total building construction in 1964 increased 9.3 per cent over 1963. The greatest gains were made in industrial, residential and commercial categories with increases in 1964 over 1963 of 24, 15 and 7 per cent, respectively.

IMPORTS AND EXPORTS

A 25.4 per cent increase in volume and 135.0 per cent increase in value was reported for imported sand, gravel and crushed stone in 1964 compared with 1963.

Preliminary estimates indicate imports of sand and gravel increased by 5.6 and 37.0 per cent, volume and value respectively. A higher-priced product, valued at $1.25 (average) per ton in 1964 compared with 96½ cents per ton obtained in 1963, probably indicates the use of better-quality aggregates rather than inflated prices; materials needed for exposed aggregate applications command a higher value. A large increase in imported crushed stone aggregates amounting to 40 per cent in volume and 187 per cent in value was also reported. The average value of this product more than doubled, rising from $1.36 per ton in 1963 to $2.79 per ton in 1964.

TABLE 3

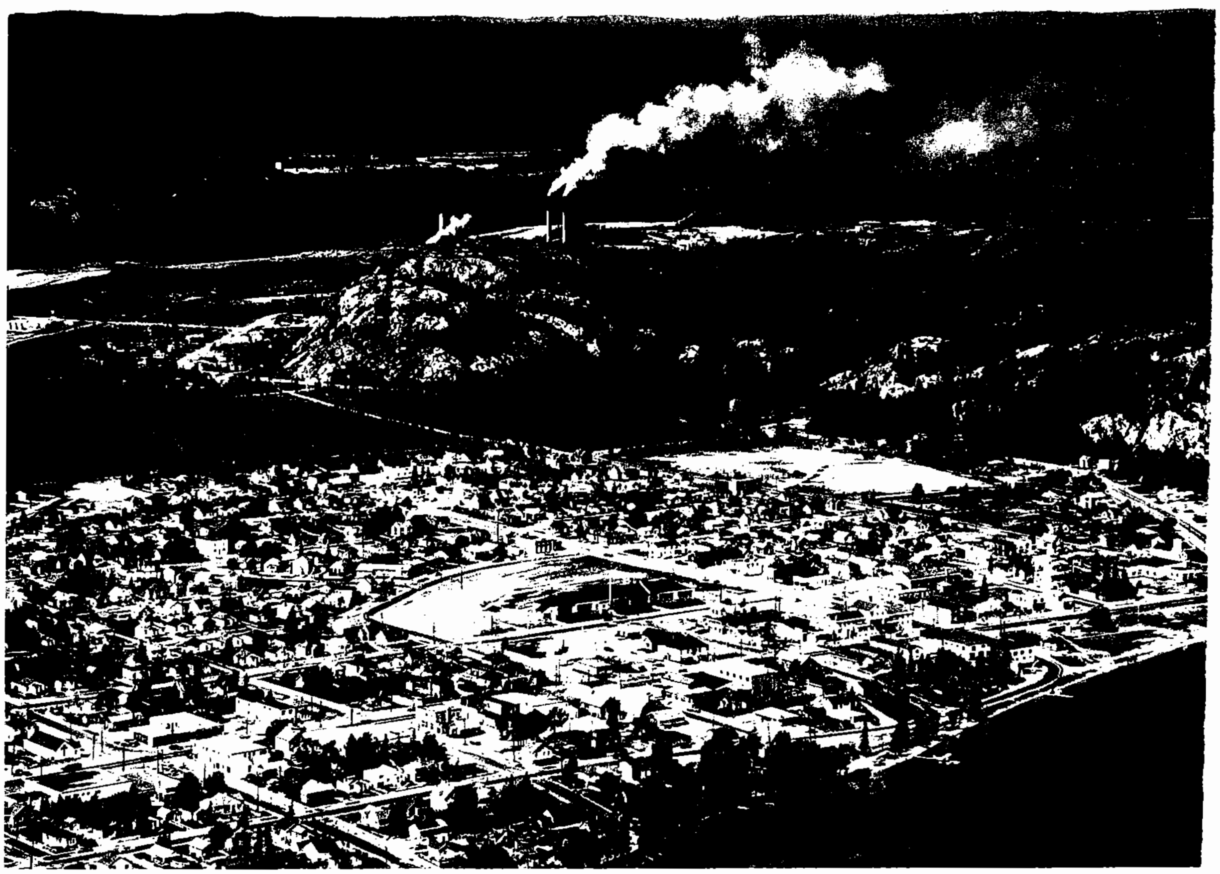
Canadian Imports and Exports of Sand, Gravel and Crushed Stone

	1963		1964p	
	Short Tons	$	Short Tons	$
Imports				
Sand and gravel.........	561,965	540,841	593,455	741,466
Crushed stone, including stone refuse..........	750,310	1,023,434	1,052,468	2,934,275
Total	1,312,275	1,564,275	1,645,923	3,675,741
Exports				
Sand	342,211	441,267	432,564	574,029
Gravel.................	13,913	12,938	28,900	30,051
Crushed limestone and refuse...............	634,055	977,060	910,829	1,290,311
Total................	990,179	1,431,265	1,372,293	1,894,391

Source: Dominion Bureau of Statistics.
p: Preliminary

Exports increased in volume and value in 1964 by 38.6 and 32.3 per cent, respectively. All commodities increased about the same rate in both volume and value.

Table 3 compares the 1964 imports and exports on a volume and value basis with 1963 statistics.



The Algoma Steel Corp. Ltd., Wawa, with treatment plant in background.

Selenium and Tellurium

A.F. KILLIN*

Selenium

Selenium is recovered as a byproduct from the treatment of tank muds produced in the electrolytic refining of copper. It is a greyish semimetal with electrical properties characteristic of the semiconductor group of metalloid elements. Selenium recovery plants were in operation at each of Canada's two copper refineries and production in 1964 totalled 448,750 pounds valued at $2,213,182. This was 20,022 pounds and $60,363 less than in 1963.

Canadian Copper Refiners Limited at Montreal East, Quebec, operates Canada's largest selenium recovery plant. The company's refinery treats copper anodes from the Noranda, Quebec, smelter of Noranda Mines Limited and the Gaspé Copper Mines, Limited, smelter at Murdochville, 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 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 slimes from the company's electrolytic copper refinery at Copper Cliff and its nickel refinery at Port Colborne, Ontario. The marketable product produced is a minus 200 mesh, 99.7 per cent selenium powder.

*Mineral Resources Division

98115—35½

TABLE 1

Selenium – Production, Exports and Consumption

	1963		1964p	
	Pounds	$	Pounds	$
Production				
All forms[1]				
Quebec	286,042	1,387,304	238,072	1,190,360
Ontario	95,100	461,235	103,405	502,548
Saskatchewan	72,194	350,141	61,362	297,606
Manitoba	15,436	74,865	45,911	222,668
Total	468,772	2,273,545	448,750	2,213,182
Refined[2]	462,400		462,795	
Exports, metal				
Britain	189,900	1,063,058	199,800	1,081,810
United States	230,200	1,216,210	174,200	990,811
Argentina	2,100	11,325	4,900	23,982
Australia	–	–	4,400	18,044
Spain	1,700	9,649	3,600	18,215
India	600	2,692	3,200	19,541
Republic of South Africa	2,900	17,048	2,800	13,306
Philippines	–	–	2,700	10,683
Brazil	3,600	16,831	1,600	7,442
France	7,100	47,497	1,500	10,109
Other countries	7,600	37,428	2,600	12,141
Total	445,700	2,421,738	401,300	2,206,084
Consumption[3](selenium content)	12,424		13,968	

Source: Dominion Bureau of Statistics.

[1]Recoverable selenium content of the blister copper treated at domestic refineries, plus refined selenium from domestic primary materials. [2]Includes production from scrap. [3]As reported by consumers.

p Preliminary

CONSUMPTION AND USES

Canadian consumption of selenium in 1964 was 13,968 pounds, 1,544 pounds more than was used in 1963. Approximately half of the domestic use was in the manufacture of glass; the rest was consumed by the rubber, electronics, steel and pharmaceutical industries.

Since World War II the principal use of selenium has been in the manufacture of dry-plate rectifiers for the electronics industry. The amount of selenium used in rectifiers has been declining because of the growing use of silicon and germanium for this application. Some electronic grade (99.99+ % Se) selenium has been used in the manufacture of modules for thermoelectric devices.

TABLE 2

Selenium – Production, Exports and Consumption, 1955–64
(pounds)

	Production		Exports[4]	Consumption[4]
	All forms[1]	Refined[2]	Metals and Salts	
1955	427,109	422,588	334,215	34,854
1956	330,389	355,024	409,729	31,669
1957	321,392	332,011	228,051	15,572
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	466,629	325,600	12,587
1963	468,772	462,400	445,700	12,424
1964p	448,750	462,795	401,300	13,968

Source: Dominion Bureau of Statistics.

[1]Recoverable selenium content of the blister copper treated at domestic refineries, plus refined selenium from domestic primary material. [2]Includes production from scrap. [3]To 1958 inclusive, producers' domestic shipments of selenium produced at domestic refineries, for 1959 and the years following, consumption (selenium content) as reported by consumers. [4]From 1955 to 1960, exports of selenium metal and compounds; from 1961, exports of metal, metal powder, shot, etc.

p Preliminary.

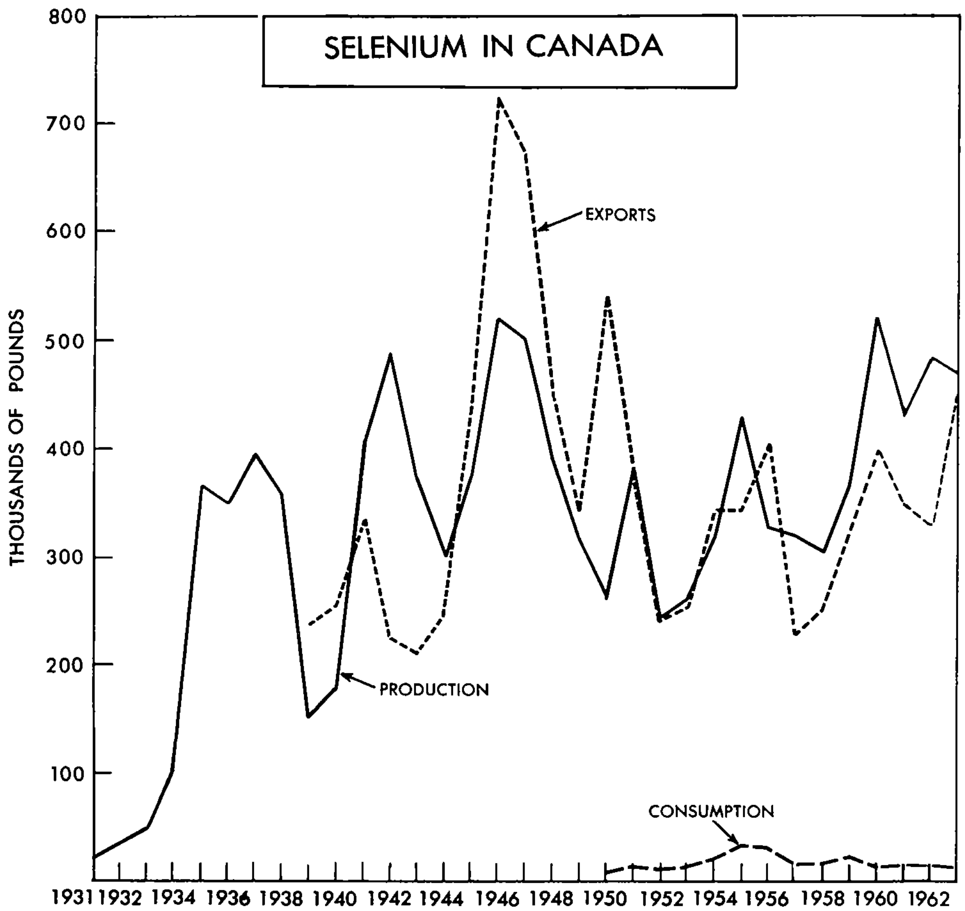
TABLE 3

Free World Production of Selenium, 1962 and 1963
(pounds)

	1962	1963
United States	999,000	928,000
Canada	487,066	468,772
Japan	309,314	313,494
Sweden	225,000e	225,000e
Northern Rhodesia	40,526	62,891
Belgium and Luxembourg, exports.......	29,542	52,900e
Other countries	40,552	44,943
Total	2,131,000	2,096,000

Source: U.S. Bureau of Mines *Minerals Yearbook, 1963*

e Estimate.



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, selenium 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 orange to dark maroon colours and in the colouring of inks for printing on glass containers.

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.

TABLE 4

Canadian Industrial Use of Selenium, 1962 and 1963
(pounds of contained selenium)

	1962	1963
By end-use		
Electronics	Reported in other	
Glass	5,347	6,189
Other *	7,240	6,235
Total	12,587	12,424
By type		
Ferroselenium	3,519	3,689
High purity	1,619	888
Metal powder	4,562	5,358
Other **	2,887	2,489
Total	12,587	12,424

Source: Consumers' reports to Dominion Bureau of Statistics.
* Rubber, steel, pharmaceuticals. ** Selenium dioxide, sodium selenite and selenium sulphide.

TABLE 5

Consumers of Selenium and Products

Quebec

Abbot Laboratories, Limited, Montreal
Canada Iron Foundries, Limited, Montreal
Consumers Glass Company, Limited, Ville St. Pierre
Dominion Glass Company, Limited, Montreal
Dominion Rubber Company, Limited, Montreal
Frigistors Ltd., Montreal
Iroquois Glass Limited, Candiac
Shawinigan Chemicals Limited, Shawinigan

Ontario

Atlas Steels Division of Rio Algom Mines Limited, Welland
Fahralloy Canada Limited, Orillia
Ferro Enamels (Canada) Limited, Oakville

British Columbia

The Consolidated Mining and Smelting Company of Canada Limited, Trail

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 aging 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 per cent, improves the porosity of stainless steel castings. Ferroselenium (55 to 57% Se) is added to stainless and lead-recarburized steels to improve their machinability and other properties.

PRICES

Throughout 1964 selenium prices per pound of selenium in the United States, as quoted by *E & M J Metal and Mineral Markets,* were:

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

UNITED STATES

Selenium metal, selenium dioxide, selenium salts – free
Other selenium compounds – 10.5% ad valorem.

Tellurium

The tellurium recovered in Canada is obtained by the same companies that recover selenium from the tankhouse slimes of the two electrolytic copper refineries and the nickel refinery. Total production in 1964 from the two plants as reported by The International Nickel Company of Canada, Limited, and Canadian Copper Refiners Limited was 79,789 pounds valued at $508,830. This was 2,947 pounds and $9,357 more in production and value than in 1963. Refined production in 1964 was 80,255 pounds, the excess over plant production being obtained from stockpiled, telluriferous refinery muds and scrap.

TABLE 6

Tellurium – Production and Consumption

	1963		1964p	
	Pounds	$	Pounds	$
Production				
All forms[1]				
Quebec	64,590	419,835	60,192	391,248
Ontario	7,705	50,082	7,900	47,400
Saskatchewan	3,751	24,382	6,691	40,146
Manitoba	796	5,174	5,006	30,036
Total	76,842	499,473	79,789	508,830
Refined[2]	79,570		80,255	
Consumption, refined[3]	1,853		1,473	

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]Reported by consumers.
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CONSUMPTION AND USES

Consumption of tellurium in Canada in 1964 at 1,473 pounds was 380 pounds less than in 1963 and 2,833 pounds less than in 1962. Consumption decreased in all industries using tellurium but the major decrease was in the metal alloy industry. It is probable that increased use of selenium has displaced tellurium in the metal alloy field.

Tellurium is nontoxic, but when absorbed into the body by direct contact or inhalation it imparts a strong odour of garlic to the breath and perspiration. Because of this adverse physiological effect, industry has used tellurium less than selenium.

TABLE 7

Production of Tellurium, 1955–64
(pounds)

	All Forms*	Refined**
1955	9,014	6,516
1956	7,867	15,915
1957	31,524	34,895
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	79,570
1964p	79,789	80,255

Source: Dominion Bureau of Statistics.

*Includes the recoverable tellurium content of blister copper, which was not necessarily recovered in the year designated, plus refined tellurium from domestic primary material. **Refinery production from all sources.

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TABLE 8

Free World Production of Tellurium, 1962 and 1963
(pounds)

	1962	1963
United States	264,000	201,000
Canada	58,725	76,842
Peru	50,472	26,634
Japan	23,168	13,256
Other countries	35	32
Total	396,400	317,764

Source: U.S. Bureau of Mines *Minerals Yearbook, 1963.*

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 aging and mechanical properties. The diethyldithiocarbamate

TABLE 9
Refined Tellurium Used in Canada, 1962 and 1963
(pounds of contained tellurium)

	1962	1963
By end-use		
Metal Alloys	1,563	811
Other*	2,743	1,042
Total	4,306	1,853
By Type		
Metal pellets	986	–
Other**	3,320	1,853
Total	4,306	1,853

Source: Consumers' reports to Dominion Bureau of Statistics.
*Rubber, electronics. **Lump, powder and compounds.

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 United States price of tellurium in 100-pound lots for 1964 as quoted by *E & M J Metal and Mineral Markets* was $6 for both powder and slab.

TARIFFS

	British Preferential	Most Favoured Nation	General
CANADA			
In lumps, powder, ingots, etc.*..................	free	15%	25%

	British Preferential	Most Favoured Nation	General
CANADA (cont.)			
In alloys, rod, sheet, or processed form	15%	20%	25%

UNITED STATES

Tellurium metal – 8% ad valorem.
Tellurium salts and compounds – 10% ad valorem.

*This tariff applies if material is determined to be of a class or kind not produced in Canada, otherwise tariff quoted immediately below applies.

Silica

R.K. Collings*

Silica (silicon dioxide) commonly occurs as quartz in the form of sand, sandstone, quartzite and vein quartz. Although deposits are widespread, only those of high silica content are of interest commercially. In Canada, current production is largely confined to five provinces – Ontario, Quebec, Manitoba, Saskatchewan and British Columbia. The chief production is lump quartzite and sandstone, and sand for use as metallurgical flux. Silica for flux represented 74 per cent of production in 1963; the remainder consisted of lump silica for ferrosilicon manufacture, and sand for glass and silicon carbide production, and for use by the foundry industry, as sand-blast sand, etc.

Total silica production increased 16 per cent in 1964, to 2.1 million tons. Value, at $4.6 million, was almost 25 per cent greater than that of 1963 and largely resulted from increased production of high-purity, premium-priced silica sand and flour.

Imports showed little change over the previous year. In spite of increased domestic production, substantial quantities of high-purity sand continue to be brought in, chiefly from the United States. A large portion of this sand is consumed by the glass industry of southern Ontario and, to a lesser degree, the Montreal area of Quebec. Imports of silica brick, again mainly from the United States, were in excess of 3 million, valued at over $1.5 million. Production of silica brick at Sydney, Nova Scotia, and at Sault Ste. Marie, Ontario, has been sharply reduced, owing to increased utilization of basic refractories in open-heart steel-making operations.

Exports of silica amounted to 145,206 tons, valued at $425,371. The bulk of these are comprised of lump silica for ferrosilicon production and crushed silica for artificial abrasives manufacture and are exported to the United States from Ontario and British Columbia.

*Mineral Processing Division, Mines Branch

TABLE 1

Silica – Production and Trade

	1963		1964p	
	Short Tons	$	Short Tons	$
Production, quartz and silica sand*				
By province				
Ontario	952,166	644,287	1,043,768	592,485
Quebec	401,063	2,266,273	547,642	2,771,375
Manitoba	279,641	468,867	301,472	644,157
Saskatchewan	160,398	86,615	168,615	134,892
British Columbia	40,483	178,937	66,340	414,955
Nova Scotia	2,861	43,000	3,000	45,000
Total	1,836,612	3,687,979	2,130,837	4,602,864
By use				
Flux	1,356,409	950,878		
Ferrosilicon	141,425	671,930		
Silicon carbide	61,865	390,067		
Glass	79,045	479,701		
Foundry	26,420	147,847		
Other uses	171,448	1,047,556		
Total	1,836,612	3,687,979		
Imports				
Silica sand				
United States	783,593	3,004,691	765,686	2,877,472
Norway	3,268	31,787	3,617	37,350
Australia	296	8,600	2,015	124,705
Belgium-Luxembourg	–	–	559	19,275
Denmark	–	–	23	868
Total	787,157	3,045,078	771,900	3,059,670
Silex and crystallized quartz				
United States	11,658	191,608	5,168	282,182
Brazil	–	–	..	44,298
Italy	17	1,710	8	825
Others	212	11,378	–	–
Total	11,887	204,696	5,176	327,305
Flint and ground flint stone**				
United States	1,552	27,256		
France	132	6,229		
Denmark	128	4,625		
Total	1,812	38,110		
Piezoelectric quartz**	lb.			
Brazil	8,264	148,196		
United States	3,292	129,354		
Others	322	8,468		
Total	11,878	286,018		

Table 1 (Cont.)

	1963		1964	
	Short Tons	$	Short Tons	$
Firebrick and similar shapes, silica	Thousands		Thousands	
United States	..	1,268,886	3,170	1,557,420
West Germany	..	12,441	22	5,492
United Kingdom	..	547	1	1,304
Total	..	1,281,854	3,193	1,564,216
Exports, quartzite	Short Tons		Short Tons	
United States	47,437	216,489	146,206	425,371

Source: Dominion Bureau of Statistics.
* Producers' shipments, including crude and crushed quartz, crushed sandstone and quartzite, and natural silica sands. ** Not available as a separate class after 1963.
Symbols: p Preliminary; — Nil; .. Not available.

TABLE 2

Available Statistics on Consumption of Silica by Specified Industries, 1963

Industry	Short Tons
Smelter flux	1,348,101
Glass manufacturing, including glass fibre	345,018
Foundry sand	246,617
Artificial abrasives	109,911
Ferrosilicon	117,221
Fertilizer, stock and poultry feed	15,618
Silica brick	8,308
Chemicals	13,409
Ceramic	11,453
Asbestos products	21,437
Paints	1,230
Soaps, cleansers and detergents	889
Other	174,286
Total	2,413,498

Source: Dominion Bureau of Statistics.

PRINCIPAL PRODUCERS

QUEBEC

Union Carbide Exploration Ltd. quarries quartzitic sandstone at Melocheville, Beauharnois County, for use in ferrosilicon manufacture at Beauharnois. Fines 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.

TABLE 3

Silica – Production and Trade, 1955–64
(short tons)

	Production			Imports			Exports
	Quartz and Silica Sand	Silica Brick* ('000 bricks)	Silica Sand	Silex or Crystallized Quartz	Flint and Ground Flint Stones	Ganister**	Quartzite
1955	1,869,913	4,763	735,458	24,517	803	456	87,622
1956	2,142,234	5,799	840,374	26,892	616	562	181,196
1957	2,139,246	4,308	744,867	13,718	528	667	232,299
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[r]	1,812	..	47,437
1964p	2,130,837	..	771,900	5,176	..	..	146,206

Source: Dominion Bureau of Statistics.
* Not available after 1959. Beginning 1960, silica used to make silica brick included in production of quartz and silica. **Included with miscellaneous stone imports from January 1, 1958.
Symbols: p Preliminary; .. Not available; r Revised.

Dominion Industrial Mineral Corporation operates a quartzite deposit at St. Donat de Montcalm, producing silica sand and flour for use in glass and silica carbide manufacture, and in other products requiring high-quality silica. The company sold its silica-milling plant at Lachine during the year and embarked on a plant expansion program, incorporating wet processing, at St. Donat. When completed in 1965, the St. Donat facility will have a rated capacity of 360,000 tons of sand per year.

Canadian Silica Corporation Limited, a subsidiary of 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. Industrial Minerals acquired a controlling interest in Canadian Silica Corporation late in the year by purchase of shares held by the three largest owners – The Canadian Faraday Corporation Limited, Metal Mines Limited and Mentor Exploration and Development Co., Limited.

ONTARIO

Union Carbide Canada Limited 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 use in ferrosilicon production. The balance is used in Canada for the same purpose.

MANITOBA

Selkirk Silica Co. Ltd. of Winnipeg 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 use in 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.

SPECIFICATIONS 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 generally 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 1½ per cent. Lime and magnesia should each be less than 0.2 per cent. Phosphorus and arsenic are objectionable. Size is generally 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.

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 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 more than 99 per cent; that of iron should be uniform and less than 0.02 per cent. Other impurities such as alumina, lime and magnesia should be low. Uniformity of grain size is important, 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 and alumina should be less than 0.1 per cent each. Lime, magnesia and phosphorus are objectionable. A coarse-grained sand is preferred for silicon-carbide manufacture but finer sands are sometimes used. 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, have a high compressive strength and a high silica content, and be free of all 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 occurring sand and sand produced by the reduction of sandstone are used extensively in 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. 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 the manufacture of portland cement.

SILICA FLOUR

Silica flour, formed by finely 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 CRYSTALS

Quartz crystals with desirable piezoelectric properties are used in radio-frequency control apparatus, radar and other electronic devices. Crystals used 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 little demand for quartz crystal in Canada, and virtually no production. In 1963, 6 tons valued at $286,000 were imported. Quartz Crystals Mines Limited, Toronto, produced a small amount from its mine near Lyndhurst, Ontario, in that year.

PRICES

The price of silica varies with location of deposit, purity of the product and purpose for which it is required. High-quality silica sand, in carload lots, sells for $8 to $9 per ton in Toronto and Montreal.

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¢
Quartzite, whether or not manufactured	free
Silica, not specially provided for	free

Open pit showing several operations on the many benches. Quebec Cartier Mining Co., Gagnon.

Silver

J.G. GEORGE*

Three new base-metal mines began recovery of silver in substantial quantities in 1964 and several other producers completed their first full year's operation. Canada's estimated mine output of silver at 31,111,943 troy ounces was 1,184,220 ounces, or about 4 per cent, more than in 1963. The province with the highest increase was New Brunswick where production was about 1,146,000 ounces higher than in 1963, mainly because of the beginning of operations at the base-metal property of Brunswick Mining and Smelting Corporation Limited. Ontario was again the leading silver-producing province with 10,720,000 ounces, an increase of 1,118,000 ounces from 1963. More than 800,000 ounces was accounted for by increased output from the Cobalt-Gowganda area where three new mines began production. Output in British Columbia, Saskatchewan and Manitoba and the Yukon Territory declined in 1964. The drop in production in the Yukon Territory was mainly because of the lower tonnage and grade of ore milled by United Keno Hill Mines Limited.

Lead-zinc and silver-lead-zinc ores were the source of almost half of Canada's mine production of silver and more than two thirds of the output from them was from mines in British Columbia and the Yukon Territory. Other important sources were copper, copper-nickel and copper-zinc ores. The remainder of the silver came from silver-cobalt ores mined in northern Ontario (about 19 per cent) and from lode and placer gold ores (less than 2 per cent). Canada in 1964 was the world's fourth largest producer of silver with its mine output being exceeded only by Mexico, Peru and the United States.

The principal mine producers of silver in Canada are listed in Table 3 and the accompanying map shows their approximate locations. The three largest producers in 1964 in declining order of output were United Keno Hill Mines Limited in the Yukon Territory, The Consolidated Mining and Smelting Company of Canada Limited (COMINCO) in southeastern British Columbia and Noranda Mines Limited (Geco Division) in Ontario. Ores mined by these three producers were the source of more than one third of Canada's total production.

*Mineral Resources Division

Canada's two largest producers of refined silver were Canadian Copper Refiners Limited at Montreal East, Quebec, which produced 8,873,000 ounces from anode and blister copper, and COMINCO in its refinery at Trail, British Columbia. At Trail, COMINCO treated its own mine concentrates and ores and concentrates from other companies and recovered 7,347,590 ounces (including metal sold in unrefined products). Other producers of refined silver were Cobalt

TABLE 1

Silver – Production, Trade and Consumption

	1963		1964p	
	Troy Ounces	$	Troy Ounces	$
Production*				
By provinces and territories				
Ontario	9,601,621	13,288,643	10,719,539	15,007,355
Yukon Territory	6,106,037	8,450,755	5,584,497	7,818,296
British Columbia	6,451,158	8,928,402	5,309,486	7,433,280
Quebec	4,441,644	6,147,235	4,757,251	6,660,151
New Brunswick	332,472	460,141	1,478,231	2,069,523
Newfoundland	981,005	1,357,711	1,338,901	1,874,461
Manitoba and Saskatchewan	1,513,117	2,094,154	1,317,771	1,844,879
Nova Scotia	423,189	585,694	539,801	755,721
Northwest Territories	77,468	107,216	66,462	93,047
Alberta	12	17	4	6
Total	29,927,723	41,419,968	31,111,943	43,556,719
By sources				
Base-metal ores	24,302,110		24,648,776	
Gold ores	560,480		530,373	
Silver-cobalt and silver ores	5,053,534		5,920,900	
Placer gold ores	11,599		11,894	
Total	29,927,723		31,111,943	
Exports				
In ores and concentrates				
United States	6,792,965	7,966,982	6,263,418	7,064,589
Belgium and Luxembourg	424,927	434,346	1,448,549	1,723,320
West Germany	529,943	629,419	630,729	591,411
Japan	239,040	281,627	364,907	457,771
Sweden	–	–	272,134	371,235
Britain	281,253	309,082	263,102	320,334
France	–	–	119,063	128,739
Mexico	–	–	78,291	57,818
Norway	–	–	38,124	44,313
Brazil	11,844	15,733	–	–
Portugal	6,784	6,196	–	–
Total	8,286,756	9,643,385	9,478,317	10,759,530

Table 1 (cont.)

	1963		1964p	
	Troy Ounces	$	Troy Ounces	$
Silver, refined metal				
United States	10,767,909	14,686,424	10,535,443	14,651,856
Brazil	61,138	85,689	29,560	42,840
Venezuela	2,878	4,385	16,379	24,938
Switzerland	–	–	1,034	1,460
Bermuda	–	–	365	598
Trinidad	–	–	335	492
Other countries	2,704	6,102	323	827
Total	10,834,629	14,782,600	10,583,439	14,723,011
Imports, silver, refined metal				
United States	7,348,541	10,013,103	5,195,559	7,268,000
United Kingdom	3,736	5,010	2,205	3,000
Bahamas	15,528	21,460	–	–
Mexico	534,814	718,941	–	–
Nicaragua	48,353	62,588	–	–
Total	7,950,972	10,821,102	5,197,764	7,271,000
Consumption, by use				
Coinage	13,012,204		13,726,413	
Silverware	1,256,044		1,456,945	
Photography	1,668,784		1,623,016	
Wire and rod	13,353		13,251	
Silver alloys	331,350		348,718	
Miscellaneous**	1,292,893		1,606,964	
Total	17,574,628		18,775,307	

Source: Dominion Bureau of Statistics.

*Computed as follows: recoverable silver in ores, concentrates and matte exported; silver in crude gold bullion produced; silver in blister and anode copper made at Canadian smelters; silver in base bullion produced from domestic ores by The Consolidated Mining and Smelting Company of Canada Limited; silver bullion produced from treatment of domestic cobalt-silver ores by Cobalt Refinery Limited at Cobalt, Ont.

**Includes sheet, anodes for electroplating and silver used in the manufacture of electrical equipment and jewelry.

Symbols: p Preliminary; – Nil.

Refinery Limited 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). Production of refined silver by Cobalt Refinery Limited, amounting to 2,753,001 ounces, was an increase of 747,147 ounces from the previous year's output. In 1964, the major portion of the silver-cobalt ores and concentrates produced in the Cobalt-South Lorrain-Gowganda area

TABLE 2

Silver – Production, Trade and Consumption, 1955-64
(troy ounces)

	Production	Exports			Imports,	
	All Forms*	In Ore and Concentrates	In bullion	Total	Unmanu- factured	Consumption **
1955	27,984,204	5,873,873	16,598,577	22,472,450	87,128	5,161,445
1956	28,431,847	6,924,414	14,341,753	21,266,167	1,010,180	7,710,925
1957	28,823,298	5,979,459	12,799,990	18,779,449	1,859,131	10,730,255
1958	31,163,470	5,098,788	16,026,550	21,125,338	2,701	9,299,809
1959	31,923,969	6,814,865	15,140,830	21,955,695	2,807,774	10,202,769
1960	34,016,829	8,897,402	12,761,063	21,658,465	3,849,115	11,742,064
1961	31,381,977	10,352,700	10,783,414	21,136,114	12,278,469	9,614,083
1962	30,422,972	8,861,858	9,445,094	18,306,952	15,182,336	15,419,342
1963	29,927,723	8,286,756	10,834,629	19,121,385	7,950,972	17,574,628
1964p	31,111,943	9,478,317	10,583,439	20,061,756	5,197,764	18,775,307

Source: Dominion Bureau of Statistics.

* Recoverable silver in ores, concentrates and matte shipped for export; in crude and gold bullion produced; in blister and anode copper made at Canadian smelters; in base bullion made by Cominco at Trail, B.C.; bullion produced from the treatment of cobalt-silver ores. **Includes consumption for coinage.

p Preliminary.

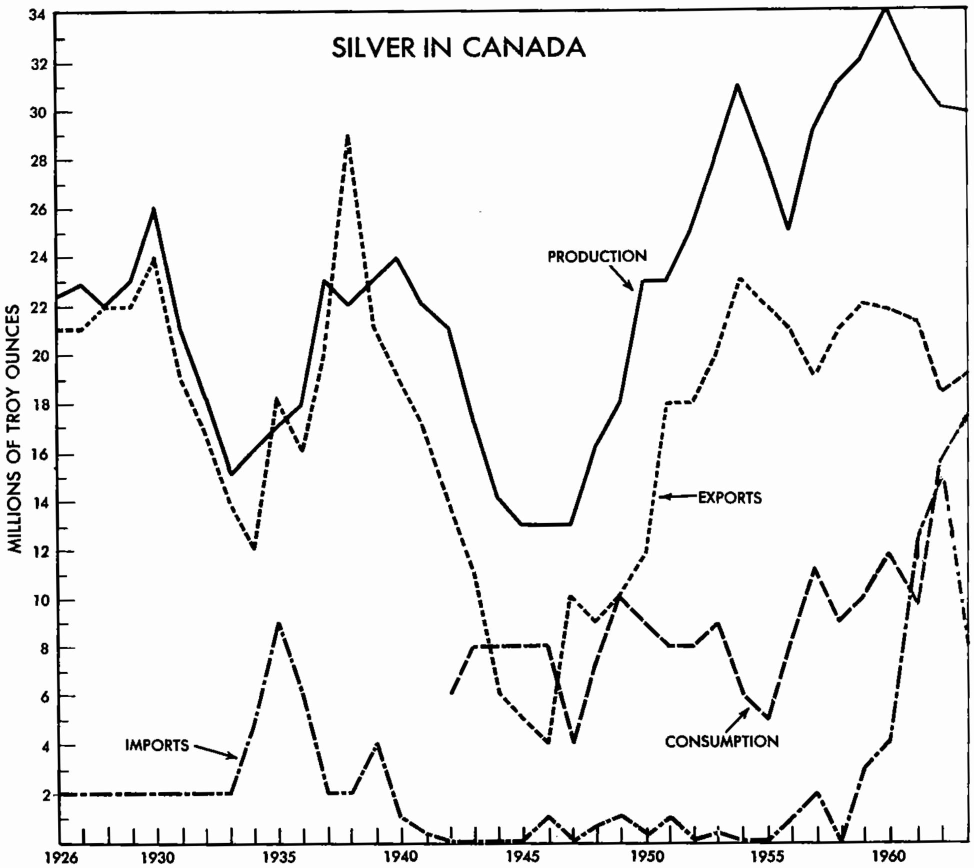
of northern Ontario was treated by Cobalt Refinery Limited; in previous years a large portion was treated elsewhere.

Canada's exports of silver in ores and concentrates and as refined metal totalled 20,061,756 ounces, an increase of 940,371 ounces from those of 1963. The export pattern showed only minor changes from the previous year. Our major customer, by far, continued to be the United States which imported about 16,798,861 ounces, or almost 84 per cent of Canada's total exports. Imports of refined silver declined to 5,197,764 ounces, a reduction of 2,753,208 ounces from 1963. Imports came from only two countries in 1964, the United States and the United Kingdom, with the former accounting for all but 2,205 ounces of the entire amount imported.

DEVELOPMENTS

YUKON TERRITORY

Although most of the exploration in the Yukon Territory was centred in the Mayo district, a substantial amount of exploration and development work was carried out in other areas including the Carmacks and Whitehorse districts. United Keno Hill Mines Limited in the Mayo district continued an extensive exploration program on its properties, particularly at the Hector-Calumet, Keno, No Cash, and Galkeno mines. The increase in lead and zinc prices has made the Onek orebody economic, as well as some ore shoots in the Hector-Calumet mine. Jersey Consolidated Mines Limited continued exploration work on its property adjoining United Keno Hill Mines Limited on Galena Hill, about 35 miles north of Mayo.

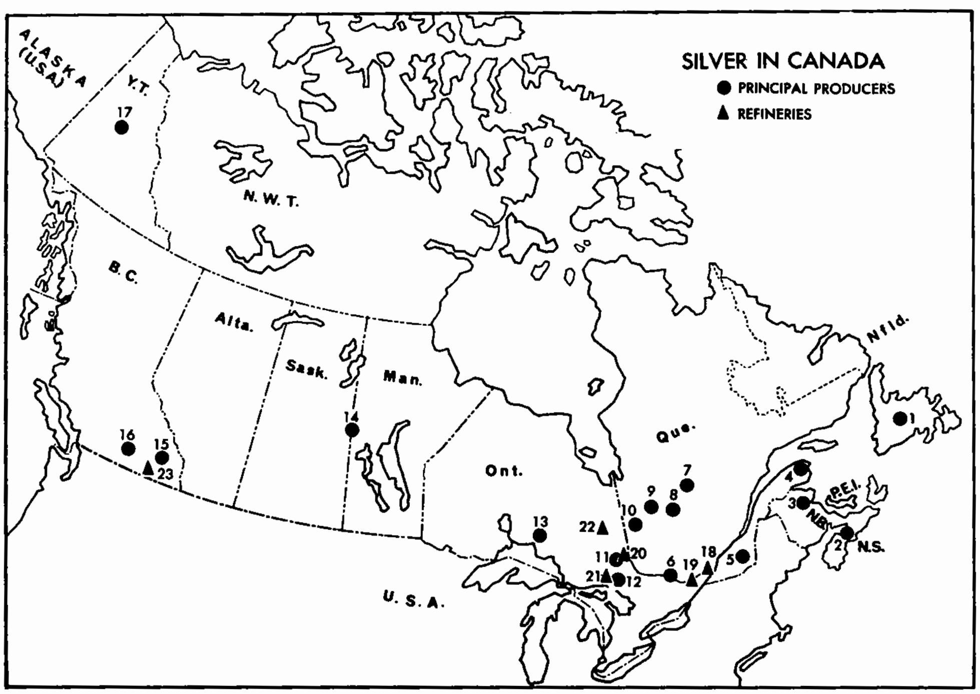


Peso Silver Mines Limited conducted intensive exploratory programs from surface and underground on its various properties in the Yukon Territory and increased its holdings from 230 to 2,000 claims. Included in the new acquisitions was controlling interest in Mount Nansen Mines Limited near Carmacks. Controlling interest was also purchased in Brown-McDade Mines Limited which owns 30 claims directly adjoining the Mount Nansen property. Vangorda Mines Limited, controlled by Kerr Addison Mines Limited, put down two large-diameter diamond drill holes on its property about 126 miles northeast of Whitehorse to obtain fresh ore samples for metallurgical testing. The results of these tests are essential for the completion of production feasibility studies of the deposit which has estimated reserves of 9,400,000 tons averaging 3.18 per cent lead, 4.96 per cent zinc, 0.27 per cent copper, 1.76 ounces of silver and 0.02 ounce of gold a ton.

BRITISH COLUMBIA

Because of the higher lead and zinc prices as well as the higher sustained silver price, increased activity was reported in many sections of Britisn Columbia. Dolly Varden Mines Ltd. continued diamond drilling and underground development work at its property near Alice Arm and is considering bringing it into production. Ore reserves, including low-grade extensions to the old Torbrit orebodies, are estimated at 7 million tons grading 4.5 ounces of silver a ton. About 4½ million tons of reserves are estimated to be available for open-pit mining operations. In the same general area, Sirmac Mines Limited explored its silver holdings. Antoine Silver Mines Ltd. continued to develop its silver-base-metal property in the Slocan district, about 30 miles west of Kaslo. In the same district, exploration work continued at the property of Reco Silver Mines Limited. Ottawa Silver Mines Ltd. continued development of its silver-lead property in the Slocan district and in April 1965 regular ore shipments commenced to the smelter at Trail, B.C., at a rate of about 400 tons monthly. The company has a 30-ton-a-day mill on the property which could be brought into operation if sufficient ore reserves are developed.

At the copper-zinc-lead-silver-gold property of Western Mines Limited at Buttle Lake, Vancouver Island, work was concentrated on proving up sufficient ore at the Lynx mine to permit planning for production. A 25-acre site at the Lynx mine was cleared and prepared for the surface plant installation including a 750-ton-a-day concentrator. Early in December 1964 production commenced at the 1,000-ton-a-day mill of the copper-silver-gold operation of Mt. Washington Copper Co. Ltd. near Courtenay on Vancouver Island. In October 1964 operations commenced at the Cork Province zinc-lead-silver mine of London Pride Silver Mines Ltd. about 10 miles from Kaslo in the East Kootenay area. Milling was



PRINCIPAL PRODUCERS

1. American Smelting and Refining Company (Buchans Unit)
2. Magnet Cove Barium Corporation
3. Brunswick Mining and Smelting Corporation Limited
   Heath Steele Mines Limited
4. Gaspé Copper Mines, Limited
5. Solbec Copper Mines, Ltd.
6. New Calumet Mines Limited
7. 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
    McIntyre-Porcupine Mines, Limited (Castle Division)
    Rix-Athabasca Uranium Mines Limited
    Silverfields Mining Corporation Limited
    Silver-Miller Mines Limited
    Silver Summit Mines Limited
    Silver Town Mines Limited
    Siscoe Metals of Ontario Limited
12. The International Nickel Company of Canada, Limited
13. Noranda Mines Limited (Geco Division)
    Willroy Mines Limited
14. Hudson Bay Mining and Smelting Co., Limited
15. The Consolidated Mining and Smelting Company of Canada Limited (Bluebell mine, Sullivan mine)
16. Mastodon-Highland Bell Mines Limited
17. United Keno Hill Mines Limited

REFINERIES

18. Canadian Copper Refiners Limited
19. Royal Canadian Mint
20. Cobalt Refinery Limited
21. The International Nickel Company of Canada, Limited
22. Hollinger Consolidated Gold Mines, Limited
23. The Consolidated Mining and Smelting Company of Canada Limited

TABLE 3

Principal Silver Producers in Canada, 1964

Company and Location	Mill Capacity (short tons/day)	Type of Ore Milled	Silver Content 1964 (1963) (oz./ton)	Ore Milled 1964 (1963) (short tons)	Silver Produced 1964 (1963) (troy ounces)
British Columbia					
The Consolidated Mining and Smelting Company of Canada Limited					
Sullivan mine, Kimberly	10,000	Pb, Zn, Ag	.. (..)	2,710,832 (2,595,000)	2,897,791[1] (3,867,000)
Bluebell mine, Riondell	700	Pb, Zn, Ag	.. (..)	257,871 (256,000)	324,174 (..)
Mastodon-Highland Bell Mines Limited, Beaverdell	90	Ag, Pb, Zn	32.28 (40.48)	25,090 (21,689)	809,819 (877,861)
Yukon Territory					
United Keno Hill Mines Limited (Hector-Calumet, Elsa, Keno and Silver King mines), Mayo district	500	Ag, Pb, Zn	33.37 (34.03)	181,849 (186,721)[2]	5,724,070 (5,978,075)[2]
Manitoba and Saskatchewan					
Hudson Bay Mining and Smelting Co., Limited	6,000 (treated at central mill at Flin Flon)	Cu, Zn, Pb, Ag	0.94 (1.10)	1,585,394 (1,618,617)	1,262,725 (1,428,886)
Flin Flon mine, Flin Flon		Cu, Zn, Ag	0.96	789,918 (924,616)	
Chisel Lake mine, Snow Lake		Zn, Cu, Pb, Ag	1.73	267,630 (300,065)	
Stall Lake mine[3], Snow Lake		Cu, Zn	0.41	264,645 (–)	Ore Produced (Flin Flon, Chisel Lake, Stall Lake, Coronation and Schist Lake mines)
Coronation mine, Flin Flon		Cu	0.21	185,069 (292,650)	
Schist Lake mine, Flin Flon		Cu, Zn, Ag	1.47	72,438 (81,150)	

Table 3 (cont.)

Company and Location	Mill Capacity (short tons/day)	Type of Ore Milled	Silver Content 1964 (1963) (oz./ton)	Ore Milled 1964 (1963) (short tons)	Silver Produced 1964 (1963) (troy ounces)
Ontario					
Noranda Mines Limited (Geco Division), Manitouwadge	3,300	Cu,Zn,Ag,Pb	2.48 (2.44)	1,299,300 (1,281,165)	2,468,813 (2,437,039)
Willroy Mines Limited (Willroy mine), Manitouwadge	1,500	Cu,Zn,Pb,Ag	1.38 (1.14)	530,151 (483,800)	512,804 (424,327)
The International Nickel Company of Canada, Limited, Sudbury Ont., and Thompson, Man.	[4]	Ni,Cu	.. (..)	16,439,000[5] (13,566,000)[5]	1,493,000[6] (1,403,000)[6]
Agnico Mines Limited (Christopher and Nipissing-O'Brien mines), Cobalt district	400	Ag,Co	11.18 (11.64)	71,489 (67,210)	730,709 (710,772)
Deer Horn Mines Limited (Cross Lake O'Brien mine), Cobalt district	100	Ag,Co	15.7 (..)	27,690 (..)	423,974 (749,838)
Glen Lake Silver Mines Limited (Baily mine), Cobalt district ..	100	Ag,Co	26.76 (..)	23,889 (..)	693,253 (942,673)[7]
Hiho Silver Mines Limited[8] (Hiho mine), Cobalt district.	ore custom-milled	Ag,Co	63.12 (—)	6,316 (—)	398,754 (—)
Langis Silver & Cobalt Mining Company Limited (Langis mine), Cobalt district	175	Ag,Co	18.95 (17.18)	36,762 (36,748)	713,593 (603,140)
McIntyre-Porcupine Mines, Limited (Castle Division), Gowganda district	125	Ag,Co	32.40 (..)	9,131 (..)	277,479 (190,780)[7]
Rix-Athabasca Uranium Mines Limited, Cobalt district.......	ore custom-milled	Ag,Co	.. (..)	12,231 (14,800)	219,580 (324,000)

Table 3 (cont.)

Company and Location	Mill Capacity (short tons/day)	Type of Ore Milled	Silver Content 1964 (1963) (oz./ton)	Ore Milled 1964 (1963) (short tons)	Silver Produced 1964 (1963) (troy ounces)
Silverfields Mining Corporation Limited[8], Cobalt district	ore custom-milled	Ag,Co	..	..	650,166[7]
			(—)	(—)	(—)
Silver-Miller Mines Limited (Conisil property), Cobalt district..	125	Ag,Co	30.17	1,008	30,415
			(—)	(—)	(—)
Silver Summit Mines Limited, Cobalt district.................	200	Ag,Co	10.45	12,527	130,953
			(..)	(..)	(143,950)[7]
Silver Town Mines Limited[8], Cobalt district	ore custom-milled	Ag,Co	26.86	3,826	102,747
			(—)	(—)	(—)
Siscoe Metals of Ontario Limited (Miller-Lake O'Brien mine), Gowganda district....................................	275	Ag,Co	21.73	64,019	1,399,522
			(21.58)	(64,660)	(1,404,027)
Quebec					
The Coniagas Mines, Limited (Coniagas mine), Bachelor Lake .	350	Zn,Ag,Pb	3.68	114,459	333,591
			(8.0)	(111,418)	(632,385)
Gaspé Copper Mines, Limited (Gaspé mine), Murdochville	7,300	Cu	..	2,725,300	521,000
			(..)	(2,676,300)	(516,000)
Lake Dufault Mines, Limited[9], Noranda	1,300	Cu,Zn,Ag	2.37	112,117	192,704
			(—)	(—)	(—)
Manitou-Barvue Mines Limited (Golden Manitou mine), Val d'Or.	1,300	Zn,Cu,Ag,Pb	3.68	142,925[10]	409,992
			(4.52)	(174,365)[10]	(590,322)
Mattagami Lake Mines Limited (Mattagami Lake mine), Matagami	3,850	Zn,Cu,Ag	1.15	1,282,072	346,600
			(1.31)	(166,725)	(..)
New Calumet Mines Limited, Grand Calumet	750	Pb,Zn,Ag	3.55	94,823[2]	289,071[2]
			(3.68)	(93,360)[2]	(289,403)[2]
Noranda Mines Limited (Horne mine), Noranda	3,200	Cu,Au	..	897,341	..
			(..)	(820,374)	(..)

Table 3 (cont.)

Company and Location	Mill Capacity (short tons/day)	Type of Ore Milled	Silver Content 1964 (1963) (oz./ton)	Ore Milled 1964 (1963) (short tons)	Silver Produced 1964 (1963) (troy ounces)
Normetal Mining Corporation, Limited (Normetal mine), Normetal	1,000	Zn,Cu,Ag	1.75	348,924	429,818
			(1.83)	(345,384)	(483,598)
Opemiska Copper Mines (Quebec) Limited, Chapais	2,000	Cu	..	748,990	281,797
			(..)	(737,543)	(276,653)
Quemont Mining Corporation, Limited, Noranda	2,300	Cu,Zn	0.70	752,691	358,589
			(0.79)	(803,003)	(425,048)
Solbec Copper Mines, Ltd., Stratford Place	1,000	Cu,Zn,Pb,Ag	1.28	424,127	279,452
			(1.54)	(188,493)	(147,809)
New Brunswick					
Brunswick Mining and Smelting Corporation Limited[8] (No.12 mine), Bathurst	4,500	Zn,Pb,Ag,Cu	2.60	777,902	..
				(–)	(–)
Heath Steele Mines Limited, Newcastle	1,500[11]	Zn,Pb,Cu,Ag	2.6	290,000	506,000
			(2.53)	(265,939)	(395,168)
Nova Sctia					
Magnet Cove Barium Corporation, Walton	125	Ag,Pb,Zn,Cu	12.7	48,927	524,200
			(12.8)	(49,058)	(545,035)
Newfoundland					
American Smelting and Refining Company (Buchans Unit), Buchans	1,250	Zn,Pb,Cu,Ag	4.07	383,000	1,337,825
			(4.09)	(376.000)	(1,379,783)

[1]COMINCO's total silver production, including that from purchased ores and concentrates, was 7,347,590 ounces. [2]Production for fiscal years ending September 30. [3]Mine brought into production February 3, 1964. [4]INCO operates seven nickel-copper mines in Sudbury district and Thompson nickel-copper mine in northern Manitoba. Ores from Sudbury district mines are treated in three mills having combined daily capacity of 48,000 tons. Thompson mill has daily capacity of 6,000 tons. [5]Ore production includes output of Thompson mine in Manitoba. [6]Silver delivered to markets. [7]Shipments via Temiskaming Testing Laboratory. [8]Production commenced in 1964. [9]Mine and milling plant reached full production October 1, 1964, following two-month tune-up period. [10]Production does not include copper ore milled in separate circuit. In 1964, 244,980 tons of copper ore were milled. Mine closed from February 20 to April 20, 1964, due to labour disagreement. [11]One half of Heath Steele's mill capacity used to treat copper ore from nearby Wedge mine operated by The Consolidated Mining and Smelting Company of Canada Limited.

Symbols: – Nil; .. Not available.

initiated at a rate of 100 tons a day and was scheduled to increase to 120 tons. Johnsby Mines Limited commenced production in the latter part of 1964 at its property near Silverton in the Slocan district. The mill treated about 40 tons of ore daily and has undertaken to treat custom ores from a number of other local operations. The mill has a capacity of 120 tons per day, which could probably be doubled with minor expenditures and mill heads were in the range of about 16 ounces of silver per ton of ore.

ONTARIO

Because of the continuing favourable price and market conditions, exploration and development activity was at a high level in the Cobalt and Gowganda areas and three new mines commenced production. In the Cobalt area, production began in 1964 at properties operated by Hiho Silver Mines Limited, Silver Town Mines Limited and Silverfields Mining Corporation Limited, the last having an output of 650,166 ounces of silver during the year. Several other companies made intermittent shipments of ore on a custom basis to nearby mills. Siscoe Metals of Ontario Limited continued to be the largest mine producer in the Cobalt-Gowganda area, although its silver output of 1,399,522 ounces in 1964 was slightly lower than that of the previous year. In spite of a prolonged labour strike, which commenced about mid-1963 and was not settled until June 17 of the following year, production of 277,479 ounces of silver in 1964 at the Castle mine (Gowganda area) of McIntyre-Porcupine Mines, Limited, was considerably higher than that of the previous year. Output from Canadian Keeley Mines Limited, formerly Keeley-Frontier Mines Limited, was very much lower than in 1964 because of an extensive underground exploration and development program. Production was also considerably reduced at Deer Horn Mines Limited; milling operations were interrupted because of shaft deepening and increased underground development work.

A significant development in Ontario was the discovery early in 1964 by Texas Gulf Sulphur Company of a major zinc-copper-silver orebody in Kidd Township, about 15 miles north of Timmins. Ore reserves have been preliminarily estimated at 55 million tons grading 7.08 per cent zinc, 1.33 per cent copper and 4.85 ounces of silver per ton. A 13-mile all-weather access road was completed to the mine site early in the autumn of 1964 and the Ontario Northland Railway will build a 16-mile spur line to the property. Plans were well advanced at the year's end for the open-pit mine, concentrator and related facilities; initial production is scheduled for the latter part of 1966. The concentrator is being designed so that its initial production capacity of 2 million tons of ore per year can be readily expanded to 3 million tons, or approximately 9,000 tons daily.

QUEBEC

Mattagami Lake Mines Limited, Orchan Mines Limited and New Hosco Mines Limited, all in the Matagami Lake area of northwestern Quebec, completed their first full year's operation in 1964. Because of the substantially greater quantity of ore milled in 1964, byproduct silver output from the base-metal mine of Solbec Copper Mines, Ltd., in the Aylmer Lake district of the Eastern Townships, was about 131,600 ounces higher than in 1963.

Lake Dufault Mines, Limited, with its mine located about 10 miles north of Noranda, also contributed to Quebec's increased output. The mine and milling plant reached full production by October 1, 1964, following a 2-month tune-up period. The mill has a rated capacity of 1,300 tons per day. Ore reserves have been estimated at 2,189,500 tons grading 3.9 per cent copper, 7.0 per cent zinc, 2.0 ounces of silver and 0.03 ounce of gold per ton. During the period October 1 to December 31, 1964, silver production amounted to 192,704 ounces.

Because of the lower silver content of the zinc-silver-lead ore milled by The Coniagas Mines, Limited, in the Bachelor Lake district its silver output in 1964 was considerably lower than that of the previous year.

NEW BRUNSWICK

A significant development in New Brunswick was the commencement of tune-up operations in March 1964 at the major zinc-lead-copper-silver property of Brunswick Mining and Smelting Corporation Limited near Bathurst. The mill, which began regular operations on July 1, was originally designed to treat 3,000 tons daily and later expanded to a rated capacity of 4,500 tons a day. Proven ore reserves in the main No. 12 orebody at the start of production were 22,095,000 tons above the 1,475-foot level grading approximately 9.69 per cent zinc, 3.77 per cent lead, 0.29 per cent copper and 2.46 ounces of silver per ton. Plans were announced for bringing the No. 6 orebody, about 5 miles south of the No. 12, into production; ore reserves there were estimated at 27 million tons, of which 11.3 million tons, containing 2.1 ounces of silver per ton, are available for open-pit mining. A new 2,250-ton-a-day concentrator is planned, to process ore from the No. 6 mine. During the period July 1 to December 31, 1964, the Brunswick mill treated 777,902 tons of base-metal ore averaging 2.6 ounces of silver per ton.

Byproduct silver output from the base-metal mine of Heath Steele Mines Limited, about 32 miles northwest of Newcastle, was somewhat higher in 1964 than the previous year because of greater tonnage and slightly higher silver content of ore milled.

The Sullivan group of companies plans to bring into production, late in 1966, the lead-zinc-copper-silver deposit, 15 miles northwest of Bathurst, of an associated company – Nigadoo River Mines Limited. Construction of a 1,000-ton-a-day concentrator is expected to commence in the spring of 1966; ore reserves are reported to contain 4.36 ounces of silver a ton.

NOVA SCOTIA

Magnet Cove Barium Corporation continued mining its silver-lead-zinc-copper orebody which underlies its barite orebody at Walton. It remained the only source of silver in the province. Other companies have shown increasing interest in the Walton district and in other areas of favourable geological conditions which include the Salmon River, Loch Lomond, and Coxheath areas of Cape Breton Island. No major discoveries of silver-bearing ores were reported to the end of 1964.

USES

Silver's greatest single use continues to be in the manufacture of coinage. This is chiefly because it has an intrinsic value, and an attractive colour and appearance; it also strongly resists corrosion and has good alloying properties. Also attributable to these properties, as well as to its high malleability, ductility and ability to take a fine finish, is its use in jewelry, sterling and plated silverware, and as a decorative material. On account of the sensitivity to light and the ease of reduction of certain silver compounds (all of which are made from silver nitrate), silver is required by the manufacturers of photographic films and sensitized paper. The photographic industry has grown to giant proportions, embracing the commercial, amateur, and motion-picture field and, accordingly, is demanding increasing quantities of silver.

The low melting point of silver-copper and silver-copper-zinc alloys, their resistance to corrosion, their high tensile strength and ability to join together nearly all nonferrous metals and alloys as well as iron and silver, make silver an important constituent of soldering alloys. These solders are used widely in the manufacture of refrigeration, air-conditioning and automotive equipment, and electrical appliances. Silver is also becoming more of an exotic metal and is employed to an increasing extent for high-temperature applications in space and scientific defence systems, such as the silver-infiltrated tungsten components in nozzle assemblies of rockets propelled by solid fuels. Silver-zinc and silver-cadmium batteries, which are rechargeable and provide good output, long life and economy, are finding increased application for portable equipment. These batteries are also used in jet aircraft, missiles, satellites and space capsules where dependability is of prime importance. Other expanding uses of silver are in the manufacture of synthetic organic chemicals in which silver's catalytic effect is important.

If future tests prove successful a relatively new market could be opened up for silver in the form of silver iodide for weather control. Research work to date has shown that silver iodide crystals convert supercooled water vapour to ice crystals in a hurricane, which in turn alters the temperature and wind in a storm, thus tending to dissipate the hurricane.

PRICES

The Canadian price of silver fluctuated within a narrow range throughout 1964, reaching a high of $1.4050 per troy ounce on both May 1 and July 10 and dropping to a low of $1.3800 on September 8. At the beginning of the year the price was $1.4020 and at the end of December it was $1.3930.

TARIFFS

	British Preferential	Most Favoured Nation	General
Silver ores and concentrates	free	free	free
Silver anodes	5% ad val	7½% ad val	10% ad val
Silver in ingots, blocks, bars, drops, sheets, or plates, unmanufactured; silver sweepings, silver scrap	free	free	free
Manufactures of silver, not otherwise provided for	17½% ad val	27½% ad val	45% ad val

WORLD REVIEW

PRODUCTION, CONSUMPTION AND PRICES

Free World silver production during the past three years has shown only a slightly increasing trend, rising from 205.7 million troy ounces in 1962 to approximately 215.0 million ounces in 1964. On the other hand, total Free World consumption for both industrial and coinage uses, excluding requirements for U.S. coinage which are supplied from Treasury stocks, was more than 90 million

TABLE 4

United States Silver Consumption, by End Use – 1960, 1963 and 1964*
(thousands of troy ounces)

End Use	1960	1963	1964
Batteries	3,500	6,200	9,000
Brazing alloys and solders	10,500	13,000	15,750
Dental and medical	4,800	5,100	5,200
Electrical contacts and other electrical uses, electronic components	19,500	26,000	30,275
Mirrors	3,000	3,100	3,100
Missiles		200	1,000
Photographic film, plates and sensitized photographic paper	31,700	33,300	40,300
Silverware and jewelry	29,000	12,000	22,500
Miscellaneous		1,100	
Total industrial use	102,000	110,000**	127,125
Coinage	46,000	111,500	203,000

Source: UNITED STATES CONGRESSIONAL RECORD – Senate, April 23, 1965, p. 8069.
*Total U.S. industrial and coinage uses in 1965 were forecast in the source reference at 135,325,000 and 235,000,000 ounces, respectively. **Figures in column total 100,000.

ounces higher than production in 1962 and 1963. Free World consumption in 1964, as defined above, and estimated at 347.4 million ounces, was more than 130 million ounces higher than production, thus considerably widening the gap between production and consumption.

98115—37½

United States production of silver has remained relatively constant during the past five years, including 1964 when its new production amounted to about 36.0 million ounces. In 1964, its consumption for industrial uses and coinage has been estimated by Handy and Harman* at 123.0 and 203.0 million ounces, respectively. The large deficit was met by imports and withdrawals from U.S. Treasury stocks; the latter continued to provide for all U.S. coinage requirements. Silver for nonmonetary or industrial uses continued to be made available from the Treasury, at the statutory price of $1.2929 a troy ounce, under the terms of legislation enacted on June 4, 1963, and which repealed all then outstanding silver purchase acts. Treasury reserves at the beginning of 1964 were about 1.58 billion ounces; by the year's end they had dropped to approximately 1.22 billion ounces, a reduction of 360,000,000 ounces.

In view of the critical silver shortage, legislation was enacted in the U.S. Congress in the last quarter of 1964 authorizing the Treasury to make a full-scale study of the silver situation and especially the problems involved in maintaining the silver content of most U.S. coins. This report was not available at year's end.

MINE PRODUCTION

On a mine-production basis, Mexico led the world for the forty-sixth consecutive year; estimated output was 41.0 million ounces. The three next largest producers in declining order of production were Peru, the United States and

TABLE 5

World Production of Silver, 1963

(troy ounces)

Mexico	42,760,487
United States	35,000,000*
Peru	36,447,110
Canada	29,927,723
Russia	27,000,000e
Australia	18,900,000
Japan	8,786,798
Other countries	49,877,882
Total	248,700,000

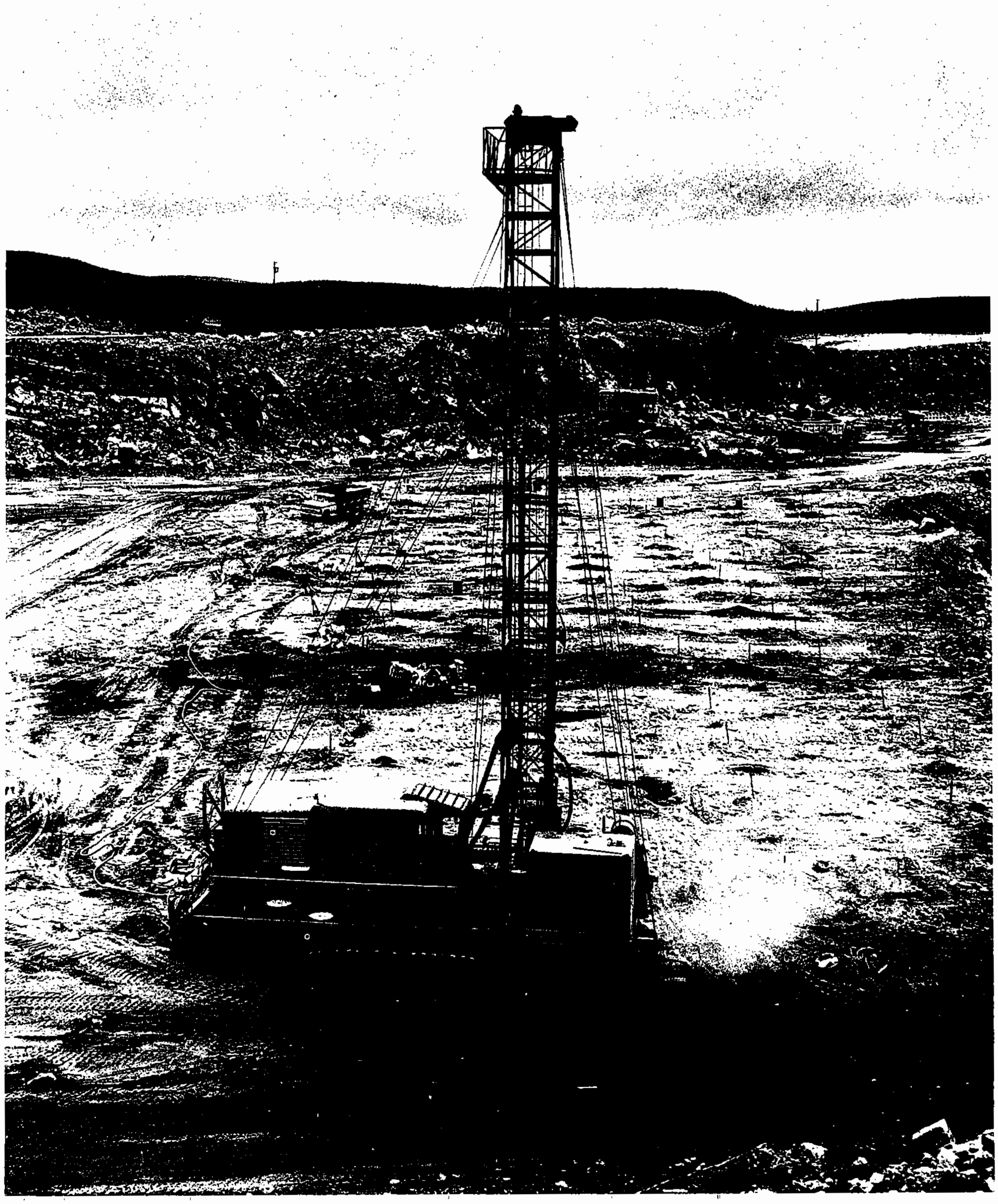
Source: U.S. Bureau of Mines MINERALS YEARBOOK, 1963.*Refinery production from domestic ores and concentrates; mine production was 35,243,000 ounces.

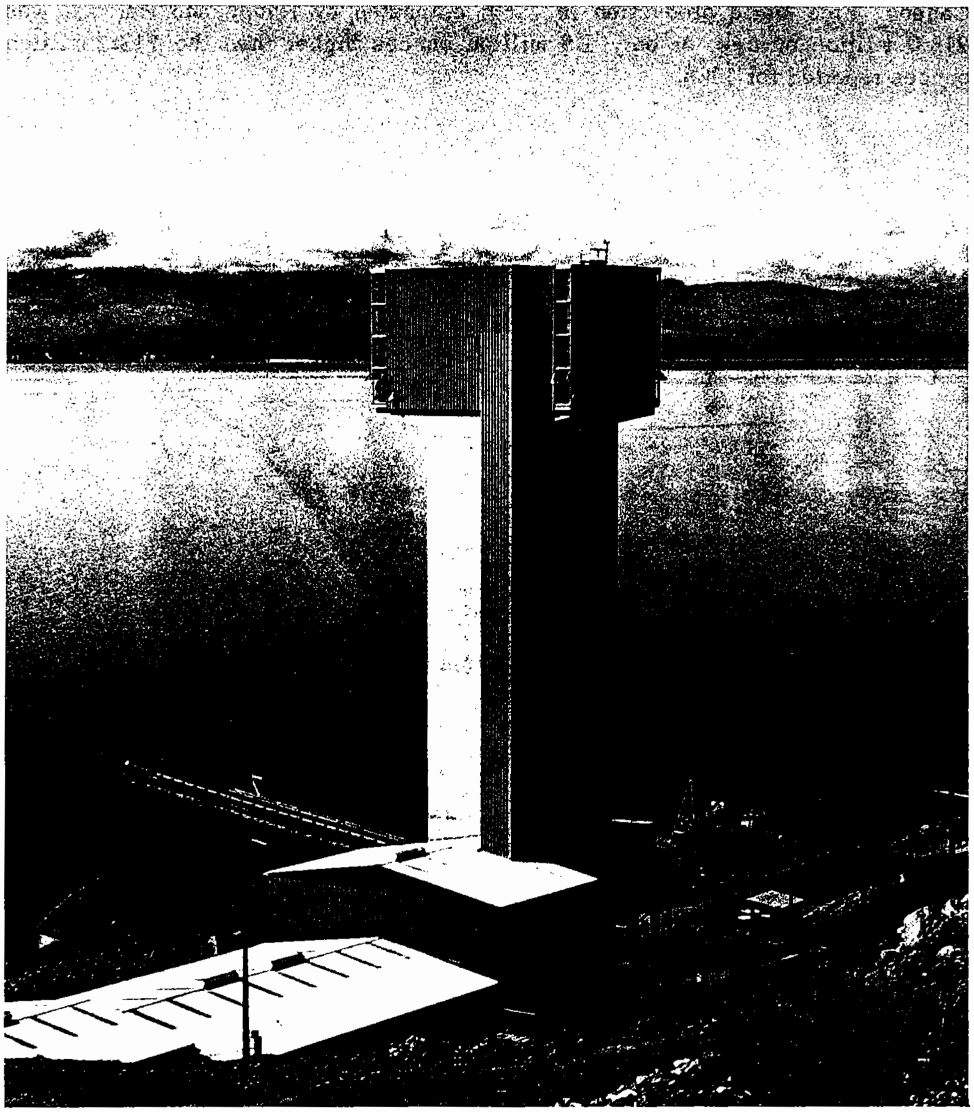
e Estimated.

*THE SILVER MARKET IN 1964 compiled by Handy and Harman, a large United States silver consumer.

Canada. Free World production in 1964, estimated by Handy and Harman, was 215.0 million ounces, or only 1.9 million ounces higher than the 213.1 million ounces reported for 1963.

Quebec Cartier Mining Co., Gagnon. Rotary drill on one of the benches in the open-pit mine.





The newly completed headframe at Texada Mines Ltd.

Sodium Sulphate

C.M. BARTLEY*

Production of sodium sulphate (salt cake) in Canada increased abruptly in 1964, rising from 250,000 tons in 1963 to a new high of 330,000 tons. Imports were higher than in 1963 but only slightly higher than the past 10-year average of 30,000 tons. Consumption and exports increased sharply to new highs.

Increased demands for kraft paper in Canada, and also in the United States, were directly responsible for the larger output, consumption and trade. Continuing high rates of activity in the pulp and paper industries indicate heavy demands for sodium sulphate in 1965 and expansion of kraft pulp capacity, particularly in western Canada, point to even higher demands for sodium sulphate in the future.

The industry in Canada appears to be approaching the point at which expansion of productive capacity will be necessary but decisions on this are complicated by the development of pulping processes which threaten to replace sodium sulphate with other materials to achieve lower processing costs. Trends in the next few years will be followed with interest by the pulp industry and by producers of sodium sulphate.

PRODUCTION AND TRADE

Production of sodium sulphate at five plants in Saskatchewan totalled 330;178 tons, valued at $5,328,220 – 28 per cent above that of 1963. Imports, at 30,834 tons, were at a normal level. Exports totalled 107,318 tons, 41 per cent above that of 1963 and an all-time high. Apparent consumption, at 250,000 tons, also set a new record.

The major part of Canadian production is supplied by four companies operating five plants at lakes in southern Saskatchewan. A minor part of total output is produced as a byproduct at one plant at Cornwall, Ontario. Imports, mainly of byproduct sodium sulphate from Europe, serve a considerable part of

*Mineral Processing Division, Mines Branch

TABLE 1

Sodium Sulphate – Production, Trade and Consumption

	1963		1964p	
	Short Tons	$	Short Tons	$
Production, shipments	256,914	4,121,114	330,178	5,328,220
Imports*				
Total crude salt cake and Glauber's Salt				
United States	13,009	272,056	21,511	400,000
United Kingdom	6,058	130,381	8,861	187,000
West Germany	340	11,780	371	10,000
Netherlands	–	–	69	2,000
Poland	–	–	22	1,000
Total	19,497	414,217	30,834	600,000
Exports				
Crude sodium sulphate				
United States	65,348	1,076,969	107,318	1,776,186
Consumption				
Pulp and paper	204,787			
Glass, including glass wool	2,866			
Soaps	4,172			
Other products	10,176			
Total	222,001			

Source: Dominion Bureau of Statistics.
*Separate classes for imports of crude salt cake and Glauber's salt are not available in 1964 due to changes in statistical classification.
Symbols: p Preliminary; – Nil.

the market in the Atlantic provinces because land freight costs make it difficult for Saskatchewan producers to compete in this area. Similarly, imports from the United States serve some markets in British Columbia although Saskatchewan material can usually compete.

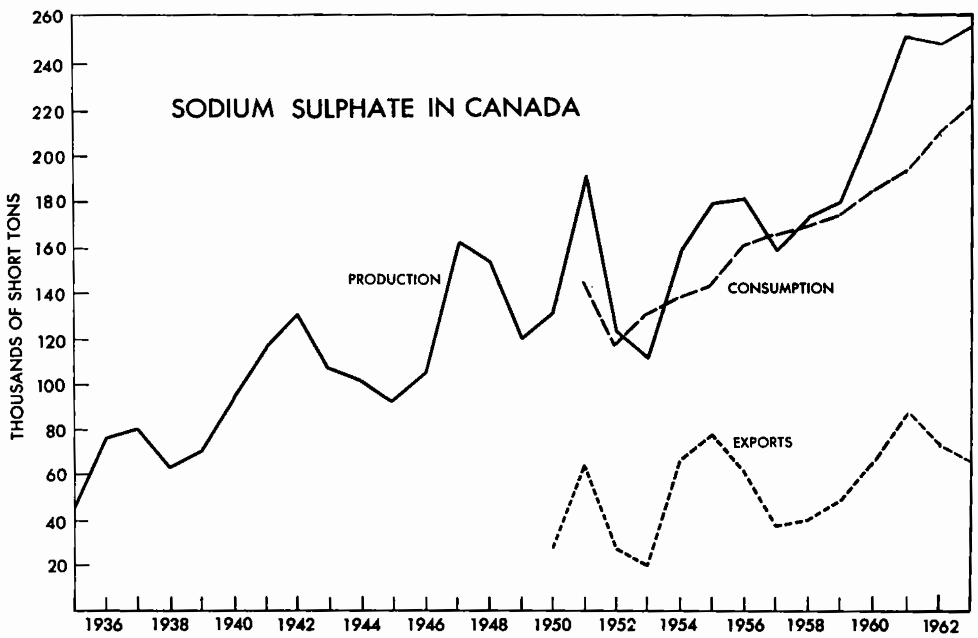
Canadian exports of sodium sulphate have been entirely to the United States and over the past 10 years have varied from 39,000 to 107,000 tons. Generally about two thirds of Canadian production is consumed in Canada and one third is exported to the United States. Canadian exports rise when demand in the United States tends to exceed United States sources of natural and byproduct supply.

TABLE 2

Sodium Sulphate – Production, Trade and Consumption, 1955-64

	Production*	Imports		Exports	Consumption
		Salt Cake	Glauber's Salt		
1955	178,888	29,927	3,888	76,894	142,055
1956	181,053	30,319	2,768	60,579	161,273
1957	157,800	28,088	1,512	37,023	163,743
1958	173,217	25,813	1,217	39,763	168,067
1959	179,535	27,157	966	47,922	171,634
1960	214,208	24,706	1,151	63,831	183,062
1961	250,996	32,310	899	87,048	200,096
1962	246,672	31,347	426	74,049	210,691
1963	256,914	19,002	495	65,348	222,001
1964p	330,178	30,834**		107,318	..

Source: Dominion Bureau of Statistics except where otherwise indicated.
*Producers' shipments of crude sodium sulphate. **Not separately available, commencing in 1964.
Symbols: p Preliminary; .. Not available.



In past years occasional inquiries regarding Canadian sources of sodium sulphate have been received from overseas countries but combined land and ocean freight charges have been obstacles to overseas exports. In 1964 renewed inquiry indicates rising demand in foreign countries and suggests the possibility of future exports to countries bordering the Pacific Ocean.

DEPOSITS

Sodium sulphate is found in many lakes and ponds of southern Saskatchewan in the form of permanent or intermittent crystal beds and the brines which cover them. Sulphates in the soil are dissolved by the water from rain and snow and the solutions accumulate in closed drainage basins. Summer evaporation reduces the water content of the brine and the solution becomes more concentrated. In the fall and winter the brine chills to the point of crystallization, and a bed of crystals is deposited at the bottom of the lake. 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 in nature as Glauber's salt or mirabilite (Na_2SO_4, $10H_2O$) and occasionally as thenardite (Na_2SO_4) or anhydrous sodium sulphate. Both minerals are soluble in water and solubility increases as the temperature rises. The fact that solubility varies with temperatures 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 millions tons. Fifteen deposits have been estimated to contain at least 1 million tons each. Similar though 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 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 using 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 the 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.

PRODUCING COMPANIES

Table 3 lists four producing companies that operate five plants in Saskatchewan with a combined annual capacity of about 400,000 tons. Courtaulds (Canada) Limited, at Cornwall, Ontario, produces a few thousand tons of by-product salt cake annually.

Late in 1963 the plant of Sybouts Sodium Sulphate Co., Ltd., at Gladmar, was destroyed by fire. Construction of a new plant was started soon after and production at normal rates is reported in 1964.

TABLE 3

Sodium Sulphate – Principal Data Concerning Producers

Company	Plant Location	Source Lake	Reported Annual Capacity (short tons)
Midwest Chemicals Limited	Palo	Whiteshore	100,000
Ormiston Mining and Smelting Co. Ltd.	Ormiston	Horseshoe	75,000
Sybouts Sodium Sulphate Co., Ltd	Gladmar	East Coteau	30,000
Saskatchewan Minerals, Sodium Sulphate Division	Chaplin	Chaplin	150,000
	Bishopric	Frederick	50,000

INDUSTRY ACTIVITIES AND OUTLOOK

A comprehensive investigation of Saskatchewan sodium sulphate occurrences by L.H. Cole of Mines Branch, Ottawa, from 1921 to 1924 provided the basic information for present operations. This general exploration and technical study was followed by detailed exploration and process development at various locations. The industry has been aware of the continued increase in the use of kraft pulp and in recent years various industry and government organizations have conducted exploration on unworked deposits and sponsored research directed to the more efficient operation of present processes or the development of new ones to suit particular occurrences.

Production of sodium sulphate in 1964 appears to be close to the nominal capacity of the present plants. The effect that unfavourable weather might have on the harvest of crystals in any one year has been considered and all the companies maintain considerable stock piles of raw crystals at the plants to insure some supply. However, any extended period of unfavourable weather, when demand is increasing, might restrict output from some of the plants. For these reasons exploration and process development have been carried out in preparation for industry expansion.

At some lakes, reserves and brine conditions are such that additional processing capacity at present plants would assure increased production. At other deposits, one or more dry years might reduce the brine volume and seriously restrict the output of the plant. To maintain and expand production under such circumstances it might be necessary to develop one of the untapped deposits and construct a new processing plant.

The decision to expand sodium sulphate production capacity has been complicated by the recent announcement of a pulping process which eliminates the need for sodium sulphate. The Rapson process, developed by Dr. Howard Rapson of the University of Toronto and Electric Reduction Company of Canada, Ltd., uses sulphur, salt and limestone to produce the chemicals, including sodium sulphate, required for the process. The process is reported to permit significant cost savings and closer control of processing efficiency but it is too early to judge its acceptance by the pulp industry.

In Alberta, Western Minerals Ltd. has investigated the potential of the Metiskow sodium sulphate deposit but no decision regarding development has been announced.

In general the outlook for the Canadian sodium sulphate industry is favourable. Demands for kraft paper are increasing in Canada and the United States and production will have to be increased to satisfy requirements. Other consumer markets, though presently minor, show some increase.

The possibility of combining sodium sulphate in the form of brine or solid with potassium chloride, which is now in large-scale production in Saskatchewan, to produce potassium sulphate fertilizer has been considered. Several methods have been investigated and production of this type of fertilizer is expected in the next few years.

USES AND SPECIFICATIONS

More than 95 per cent of the 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 the production of 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

CANADA

The Canadian price of sodium sulphate (salt cake) bulk, carload, f.o.b. works as reported by CANADIAN CHEMICAL PROCESSING in October 1964 was $16.50 a ton.

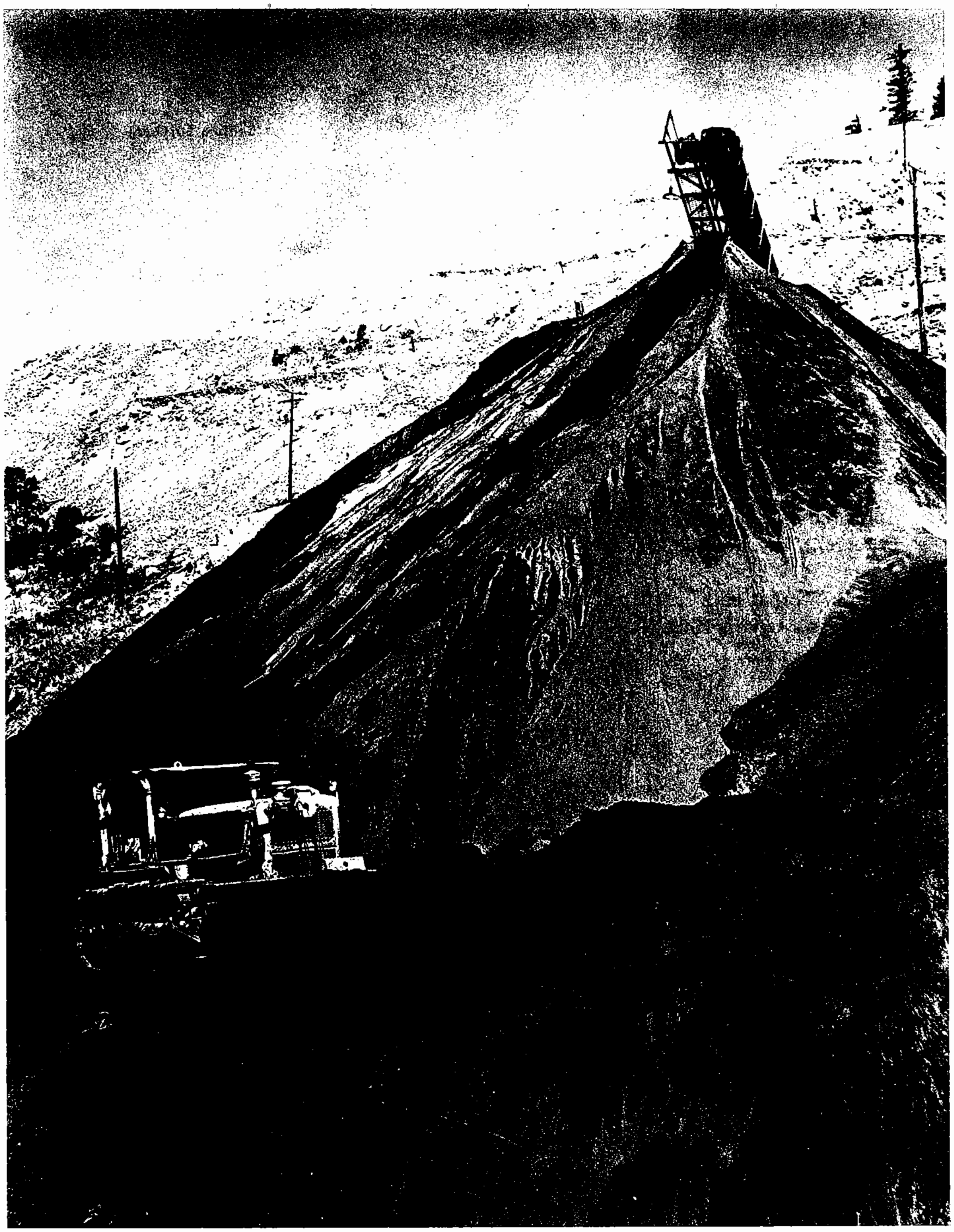
UNITED STATES

According to the OIL, PAINT AND DRUG REPORTER of December 28, 1964, United States prices of sodium sulphate were:

	(per short ton)
Anhydrous, technical-grade, bags, car lots	$56
Detergent, rayon-grade, car lots	
bags	38
f.o.b. works, bulk	34
Crude (salt cake), 100% Na_2SO_4, domestic, bulk, f.o.b. works	28

TARIFFS

	British Preferential	Most Favoured Nation	General
CANADA			
Crude (salt cake), per lb.	1/5¢	1/5¢	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		



Texada Mines Ltd. Stockpiles of processed iron ore awaiting shipment.

Stone, Building and Ornamental

F.E. HANES*

The estimated value** of stone produced in Canada in 1964 was $7,277,000, an increase of almost 6 per cent over the final 1963 value of $6,866,689, which is 9 per cent higher than the value estimated at the beginning of 1963. The estimated** volume of stone produced in Canada in 1964 was 197,250 short tons, an increase of 1.1 per cent over the 1963 volume of 195,098 short tons. This final 1963 volume is an increase of 14 per cent over the 1963 estimated volume of 171,000 short tons.

Final 1963 figures showed the estimates for the year 1963 to be conservative. The value and volume of granite production in the final figures were 20.5 and 72.9 per cent higher than their earlier estimates; similarly, limestone was 17.4 and 11.6 per cent higher, respectively.

The stone products of reference reported in this annual review include building, monumental and ornamental dimension stone and rough blocks, and, in addition, flagstones, curbstones and paving blocks. Estimates of the production of these articles in 1964 were obtained by projecting the share per cent of construction stones against total stone production as given in the STONE QUARRIES REPORT (DBS). The percentage values derived in this manner amounted to 8.7 and 0.31 for value and volume, respectively, and are applicable during a year when the country continues developing under an expanding economy.

Such preliminary estimates are satisfactory for the Canadian total production; they are of no value for provincial estimates because of fluctuations in volume

* Mineral Processing Division, Mines Branch

** Estimates calculated on 1962 total stone statistics (DBS) – STONE QUARRIES REPORT No. 26-217 Annual and 1963 final total stone statistics.

TABLE 1

Canadian Production of Building and Ornamental Stone, 1963 and 1964

	1963		1964p	
	Short Tons	$	Short Tons	$
Granite.................	86,425	3,851,019	87,300	4,090,000
Limestone..............	68,079	2,263,558	68,850	2,390,000
Marble..................	2,561	38,827	2,585	41,200
Sandstone..............	38,033	713,285	38,500	756,000
Total................	195,098	6,866,689	197,250	7,277,000

p: Preliminary estimate.

TABLE 2

Canadian Production of Building and Ornamental Stone, by Areas, 1963 and 1964

	1963		1964p	
	Short Tons	$	Short Tons	$
Atlantic Provinces.........	4,509	302,663	4,560	320,000
Quebec....................	99,456	4,370,085	100,600	4,630,000
Ontario....................	71,087	1,171,830	71,820	1,240,000
Western Provinces.........	20,046	1,022,111	20,270	1,087,000
Total..................	195,098	6,866,689	197,250	7,277,000

p: Preliminary estimate.

and value from province to province. However, direct comparison with 1963 production by province or area probably supplies a preliminary estimate of reasonable value for the purpose.

Growth in the construction industry means continued expansion in the stone industry. Volume and value increases have been reported for clay products and for the cement and lime industries. Sand and gravel is relatively unchanged with a very slight volume decrease and a very slight value increase. The total value in 1964 for this group is 5.7 per cent greater than the 1963 value.

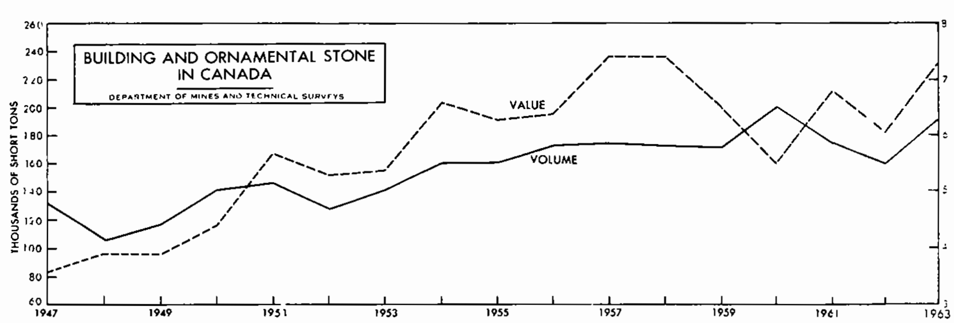


TABLE 3

Production of Building and Ornamental Stone, 1963

	Granite		Limestone		Marble		Sandstone		Total	
	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$	Short Tons	$
By Type										
Building										
Rough...........	28,429	590,468	27,368	416,237	2,361	28,827	29,321	498,149	87,479	1,533,681
Dressed.........	25,095	1,676,608	35,712	1,815,879	–	–	2,491	140,415	63,298	3,632,902
Total	53,524	2,267,076	63,080	2,232,116	2,361	28,827	31,812	638,564	150,777	5,166,583
Monumental										
Rough...........	19,516	613,221	–	–	200	10,000	–	–	19,716	623,221
Dressed.........	6,993	821,282	–	–	–	–	743	10,815	7,736	832,097
Total	26,509	1,434,503	–	–	200	10,000	743	10,815	27,452	1,455,318
Flagstone	787	11,018	4,999	31,442	–	–	5,478	63,906	11,264	106,366
Curbstone..........	5,605	138,422	–	–	–	–	–	–	5,605	138,422
Paving............	–	–	–	–	–	–	–	–	–	–
Total	6,392	149,440	4,999	31,442	–	–	5,478	63,906	16,869	244,788
Grand total	86,425	3,851,019	68,079	2,263,558	2,561	38,827	38,033	713,285	195,098	6,866,689
By Areas										
Atlantic provinces ..	891	155,095	786	3,530	–	–	2,832	144,038	4,509	302,663
Quebec............	72,819	3,360,149	21,064	953,260	1,198	19,302	4,375	37,374	99,456	4,370,085
Ontario............	3,315	47,775	35,900	579,203	1,363	19,525	30,509	525,327	71,087	1,171,830
Western provinces ..	9,400	288,000	10,329	727,565	–	–	317	6,546	20,046	1,022,111
Total, Canada..	86,425	3,851,019	68,079	2,263,558	2,561	38,827	38,033	713,285	195,098	6,866,689

– Nil.

Construction in Canada during 1964 increased in value and volume compared with 1963 by 12.1 and 8.3 per cent, respectively, resulting in a record $8.6 billion. Increased construction brings with it an increased demand for all types of materials required for its expansion. Continued development in construction is expected in 1965 and is estimated to reach a total of $9.8 billion*.

The stone industry has kept pace with the expansion of construction by modernizing its quarrying and dressing plant operations and by upgrading its product by increased quality control measures. By utilizing waste materials, operators of stone quarries have created market outlets for greater economic exploitation of their deposits. Such additional materials as crushed stone aggregates for road and concrete use, fines resulting from crushing operations for use as additives and fillers in asphalt and concrete mixes, artificial stone manufacture and other applications are examples of this exploitation.

Granite was the most popular stone produced in Canada in 1964. Its production amounted to 44.2 per cent of the total volume and 56.2 per cent of the total value. Limestone production was second to granite with 35 and 33 per cent, respectively, of the total production and value. Twenty per cent of the total volume was sandstone which amounted to 10 per cent of the Canadian total stone value. Marble production with 1.3 per cent of the total volume was credited with only 0.6 per cent of the total value.

Quebec was the major producer of stone in 1964 with 51 per cent of the volume and 63.6 per cent of the value of the total Canadian product. Ontario, the second important producer, accounted for 36.4 and 17.0 per cent, respectively, of the totals. The western provinces with 10.3 and 15.0 per cent and the Atlantic provinces with 2.3 and 4.4 per cent, respectively, made up the remaining production.

IMPORTS AND EXPORTS

Canada's total import of building and ornamental stone amounted to $3,436,560, an increase of almost $138,000 or 4.2 per cent in 1964 compared with 1963. The imported stone product, in value, amounts to 47.2 per cent of the Canadian stone production. The largest share of the import value is accounted for by marble, essentially shaped or dressed. The value of marble imports amounts to 52.5 per cent of the total imported value. Imported granite amounting to $784,247 compared with our own Canadian product valued at $4,090,000, amounts to 19.2 per cent.

Canada exported $1,184,030 worth of stone in rough and basic products, an increase of $313,891 or 36.1 per cent over the 1963 value.

* Dominion Bureau of Statistics, *Construction in Canada* 1963-65 Catalogue No. 64-201, Annual.

TABLE 4

Building and Ornamental Stone, Imports and Exports

	1963		1964p	
	Short Tons	$	Short Tons	$
Imports[1]				
Granite				
Rough		521,853	13,148	565,543
Shaped or dressed		135,768		218,704
Manufactures		300,159		*
Total		957,780		784,247
Marble				
Rough		125,276	2,429	176,313
Shaped or dressed		1,019,945		1,627,299
Ornamental for churches		174,446		*
Other manufactures		189,019		*
Total		1,508,686		1,803,612
Slate				
Natural stone basic products, n.e.s.		14,530		372,607
Manufactures		237,392		*
Total		251,922		372,607
Building stone, rough, n.e.s.	18,619	580,438	17,610	476,094
Total building and ornamental stone		3,298,826		3,436,560
Exports				
Building stone, rough[2] (short tons)	23,722	502,432	22,254	499,786
Natural stone, basic products[3]		367,707		684,244
Total		870,139		1,184,030

p Preliminary.
[1]Due to changes in import classification, effective 1964, imports for 1964 as reported are not completely comparable with previous years. [2]Includes building stone, unwrought, and granite and marble, unwrought. [3]Includes all kinds of building stone.
*Comparable classes are not available after 1963.
Source: Dominion Bureau of Statistics.

CANADIAN DEPOSITS OF BUILDING AND ORNAMENTAL STONE

Building stones are used as rough blocks, dimensioned slabs and dressed units to meet specification requirements in all types of building construction. Monumental and ornamental stones are dressed for use in cemeteries, churches and in buildings.

TABLE 5

Sources of Building and Ornamental Stone in Canada

	Granite	Limestone	Marble	Sandstone
Quebec.............	x	x	x	x
Ontario.............	x	x	x	x
Nova Scotia.........	x			x
New Brunswick......	x	x		x
British Columbia	x			
Manitoba	x	x		

GRANITE

Nova Scotia. Grey granite is produced near Halifax, Middleton-Nictaux and Shelburne. 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 located 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 found 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, Stanhope, St.-Samuel-St.-Sebastien and St.-Gerard. Fine- and medium-grained, dark grey-blue essexite is quarried on Mount-St.-Gregoire. A coarse-grained, dark green nordmarkite is available from the Lake Megantic mountain area. A fine-grained, apple-green granite is also produced near St.-Gerard.

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-gray, deeper pink-grey, dark green, black and grey gneissic granites come from the Rivière-à-Pierre district; pink, fine-grained granite is quarried at Guenette, near Mt.-Laurier. St.-Alban supplies 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 located 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 multi-coloured 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 shows good potential.

Manitoba. A durable, red granite of good quality is being quarried in the Lac du Bonnet area, 70 miles northeast of Winnipeg.

British Columbia. A light grey and blue-grey, even-grained granite is 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-Carrières. The stone, besides being used in rough and sawn finishes, takes a good polish and is suitable for decorative use. Rough building stones are produced in small quantities from quarries near Montreal particularly on Ile-Jesus, north of the city. Small amounts of building blocks are quarried at scattered points in the province for local use. A deposit of buff and red sandstone is being quarried in the Trois Pistoles area.

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.

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 varicoloured in light buff, brown and deep brown-red. Medium-grained, buff- to cream-coloured stone near Bells Corners is available. A highly coloured, medium-grained, banded and mottled sandstone is produced from deposits 20 miles north of Kingston.

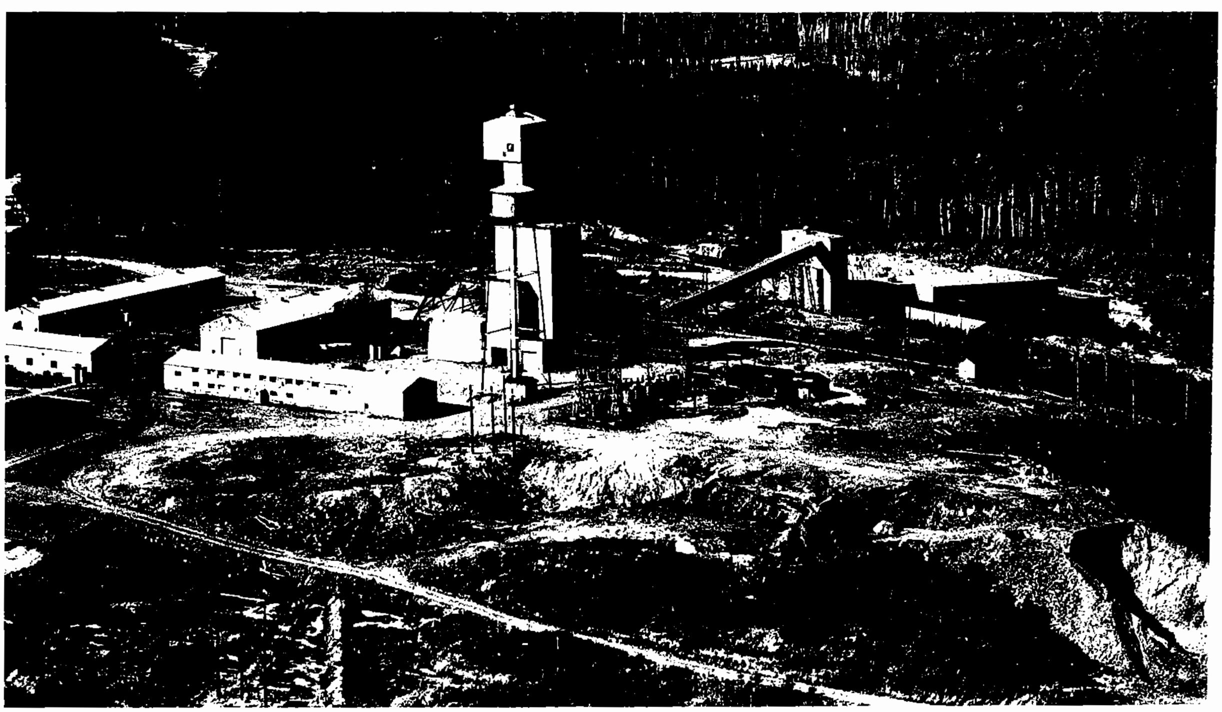
Alberta. A hard, very fine grained, medium-grey sandstone, sometimes referred to as 'rundle stone', is quarried near Banff. It is used as rough building stone.

MARBLE

Quebec. A small quantity of light and dark grey, green-white mottled marble is quarried in the Philipsburgh area, near the United States border south of Montreal. Sporadic quarrying of a white-grey marble is carried on in the western part of the Stukely area. A grey, mottled marble is potentially available from near Marbleton.

Ontario. Production of blue, blue-white, buff, white and grey, recrystallized limestone marbles are 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.

Willroy Mines property.



Sulphur

C.M. BARTLEY*

Canadian sulphur producers during 1964 conformed to the rapidly changing world situation by increasing production, sales, and consumption. Production of elemental sulphur from sour natural gas in western Canada reached a new high of nearly 1.65 million tons and shipments, at more than 1.77 million tons, were made to domestic and foreign markets only by drawing on stockpiles. The sulphur derived from pyrites was lower than in past years but smelter gas sulphur increased substantially and elemental sulphur produced from sulphides and at oil refineries in eastern Canada increased as new plants began to operate.

Canadian sulphur exports to 23 foreign countries increased 56 per cent, and imports were fractionally lower than in 1963. Consumption of sulphur, mainly as sulphuric acid, increased substantially as new plants for fertilizer and other consuming industries came into operation.

Sulphur producing capacity in Alberta was increased by the addition of three new plants in 1964, by adjustments in processing at some existing plants and by large-scale expansion at one plant. These changes contributed in some measure to increased production in 1964 but their full effect will not be realized until 1966. For various reasons production decreased at two plants in Alberta, and the single sulphur producer in Saskatchewan ceased operations.

Industrial activity in sulphur in Canada, a major producer and exporter of sulphur, is closely related to the changing world situation and domestic developments will be influenced by, and react to, world demand and supply. With sulphur in short supply and prices at a long-term high, it is likely that efforts will be made to increase sulphur production from sour gas sources in western Canada. It is expected that renewed interest will be shown in pyrites as a source of equivalent and elemental sulphur, and high-grade processed iron ore. At current

*Mineral Processing Division, Mines Branch

and anticipated sulphur prices several base metal operations in eastern Canada might find it attractive to recover and process pyrites now partially or wholly wasted.

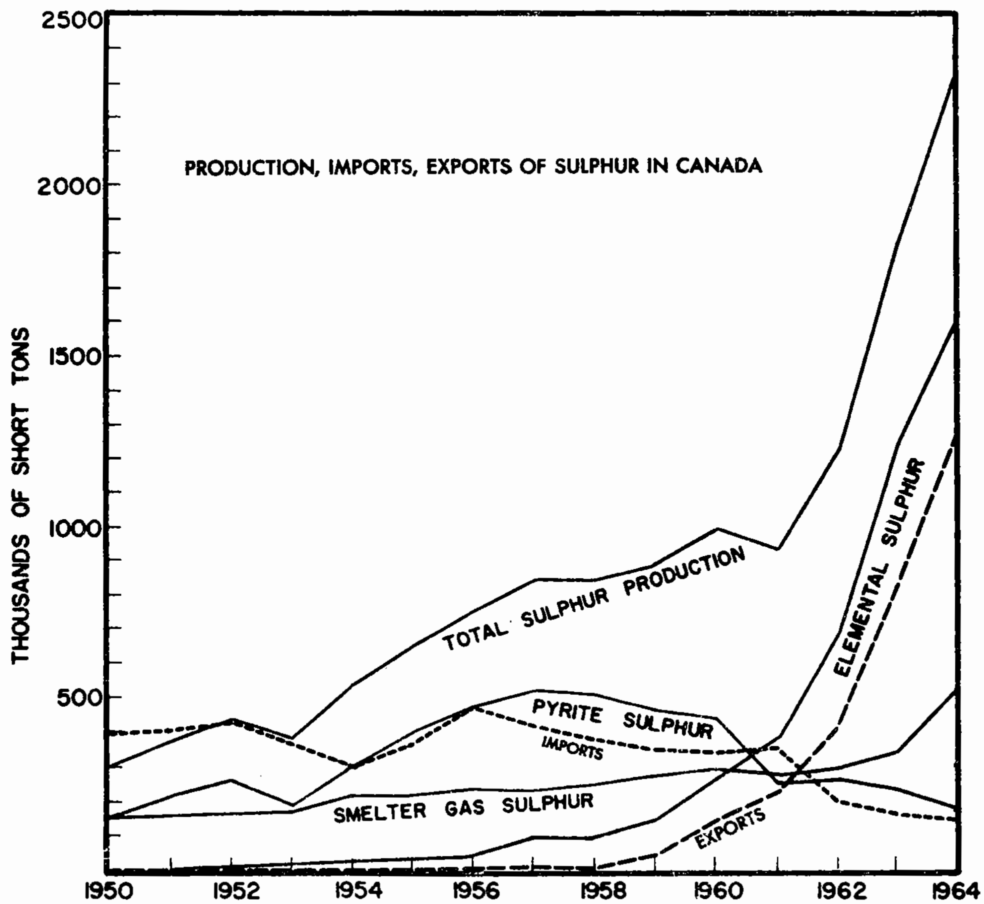


TABLE 1

Sulphur — Production and Trade

	1963		1964p	
	Short Tons	$	Short Tons	$
Production				
Pyrite and pyrrhotite[1]				
Gross weight	476,438		356,349	
Sulphur content	235,410	1,643,629	176,000e	1,128,019
Sulphur in smelter gases[2]	353,243	3,488,181	434,776	4,493,182
Elemental sulphur[3]	1,249,887	13,380,182	1,611,181	15,409,943
Total sulphur content	1,838,540	18,511,992	2,221,957	21,031,144

TABLE 1 (Cont'd.)

	1963		1964p	
	Short Tons	$	Short Tons	$
Imports				
Sulphur, crude or refined				
United States	150,579	3,499,830	149,527	3,470,839
France	58	5,565	40	3,682
Total	150,637	3,505,395	149,567	3,474,521
Exports				
Sulphur in ores (pyrite)				
United States	..	881,506	..	846,570
Britain	..	56,377	..	31,415
West Germany............	—	—	..	560
Total.................	..	937,883	..	878,545
Sulphur, crude and refined				
United States	534,258	7,101,242	633,293	7,986,280
Australia	42,287	730,978	143,761	2,488,843
U.S.S.R.................	59,211	947,376	96,020	1,646,935
Taiwan..................	55,414	915,267	87,335	1,590,792
Italy	—	—	50,045	950,855
New Zealand	14,342	229,472	47,899	734,487
Republic of South Africa ...	31,978	509,348	34,970	577,585
Britain	18,788	280,008	29,678	374,656
Venezuela................	—	—	23,864	387,624
Greece	—	—	23,589	448,191
Pakistan.................	1,375	19,160	17,659	204,953
Poland	—	—	15,445	275,800
Japan....................	18,545	520,458	13,302	422,498
Tunisia	—	—	13,091	248,729
Brazil....................	—	—	12,853	228,176
Lebanon	—	—	11,149	211,831
Netherlands..............	—	—	10,110	203,827
Philippines	2,522	41,795	10,094	178,534
India.....................	36,777	582,786	5,947	101,568
Other Countries	5,432	94,456	14,483	263,497
Total..................	820,929	11,972,346	1,294,587	19,525,661
Consumption				
Elemental sulphur............	525,795		512,417	

Source: Dominion Bureau of Statistics.
[1] Producers' shipments of byproduct pyrite and pyrrhotite from the processing of metallic-sulphide ores. [2] Includes also sulphur in acid made from roasting zinc-sulphide concentrate.
[3] Producers' shipments of elemental sulphur produced from natural gas. Includes a small quantity of elemental sulphur derived from treatment of nickel-sulphide matte at Port Colborne, Ontario.
Symbols: p Preliminary; — Nil; .. Not available.

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PRODUCTION AND TRADE

Canadian production of sulphur from all sources increased appreciably in 1964 to a total of more than 2.33 million tons. Elemental sulphur from western sour gas and other sources, totalled 1.70 million tons and smelter gas, 434,776 tons. The sulphur content of pyrites, at 176,073 tons alone showed a decrease from 1963 figures. Sales of Canadian sulphur (shipments) totalled 2.55 million tons and indicate a substantial reduction of sulphur inventory in western Canada.

At 149,567 tons, sulphur imports were slightly lower than in 1963 and developments in eastern Canada suggest that imports may further decrease in 1965.

During 1964 Canada's exports of sulphur increased 57 per cent to a new high of 1.29 million tons. Shipments were made to 23 foreign countries with the United States receiving about 50 per cent and 11 countries bordering the Pacific Ocean 28 per cent. The change in Canada's position from that of a large

TABLE 2

Sulphur – Production, Trade and Consumption, 1955-64
(short tons and dollars)

	Production				Imports	Exports		Consumption
	In Pyrites Shipped[1]	In Smelter Gases[2]	Elemental Sulphur[3]	Total	Elemental Sulphur	In Pyrite[4]	Other Sulphur[5]	Elemental Sulphur[6]
1955	403,986	224,457	29,093	657,536	373,373	$2,001,575	3,051	393,148
1956	473,605	236,088	33,464	743,157	474,117	$2,649,349	4,331	431,202
1957	515,096	235,123	93,327	843,546	416,930	$2,852,753	12,364	480,941
1958	512,427	241,055	94,377	847,859	375,331	$1,879,251	7,608	515,047
1959	465,611	277,030	145,656	888,297	332,430	$1,018,608	26,526	483,482
1960	437,790	289,620	274,359	1,001,769	328,765	$1,259,151	143,040	507,810
1961	255,376	277,056	394,762	927,194	329,556	$ 899,755	217,866	513,000
1962	257,084	292,728	695,098	1,244,910	195,089	$ 890,055	400,026	523,000
1963	235,410	353,243	1,249,887	1,838,540	150,637	$ 937,883	820,929	526,000
1964p	176,000e	434,776	1,611,181	2,321,957	149,567	$ 878,545	1,294,587	512,000

Source: Dominion Bureau of Statistics.

[1] Sulphur content of pyrite and pyrrhotite shipped by producers. Not necessarily all recovered. For 1955, includes the sulphur content of acid made by roasting zinc-sulphide concentrate at Arvida, Quebec. Pyrite used to make byproduct iron sinter in 1961, 1962 and 1963 not included. [2] Sulphur in liquid sulphur dioxide and sulphuric acid from the smelting of metal-sulphide ores. For 1956 and years following includes sulphur in acid made from roasting zinc-sulphide concentrates. [3] Elemental sulphur produced from natural gas. Production for the period 1955-56 and sales from 1957 on. Starting in 1957 elemental sulphur derived from the treatment of nickel-copper sulphide matte at Port Colborne, Ontario, is included. [4] Exports of pyrite, sulphur content. Quantities for 1955 and following years are not available for publication. [5] Exports of sulphur produced from natural gas and other sources. [6] Consumption of elemental sulphur by industries as reported by consumers.

Symbols: p Preliminary; e Estimate.

importer to a major exporter of sulphur, is doubly important in that exports earn substantial foreign exchange at the same time that foreign expenditures for imported material are reduced. Exports of sulphur in pyrites dropped to a 10-year low at a value of $878,545.

Sulphur consumption in 1964, reported at 512,000 tons, is believed to be low since the production of sulphuric acid and pulp and paper, both major consumers of sulphur, showed increases.

Expansion of sulphur-producing capacity in Alberta during 1964 was under way at two large plants and three new plants were under construction. These additions will add 1,900 tons a day to capacity in 1966 and contribute about 300,000 tons to annual output in 1965 and 700,000 in 1966. Other projects under development and being planned will add to this capacity. In 1964 sulphur plants in western Canada were operated at more than 80 per cent of capacity.

The world-wide sulphur industry has moved from a production surplus, depressed price, highly competitive period to a heavy demand, high price and near shortage period in two years. For several reasons the major producers of elemental sulphur did not expand productive capacity immediately: large stocks of sulphur were available on surface in 1963, and the construction of large volume Frasch sulphur mines takes two or three years and, at 1963 sulphur prices, was not economically attractive. Also, although a balance of sulphur supply and demand was expected by 1967, the increase in consumption which started in mid-1963, was not recognized immediately as a definite long-term trend. Rising demand for sulphur was greeted with relief by major producers who were pleased to reduce their swollen surface stockpiles (7.75 million tons at the start of 1963) at slightly improved prices.

By mid-1964 it had become clear that the rising demand for sulphur was a basic swell in consumer needs related to the world-wide surge in fertilizer expansion and increased chemical industry activity throughout the world. In 1964 Free World sulphur consumption reached a new high of about 22 million tons compared to production of about 21 million tons, and a 10 per cent increase in consumption has been predicted for 1965. In spite of several price increases in 1964 and early 1965 there is only limited ability to increase sulphur production, and surface stocks, reduced by nearly a million tons in 1964, will be further reduced in 1965. At the end of 1964 in the face of a threatened shortage of sulphur, prices had reached a 10-year high and further increases were predicted.

PYRITES – PYRITE, PYRRHOTITE AND OTHER SULPHIDES

In Canada only minor amounts of pyrites are used as a source of sulphur and exports decreased in value from $2.85 million in 1957 to $0.88 million in 1964. Pyrites concentrate is being recovered at several plants (Table 6) and could be produced in large volume at these and several other plants if markets were available.

Pyrites, the earliest source of sulphur in Canada, lost markets to elemental sulphur from 1957 to 1964. During periods of low sulphur prices, higher capital and operating costs make pyrites less attractive as a source of sulphuric acid

TABLE 3

Consumption of Elemental Sulphur in Canada, 1963
(short tons)

Chemicals, miscellaneous	129,318
Paper pulp	294,925
Paper and paper products	4,970
Rubber products	3,125
Fertilizers	50,131
Iron and steel	1,375
Pesticides	1,012
Titanium processing	20,380
Uranium processing	18,525
Other industries	2,034
Total	525,795

except in places where large volumes of material and efficient processing provides credit for iron and other values, or exchange restrictions encourage the use of domestic material. Several operations in Europe illustrate the former, and Japanese use of pyrites the latter.

TABLE 4

Available Data on Consumption of Sulphuric Acid,
by Industries, 1962
(net tons of 100% acid)

Iron and steel mills	58,434
Other iron and steel	11,750
Electrical products	5,026
Vegetable-oil mills	105
Sugar refineries	243
Leather tanneries	2,025
Textile dyeing and finishing plants	48
Pulp and paper mills	42,904
Processing of uranium ore	239,700
Manufacture of mixed fertilizers	237,497
Manufacture of plastics and synthetic resins	22,425
Manufacture of soaps and cleaning compounds	17,514
Other chemical industries	10,680
Manufacture of industrial chemicals[1]	885,238
Petroleum refining	12,847
Mining[2]	46,400
Miscellaneous[3]	65,369
Total accounted for	1,658,205r

Source: Dominion Bureau of Statistics.
[1]Includes consumption of "own make" or "captive" acid by firms classified to these industries. [2]Includes metal mines, nonmetal mines, mineral fuels and structural material. [3]Includes synthetic textiles, explosive ammunition and other petroleum and coal products.
rRevised from previously published figure.

TABLE 5

Sulphuric Acid – Production, Trade and Apparent Consumption, 1955-64
(short tons of 100% acid)

	Production	Imports	Exports	Apparent Consumption
1955	950,277	151	29,578	920,850
1956	1,052,000	2,100	23,660	1,030,440
1957	1,290,000	1,046	29,550	1,261,496
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	1,696,000r	7,162	34,960	1,668,202r
1963	1,902,000	5,634	37,316	1,870,318
1964p	1,960,393	4,209	67,409	1,896,800

Source: Dominion Bureau of Statistics.
Symbols: p Preliminary; r Revised from previously published figure.

Under present conditions of near-shortage and rising sulphur prices, pyrites is again being considered as a source of sulphur, particularly since sulphur demand will continue to rise and probably at a faster rate than in the past. The recent surge in demand for fertilizer has an immediate effect on sulphur consumption because about 30 per cent of the world's annual sulphur consumption is used to produce fertilizers.

TABLE 6

Producers of Pyrite and Pyrrhotite for Sulphur Content

Company	Location	Products	Uses
The Consolidated Mining and Smelting Company of Canada Limited.	Kimberley, B.C.	SO_2 iron ore	H_2SO_4 steel plant
The Anaconda Company (Canada) Ltd.	Britannia Beach, B.C.	pyrite concentrate	sale
Noranda Mines Limited	Noranda, Que.	pyrite concentrate	sale
Quemont Mining Corporation, Limited	Noranda, Que.	pyrite concentrate	sale
Normetal Mining Corporation, Limited	Normetal, Que.	pyrite concentrate	sale

Over the long term world reserves of natural elemental sulphur or present sources of recovered elemental sulphur do not appear adequate. This condition suggests higher sulphur prices, and higher prices in turn will permit the economic use of the sulphur values in pyrites. Both before and since the sulphur shortage of 1950 considerable attention has been given to the development of processes for the production of sulphur, as sulphur dioxide gas or elemental sulphur, and clean concentrates of iron, from pyrites. Recent projects in Europe and India indicate that improved processes are now available and in areas where domestic supplies of elemental sulphur are lacking, or freight from established sources makes purchase too costly, pyrites will probably serve as sources of sulphur and iron. Although generalization is difficult because of widely varying local conditions it would appear that pyrites sources would become attractive when the price of sulphur approaches $35 f.o.b. Gulf ports. The addition of freight and handling charges would increase the consumer cost appreciably.

Several large base metal sulphide mining and processing operations, and others under development, in eastern Canada could contribute substantial amounts of sulphur and appreciable amounts of iron ore if sulphur prices increase enough to justify the cost of such processing plants. The utilization of pyrites (pyrrhotite) by COMINCO at Trail, British Columbia to make sulphuric acid and iron, and a similar operation under construction by Brunswick Mining and Smelting Corporation Limited at Belledune, New Brunswick, are examples which are presently realistic in that sulphur values, as SO_2 gas, can be converted to sulphuric acid and used at the site to manufacture fertilizer. Operations at more remote locations such as Thompson, Manitoba, or Noranda, Quebec might have to convert SO_2 gas to elemental sulphur in order to market it economically.

SMELTER GAS

The steady rise in the recovery of smelter gases for their sulphur content (Table 2) illustrates their efficient use in sulphuric acid production, largely for phosphate fertilizers manufacture. Smelting operations at Arvida, and Valleyfield, Quebec, Copper Cliff and Port Maitland, Ontario, and Trail and Kimberley, British Columbia recover smelter gases for the manufacture of sulphuric acid. Much larger amounts of sulphuric acid could be derived from these and similar sources if markets were available.

In addition to the economic attraction of recovering material of value which might otherwise be wasted, there is increasing pressure to recover sulphur dioxide gas in the interest of reducing air pollution.

ELEMENTAL SULPHUR FROM SULPHIDES

Elemental sulphur is obtained by the electrolytic refining of nickel sulphide matte in the INCO refineries at Port Colborne, Ontario and Thompson, Manitoba.

Using different processes, sulphur was also recovered from pyrite by Noranda Mines Limited, at Port Robinson, Ontario, from 1954 to 1959, and from pyrrhotite by COMINCO at Kimberley from 1936 to 1943. The International Nickel Company of Canada, Limited, and Texas Gulf Sulphur Company operated a pilot plant recovering elemental sulphur from sulphur dioxide gases at Copper Cliff in 1958 to 1959 but the process was not used for commercial production.

SULPHUR FROM OIL REFINERIES

Many crude oils contain sulphur compounds which may be released as hydrogen sulphide during refining and recovered by the same processes used in gas-sulphur plants. Foreign crude oils refined in the Montreal area and near Saint John, New Brunswick supply hydrogen sulphide for sulphur production at the plants of Laurentide Chemicals & Sulphur Ltd. and Irving Refining Limited respectively.

Similar plants have been built in Ontario by Shell Canada Limited at Oakville, by The British American Oil Company Limited at Clarkson, and by Imperial Oil Limited at Sarnia. These eastern Canada plants have a total productive capacity of more than 100,000 tons per year. Output during 1964 was about half this amount.

OTHER SULPHUR

The sulphur in nickel sulphide ore is converted into sulphate by another process at the Fort Saskatchewan, Alberta, refinery of Sherritt Gordon Mines, Limited. An ammonia leach process is used to treat nickel-sulphide concentrates and byproduct ammonium sulphate is recovered. It is estimated that the equivalent of 19,000 tons of sulphur were recovered in this process during 1964.

NATURAL GAS SULPHUR

Canada has become a major sulphur producer indirectly. Exploration for oil in western Canada gradually disclosed large reserves of natural gas, a proportion of which was "sour" (containing hydrogen sulphide). For many years the natural gas had little value because few markets were available in western Canada, and the potential large-scale distant markets in eastern Canada and the United States would require costly pipeline systems. Two conditions had to be satisfied before pipelines could be built to serve these markets. The first was ample reserves of gas to serve both domestic and export markets over a long period of time, and second, the assurance of long-term gas contracts. By 1960 both conditions had been satisfied. Markets for gas had expanded so that sweet gas reserves were largely committed and sour gas reserves had to be used to fulfil the demand.

Before sour gas can be used as fuel, hydrogen sulphide (H_2S) and other sulphur compounds must be removed. Large gas-cleaning plants were built to remove sulphur compounds, excess liquid petroleum gases and inert gases, and to produce a fuel gas of definite specifications. H_2S is removed by passing the sour gas through a solution (usually monoethanolamine) which has an affinity for H_2S. Concentrated H_2S is stripped from the solution by distillation, the H_2S going to the sulphur furnace and the regenerated solution being recirculated. The H_2S is burned in a Claus furnace to produce a mist of sulphur droplets, which are condensed to liquid sulphur, and pumped to storage vats.

Two important facts are implicit in the production of sulphur from sour natural gas: first, the removal of H_2S is obligatory if the gas is to be used as fuel; second, at least two products of value are recovered from the raw gas. This means that the cost of exploration, and production and treatment of raw gas may be shared by several products of which sulphur is only one. A low H_2S content in raw gas may be considered waste, and sulphur derived from this material would be very low in cost because the raw material is free.

Estimated proved reserves of sulphur in sour gas in western Canada at the end of 1964 were reported by the Canadian Petroleum Association as equivalent to 77 million short tons, an increase of 15 million short tons above that of 1963.

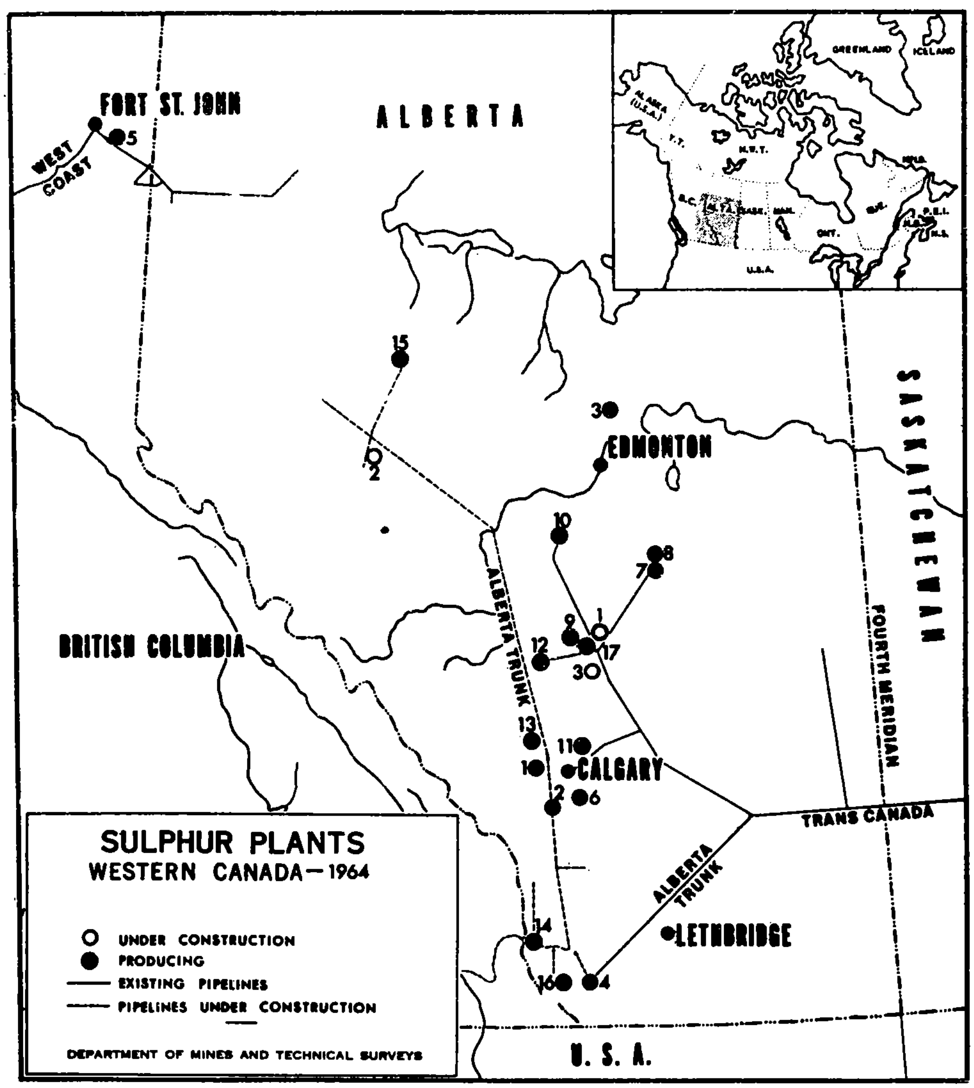

TABLE 7

Sulphur Plants, Western Canada, 1964

Operating Company	Source field	Plant Built	Approximate percentage H_2S	Capacity in Short Tons Daily	Capacity in Short Tons Annual*
Producing plants (numbered on map and indicated by •)					
1 Shell Canada Limited	Jumping Pound, Alta.	1951	4	110	38,000
2 Royalite Oil Company, Limited	Turner Valley, Alta.	1952	4	33	11,500
3 Imperial Oil Limited	Redwater, Alta.	1956	3	10	3,500
4 The British American Oil Company	Pincher Creek, Alta.	1957	10	755	264,000
5 Jefferson Lake Petrochemicals of Canada Ltd.	Taylor Flats, B.C.	1957	3	330	115,000
6 Texas Gulf Sulphur Company	Okotoks, Alta.	1959	35	415	145,000
7 The British American Oil Company	Nevis, Alta.	1959	4-6	85	30,000
8 The California Standard Company	Nevis, Alta.	1959	6	130	45,000
9 Shell Canada Limited	Innisfail, Alta.	1960	14	110	38,000
10 The British American Oil Company	Rimbey, Alta.	1961	2	280	98,000
11 Petrogas Processing Ltd.	East Calgary, Alta.	1961	16	965	337,700
12 Home Oil Company Limited	Carstairs, Alta.	1961	1	56	19,600
13 Canadian Fina Oil Limited	Wildcat Hills, Alta.	1961	4	117	41,000
14 Jefferson Lake Petrochemicals of Canada Ltd.	Coleman, Alta.	1961	14	420	147,000
15 Texas Gulf Sulphur Company**	Windfall, Alta.	1961	15-20	1,290	451,000
16 Shell Canada Limited	Waterton Alta.	1962	22-27	1,550	542,000
17 Amerada Petroleum Corporation	Olds, Alta.	1964	7	120	42,000
Totals				6,776	2,369,000
Plants under construction in 1964 (numbered on map and indicated by o)					
1 Socony Mobil Oil of Canada, Ltd.	Wimborne	1965	16	368	128,000
2 Hudson's Bay Oil and Gas Company Limited	Edson	1966	2	100	35,000
3 Pan American Petroleum Corporation	Crossfield East	will recover sulphur in 1975			
Totals				468	163,000
Grand Total				7,244	2,532,000

Source: Oil and Gas Conservation Board of Alberta and others.

*Calculated on the basis of 350 operating days a year. **Sulphur production owned by Texas Gulf Sulphur Company. Production will increase later to 1,800 tons a day.

Note: In addition, other plants of which details and location are not yet available, will be constructed later. It is expected that these will raise sulphur productive capacity to 2.6 million tons by 1965 and 2.8 million tons or more by 1970.

Experienced engineers have suggested that several times this amount will be found. The current increase in sulphur prices would tend to increase reserves (by making lower grade gases economical) and encourage exploration for sour gas.

During 1964, 18 gas-processing and sulphur recovery plants operated in western Canada, 17 in Alberta and one in British Columbia. A small plant at Steelman in Saskatchewan did not operate in 1964, although some shipments were made. Two new plants started production in Alberta, at Olds and Wimborne. In additon the Texas Gulf Sulphur plant at Windfall completed a 500-ton-a-day expansion. An 800-ton-a-day expansion at Petrogas Processing Ltd., East Calgary, and a new plant at Edson, Alberta, are under construction and will produce in 1965. Early in 1965 a new plant was announced for the Harmattan area. This project is unusual in that it will treat a gas containing 53 per cent H_2S to produce 900 tons of sulphur a day and primarily will be a sulphur producer rather than a gas producer. Several other plants are planned but no firm announcements have been made. In some cases plant construction depends on new contracts to sell gas, and in the case of high sulphur content gas fields, operating processes are not yet decided. Table 7 lists the plants operating and under construction.

During 1964 sulphur plants in western Canada operated at about 80 per cent of total capacity but, since for different reasons several cannot achieve capacity at will, very little further expansion from current facilities is possible. Additional sales of gas would result in expanded sulphur production and there is no doubt that the incentive of increased sulphur prices will encourage the construction of plants for sulphur production from the several high H_2S sources which would not require markets for fuel gas. In both cases, however, new plants would be required and, because construction would take at least a year, only limited expansion of sulphur production can be seen during 1965 and 1966. Available data suggests that capacity will increase possibly 300,000 tons a year during 1965 and 400,000 tons a year in 1966, although the 1966 figure may be increased by new developments starting in 1965.

ATHABASCA OIL SAND SULPHUR

The occurrence of oil-bearing deposits along the Athabasca River in northern Alberta has been known since 1883 and their extent and nature was investigated by S.C. Ells of the Federal Mines Branch 50 years ago. Although the sands contain extremely large quantities of oil and a small but significant percentage of sulphur, their location discouraged early attempts at development.

At present, however, interest in the oil potential of these deposits has been revived and four proposals have been made to the government of Alberta regarding various methods of obtaining oil from them. One project, that of Great Canadian Oil Sands Limited, has been approved and production expected in 1967 will include some 150,000 tons of sulphur a year.

Estimated oil reserves in the sands total more than 300 billion barrels and, at a five per cent by weight basis, sulphur reserves would amount to about one billion tons. Large-scale production of oil from the sands would thus appear to reduce the danger of future sulphur shortages.

SULPHURIC ACID

Sulphuric acid production reached a new high of 1.96 million tons (100% H_2SO_4). Imports declined 25 per cent and exports increased 80 per cent. Although current consumption statistics are not yet available it is clear from activity in the fertilizer and chemical industries that consumption is appreciably higher than in 1963 and a continuing increase in consumption is expected as new fertilizer and other acid-consuming industries now under construction come into operation.

WORLD REVIEW AND OUTLOOK FOR CANADIAN SULPHUR

World production of sulphur in all forms in 1964 is estimated at more than 27.3 million metric tons. Western world production increased about 8 per cent to a new high of some 21.1 metric tons but still fell short of consumption by more than 1 million tons and stockpiles were reduced accordingly. Communist countries apparently consumed more sulphur than they produced as substantial shipments were made by Mexico, Canada and the United States to Communist Bloc countries. On a world-wide basis trade in sulphur has increased almost 50 per cent since 1962. The four major exporters during 1964, in order of amount were, Mexico, United States, Canada and France, and these countries accounted for more than 90 per cent of total sulphur trade. Canadian exports showed the largest percentage increase in 1964.

The main factor in the current rising demand for sulphur is the rapid expansion in fertilizer production on a world-wide basis. In the United States it is estimated that more than 40 per cent of the sulphur consumed is used to produce fertilizer and although the proportion is lower on a world basis it is still the major use. At the same time other demands for sulphur, both for acid and non-acid uses, have increased steadily. The surge in fertilizer demand and the quickened pace of industrial activity throughout the world are not regarded as short-term events but as trends which result from real needs. For this reason it is apparent that sulphur demand will continue to grow and that a considerable effort will be required to expand sulphur production to balance the rising demand. Because high-quality, large-volume sources of sulphur now appear to be limited, in terms of present needs, it is expected that shortages will appear in 1965 and that prices will rise. In early 1965 sulphur supplies were limited and price increases had occurred.

Various estimates of sulphur supply and prices over the next ten years indicate that supplies will be limited and that prices will stabilize at a figure somewhat higher than the long-term average. The new price probably will be determined by its ability to stimulate the sulphur production required by world industry. For nearly 50 years (1905-1955) world sulphur trade has been supplied and dominated by the United States Frasch sulphur industry as the only large source of high purity sulphur at relatively low prices. The average price of sulphur over this period is probably one cent a pound or less. The sulphur shortage

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of 1950-51 indicated two facts in the changing world sulphur picture: one, that the rising scale of world demand and the continued production from the United States Frasch mines had reduced these reserves to the point that they alone could no longer be considered an adequate supply for world-wide needs and, two, that developments in metallurgy, petroleum and natural gas processing had, at present volumes and values, opened the way to high-quality sulphur production at costs competitive with Frasch sulphur. Sulphur produced from sour natural gases and from refinery wastes is a coproduct or byproduct and, therefore, enjoys certain economic advantages in shared production costs. Metallurgical processes now available permit pyrites to be used in some places as a source of high-grade iron ore and sulphur dioxide gas for either direct conversion to sulphuric acid or reduction to elemental sulphur, or both.

Over the past 50 years, world sulphur consumption has increased at a rate of 4 to 5 per cent annually but in the past two years the rate in the Free World has been 6 to 10 per cent. With current Free World consumption at 22 million tons, annual increase is more than 1.5 million tons. Since 1950, present sources of

TABLE 8

Estimated World Production of Sulphur in All Forms[1]
(' 000 metric tons)

Country	1964					1963
	Frasch	Other Elemental	In Pyrites	In Other Forms[2]	Total	Total
United States	5,312	1,002	308	860	7,482	7,162
USSR		1,230	1,900	600	3,730	2,444
Japan		201	1,279	651	2,132	1,998
Canada		1,545[3]	160	411	2,116[3]	1,789
Mexico	1,649	63	—	10	1,722	1,563
France		1,520	82	100	1,702	1,637
Spain		35	1,115	37	1,187	992
Italy		82	620	200	902	961
China		140	504	70	714	699
West Germany		78	188	270	536	527
Poland		304	84	90	478	408
Cyprus			328	—	328	451
Norway			292	—	292	323
East Germany		120	42	110	272	272
Finland		68	91	50	209	242
Other countries		378	1,763	1,432	3,573	4,515
Totals	6,961	6,766	8,756	4,891	27,374	25,983

[1] Main sources British Sulphur Corp. Ltd. and U.S. Bureau of Mines. [2] Sulphur in smelter gas, anhydrite-gypsum, spent oxide, hydrogen-sulphide (other than elemental) and other smaller sources. [3] Total output rather than shipments.

Frasch sulphur in the United States and Mexico, and sour gas and refinery sulphur have not been able to supply this annual increment consistently.

Two sources are available at sulphur prices somewhat higher than the long-term average. These are: additional recovery of sulphur waste gases from smelting and oil refining operations, and the use of pyrites on an expanded scale as a source of sulphur and iron ore. At present in Canada some 434,000 tons of sulphur are being recovered from smelter gases annually. However, it is estimated that at least 5,000 tons of sulphur a day are being wasted to atmosphere – on an annual basis this would total more than 1.75 million tons – more than the sour gas sulphur recovered in 1964. The fact that smelter gas is already a significant source of sulphur does not mean that this source can be expanded immediately or simply. Present recoveries are based on the fact that economics are favourable if there is a use, or markets, for sulphuric acid, at the smelter site. Fertilizer manufacture is an example. However, sulphuric acid is costly to ship and if markets are not available within 200 miles it rarely pays to make acid at smelting plants. This situation existed under past sulphur prices. At present sulphur prices the economics may be open to reconsideration because acid prices will probably increase and also, at current and expected future prices, it may be possible to convert sulphur dioxide gas into elemental sulphur, which can be shipped much greater distances. These possibilities will certainly receive attention if sulphur demand and prices remain at high levels.

A similar situation exists with regard to pyrites as a source of sulphur particularly in eastern Canada. Pyrites have been the original and continuous source of domestic sulphur since 1870 both for indigenous use and export. In the late 1950s the sulphur content of pyrites shipped amounted to more than 500,000 tons. As the price of sulphur fell between 1960 and 1963 pyrites became less attractive and its use declined to 176,000 tons in 1964. However, the developing sulphur shortage and repeated price increases in late 1964 and early 1965 opens some interesting possibilities to pyrites producers. The potential pyrites recovery at existing and developing base metal mining and smelting operations in Canada is very large. At sulphur prices above $35 a ton and considering the value of concurrent iron ore production, these should be attractive sources of income from what has been a waste or low value byproduct. In the past, most Canadian pyrites have been marketed to export markets as a bulk concentrate of low value. The current trends in sulphur demand and supply suggest that on-site processing to produce sulphuric acid (where such can be used) or elemental sulphur and processed iron ore should be given serious consideration. Canadian smelters are served by rail transport and, in eastern Canada at least, are better located to serve sulphur and iron markets than the primary sources of sulphur and iron.

On the basis of developments outlined above, the outlook for sulphur in Canada is highly promising. Present prices provide an adequate incentive for increased output of sour gas sulphur in western Canada, both from the normal gas-coproduct sulphur operations and also from the high H_2S sources. In 1967 Athabasca oil sands production will contribute increasing amounts of sulphur to the supply. Expanding amounts of sulphur dioxide are being obtained from smelter gas sources and this recovery could be greatly enlarged. The re-establishment of pyrites as a major source of Canadian sulphur, together with concurrent iron production, appears to be logical and necessary considering the demand-supply trends in sulphur. The expected pyrite operations would be larger and would involve more sophisticated processing to produce high-quality sulphur and iron products. Plants of this nature are in operation in British Columbia, and in Italy, and under construction in India and New Brunswick.

PRICES

In the last quarter of 1964, the Canadian price of sulphur was quoted in CANADIAN CHEMICAL PROCESSING as follows:

Sulphur, elemental, carloads, works, ton	$17.00

United States prices per long ton quoted by the OIL, PAINT AND DRUG REPORTER of December 30, 1963 were as follows:

Crude, domestic, bright, bulk f.o.b. cars, mines	$23.50
Crude, exports, f.o.b. vessels, Gulf ports	$25.00
Crude, U. S. and Canada, f.o.b. Gulf ports	$25.00
Domestic, dark	$ 1.00 lower
Crude, imported, Mexican, bulk, filtered, f.o.b. vessel Coatzacoalcos	$23.50
Pyrites, Canadian 48-50% S, f.o.b. mines	$ 4.50-5.00

TARIFFS

CANADA

Sulphur, crude, or in roll or flour form	free

UNITED STATES

Sulphur in any form, sulphur ore such as pyrites or sulphide of iron in its natural state	free
Elemental sulphur	free
Sulphuric acid	free
Sulphur dioxide	12.5% ad val
Sulphur compounds	10.5% ad val

Talc and Soapstone; Pyrophyllite

J.E. REEVES*

In 1964, production of talc, soapstone and pyrophyllite was higher than in 1963. Shipments of talc and soapstone from Quebec increased about 6 per cent, talc from Ontario about 14 per cent and pyrophyllite from Newfoundland about 3 per cent.

Whereas Canadian production of talc has shown no long-range upward trend, imports have increased steadily for many years, reaching a level in 1964 – at 32,259 short tons – 17 per cent above imports in 1963. Canada imports comparatively high-quality grades of talc from the United States for use in the paint, ceramics and paper industries and especially high-quality talc from Italy for cosmetic and pharmaceutical uses.

PRODUCERS

QUEBEC

Baker Talc Limited obtains talc and soapstone from its underground mine near South Bolton, about 60 miles southeast of Montreal. The talc is processed at a mill near Highwater, about 10 miles south of the mine, to produce relatively low-grade ground products. Rough and sawn soapstone blocks are sold for sculpturing.

Broughton Soapstone & Quarry Company, Limited, mines talc and soapstone from separate deposits near Broughton Station in the Eastern Townships. The talc is ground to produce several lower-priced grades and the soapstone is sawn into metalworkers' crayons, refractory blocks and blocks for sculpturing.

*Mineral Processing Division, Mines Branch

TABLE 1

Production, Trade and Consumption

	1963		1964p	
	Short Tons	$	Short Tons	$
Production (shipments)				
Talc and soapstone				
Quebec*	15,564	173,147	16,434	193,914
Ontario**	6,903	107,986	7,900	133,000
Total	22,467	281,133	24,334	326,914
Pyrophyllite: Newfoundland	31,783	476,745	32,816	492,240
Imports, talc				
United States	26,339	1,204,275	30,546	1,267,000
Italy	1,194	84,136	1,711	119,000
West Germany	—	—	2	2,000
France	6	433	—	—
Total	27,539	1,288,844	32,259	1,388,000
	1962		1963	
Consumption, ground talc (available data)				
Ceramic products	9,732		11,382	
Paints and wall-joint sealers	8,711		7,931	
Roofing	7,641		6,855	
Paper	3,643		3,639	
Rubber	1,532		1,994	
Insecticides	2,116		1,691	
Toilet preparations	1,560		1,206	
Gypsum products	831		844	
Cleaning compounds	649		782	
Asphalt products	811		655	
Pharmaceutical preparations	238		413	
Leather products	17		26	
Other products	496		1,883	
Total	37,977		39,301	

Source: Dominion Bureau of Statistics.
*Ground talc, soapstone blocks and crayons. **Ground talc.
Symbols: p Preliminary; — Nil.

TABLE 2

Production and Trade, 1955–64

(short tons)

	Production*		Imports	Exports
	Talc and Soapstone	Pyrophyllite	Talc	Talc
1955	27,153	7	11,382	4,428
1956	27,947	1,379	16,268	2,613
1957	29,039	5,686	14,949	2,353
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**
1962	23,367	22,794	24,148	2,300**
1963	22,467	31,783	27,539	2,200**
1964p	24,334	32,816	32,259	2,600**

Source: Dominion Bureau of Statistics.
*Producers' shipments. **Estimated, not available as a separate trade class after 1960.
p Preliminary.

ONTARIO

Canada Talc Industries Limited mines talc from two adjacent underground mines and produces several lower-quality grades of ground talc, at Madoc in southeastern Ontario. During the year an underground development program was initiated to tap a reserve of high-grade flaky talc, which will be shipped in crude form to the United States for processing into cosmetic-grade talc. By year's end 200 feet of shaft deepening had been completed, preparatory to the lateral development.

NEWFOUNDLAND

Newfoundland Minerals Limited mines high-quality pyrophyllite from deposits near Manuels and ships it for processing and use to American Olean Tile Company, Inc., at Lansdale, Pennsylvania.

TECHNOLOGY

Talc is a hydrous magnesium silicate. It is soft and flaky, has a greasy feel or 'slip' and grinds to a near-white powder. It is relatively inert chemically and has a high fusion point and low electrical and thermal conductivity.

Many kinds of commercial talc are mixtures of talc and other minerals. 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 by the removal of the impurities by some beneficiation process. The Madoc deposits are altered near-white dolomitic limestone consisting principally of talc, tremolite and dolomite in various proportions. Ground products are near-white, naturally low in iron but limited in their 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 properties desirable to some applications of commercial talc.

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 the production of high-quality products would require the application of electromagnetic separation or flotation.

Soapstone is essentially an impure talcose rock from which blocks and crayons can be readily sawn. The soapstone in southern Quebec was altered from serpentinized peridotite and is grey.

Pyrophyllite, a hydrous aluminum silicate, is physically very 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 a versatile raw material with numerous industrial applications, although most is used in less than a dozen industries.

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 D605–53T, 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 an agreement between consumer and supplier. Paper manufacturers require talc of high reflectance, high retention in the pulp, low abrasiveness and freedom from chemically active substances. The ceramic industry specifies fine particle size and freedom from impurities that would discolour the fired product. Talc of high purity is demanded for use in cosmetic and pharmaceutical preparations.

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, low carbonate is specified to avoid a reaction with soil acids.

Because of its unusual characteristics, talc has a number of minor applications, including its 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 a very limited use as a refractory brick or block but, because of its resistance to heat and its softness, it is still used by metalworkers as marking crayons. Its softness and the ease with which it can be carved make 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.

PRICES

Prices vary considerably according to quality. A product with a low impurity content, fine particle size and a high degree of whiteness will command a higher price. There are no published prices for Canadian products, but a wide range of United States prices of ground talc is quoted periodically in *E & M J Metal and Mineral Markets* and in *Oil, Paint and Drug Reporter.*

TARIFFS

Tariffs in effect at the time of writing include:

	British Preferential (%)	Most Favoured Nation (%)	General (%)
CANADA			
Talc or soapstone	10	15	25
Pyrophyllite	free	free	25
Micronized talc	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¢ " "
Ground, powdered, pulverized or washed	12½%
Other, not specially provided for	24%

Tin

W.H. JACKSON*

Production of tin in concentrate and the tin content of a primary lead-tin alloy from smelting amounted to 159 tons** in 1964 compared with 414 tons in 1963. New metal supply of 4,849 tons valued at $17.6 million consisted entirely of imports. Malaysia is the main supplier. Tin stocks held by Canadian consumers totalled 775 tons on December 31, 1964, an increase of 22 tons from the previous year. Consumption of primary tin totalled 5,094 tons, an increase of 3.1 per cent from 1963, the main increase being in the production of tin solders. After four successive years of rising consumption, a slight decline is expected in 1965.

Tin concentrate is produced as a byproduct of lead-zinc recovery by The Consolidated Mining and Smelting Company of Canada Limited. Mill tailings from the zinc rougher-flotation cells of the Sullivan concentrator at Kimberley, B.C., contain 35 to 40 per cent iron plus cassiterite, and grade 0.04 to 0.06 per cent tin. Some 5,700 tons daily are treated. Iron minerals are floated off and the residue constitutes feed to the gravity section of the tin plant that contains 22 Buckman tilting tables and 10 standard 12x4-foot Deister tables. Recovery is about 47 per cent in a concentrate grading 61 to 68 per cent tin. The concentrate is dewatered, dried and exported for smelting. In addition, small amounts of a lead-tin alloy are produced from the treatment of lead bullion dross in the indium circuit of the Trail smelter.

Mount Pleasant Mines Limited continued test and evaluation work on its property in Charlotte County, New Brunswick. The company plans to erect a pilot mill on the property capable of treating 125 tons of ore a day to establish the feasibility of recovery methods.

*Mineral Resources Division
**Long tons, 2240 pounds, used throughout.

TABLE 1

Tin – Production, Imports and Consumption, 1963 and 1964

	1963		1964p	
	Long Tons	$	Long Tons	$
Production				
Tin content of tin concentrates and lead-tin alloy	414	648,943	159	623,128
Imports				
Blocks, pig, bars				
Malaysia	3,095	8,668,763	4,038	14,464,371
United States	267	737,783	497	1,698,048
Britain	550	1,516,814	284	1,302,705
Bolivia	5	13,025	30	102,729
Belgium and Luxembourg	220	584,412	–	–
Nigeria	56	164,256	–	–
Total	4,193	11,685,053	4,849	17,567,853
Tinplate				
United States	1,784	302,505	3,135	551,417
United Kingdom	1,942	500,917	1,600	401,646
Total	3,726	803,422	4,735	953,063
Tin fabricated materials*				
United States			11	33,462
United Kingdom			1	2,359
Total			12	35,821
Consumption				
Tinplate and tinning	2,581		2,573	
Solder	1,366		1,528	
Babbitt	223		232	
Bronze	197		233	
Galvanizing	5		6	
Other uses (including collapsible containers, foil, etc.	570		522	
Total	4,942		5,094	

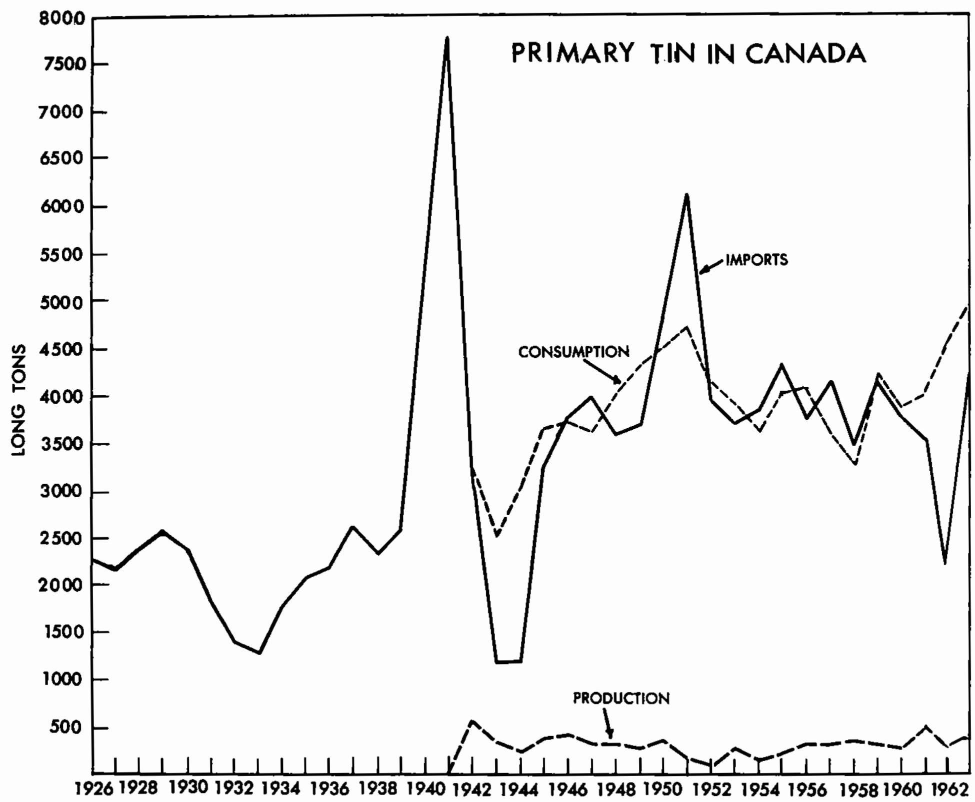
Source: Dominion Bureau of Statistics.
*Not available as a separate class prior to 1964.
Symbols: p Preliminary; – Nil.

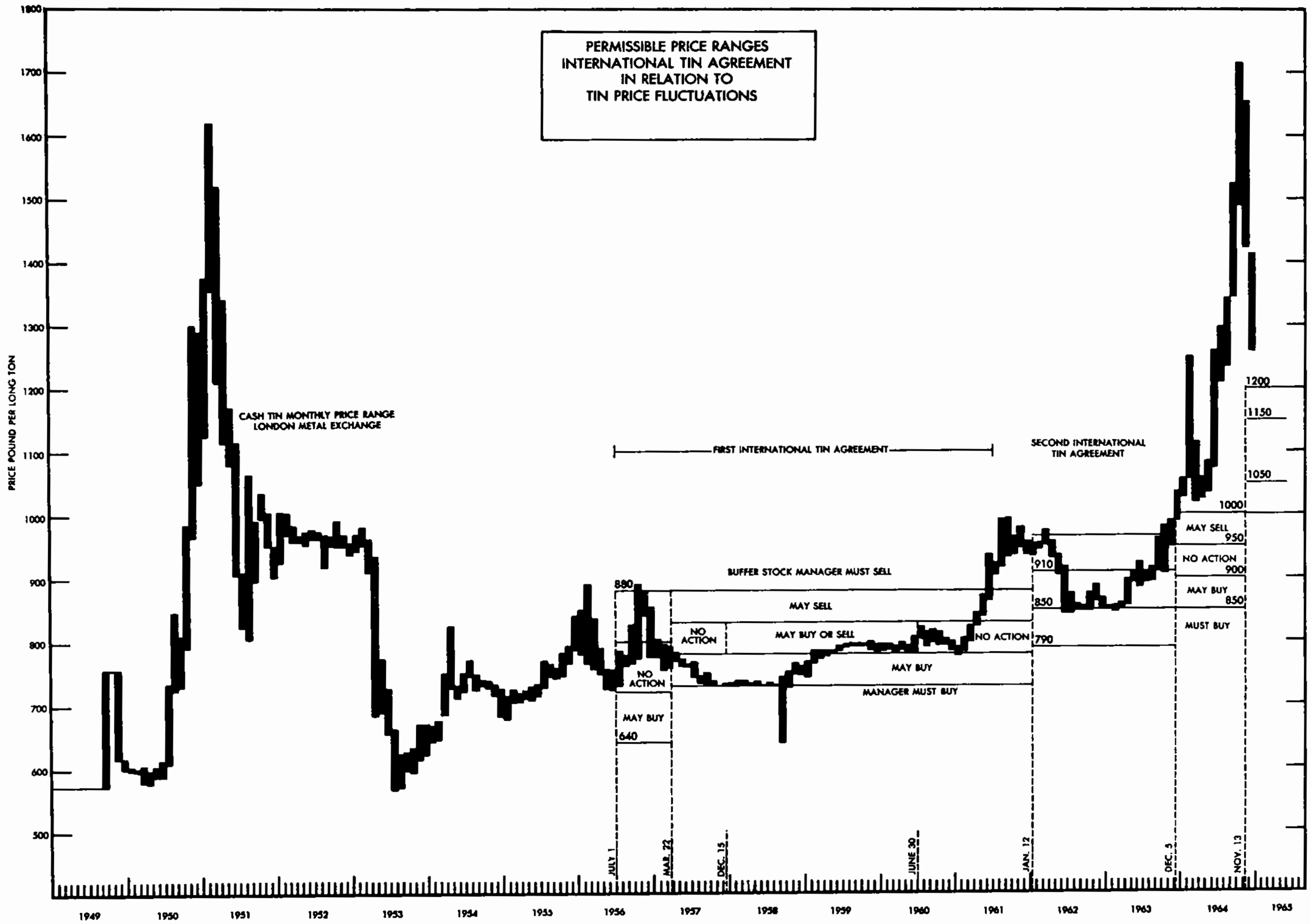
TABLE 2

Tin – Production, Imports and Consumption, 1955-64
(long tons)

	Production[1]	Imports[2]				Consumption[3]
		Blocks, Pig, Bars	Tinfoil	Babbitt Metal	Tinplate	
1955	220	4,318	15	19	9,915	4,019
1956	338	3,774	7	18	3,417	4,085
1957	317	4,155	7	17	4,884	3,622
1958	355	3,461	9	10	5,960	3,292
1959	334	4,183	8	29	4,977	4,223
1960	278	3,768	9	29	5,626	3,880
1961	500	3,525	12	34	3,080	3,953
1962	291	2,274	6	22	3,712	4,507
1963	414	4,193	6	9	3,726	4,942
1964p	159	4,849	..	..	4,735	5,094

Source: Dominion Bureau of Statistics.
[1]Tin content. [2]Gross weight. [3]Virgin tin.
Symbols: p Preliminary; .. Not available.





PERMISSIBLE PRICE RANGES
INTERNATIONAL TIN AGREEMENT
IN RELATION TO
TIN PRICE FLUCTUATIONS
PRICE POUND PER LONG TON
CASH TIN MONTHLY PRICE RANGE
LONDON METAL EXCHANGE
FIRST INTERNATIONAL TIN AGREEMENT
SECOND INTERNATIONAL
TIN AGREEMENT
BUFFER STOCK MANAGER MUST SELL
MAY SELL
MAY BUY OR SELL
NO ACTION
MAY BUY
MANAGER MUST BUY
MUST BUY
880
640
910
850
790
1000
950
900
1200
1150
1050
JULY 1
MAR. 22
DEC. 15
JUNE 30
JAN. 12
DEC. 5
NOV. 13
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965

WORLD DEVELOPMENTS

Canada is signatory to the Second International Tin Agreement which terminates June 30, 1966. Tin is the only metal for which an international agreement exists under United Nations auspices between countries designated as producers and consumers. Each group has equal votes in a governing body, the International Tin Council. Member countries of the Second International Tin Agreement control about 95 per cent of Free World production, some of it being minor production by consumer countries. Producer members (Bolivia, Congo, Indonesia, Malaysia, Nigeria, Thailand) contribute cash or tin to a buffer stock. The International Tin Council determines price ranges within which the buffer stock manager may operate to modify price fluctuations on the market by buying or selling tin. Under certain conditons, the council may also declare controls on the production and exports of producer members. Tin price fluctuations from 1949 to 1964 are shown on the accompanying graph in relation to price ranges considered desirable at various periods by the Tin Council.

In November of 1964, floor and ceiling prices were adjusted upwards by the International Tin Council to encourage further development of tin resources but market levels are above these ranges.

Following the period of high industrial demand and stockpile accumulations in the early 1950s, problems of price maintenance were solved by buffer stock activities and drastic production curtailment. When export controls were removed in 1960, production was slow to respond. Because none of the main consuming countries are self sufficient in tin, prices tend to be sensitive to such international events as the rebellion in the Congo, declining production in Indonesia which reached a low in 1963 and its confrontation with Malaysia, the unprofitable

TABLE 3

Estimated Free World Production of Tin in Concentrates, 1963 and 1964

(long tons)

	1963	1964
Malaysia	59,947	60,004
Bolivia	22,246	24,199
Thailand	15,585	15,595
Indonesia	12,947	16,345
Federation of Nigeria	8,729	8,721
Republic of the Congo	7,053	6,492
Total, including countries not listed	141,500	146,900

Source: International Tin Council, STATISTICAL BULLETIN.

industry of Bolivia and the difficulty of implementing a mine rehabilitation program. These events and the gradual emptying of the supply pipeline led consumers to bid up the price of tin. Consumption rose from 142,000 tons in 1954 to an estimated 166,700 tons in 1964. There is no physical shortage of tin but the imbalance between production and consumption is now being met by disposals from the U.S. stockpile in quantities consistent with market requirements. An estimate of the supply-demand situation is given in Table 5. In the next few years production must increase to displace the limited tonnage of metal available from the stockpile or consumption must decline. The future position of Russia and China, both major producers, in the trade of tin is not predictable.

TABLE 4

Estimated Free World Production of Primary Tin Metal, 1963 and 1964

(long tons)

	1963	1964
Malaysia	84,001	71,351
United Kingdom	17,444	16,849
Federation of Nigeria	9,051	8,748
Belgium	7,044	5,458
Netherlands	5,762	15,858
Australia	2,626	3,044
Bolivia	2,462	3,611
Brazil	2,051	2,100
Total, including countries not listed	143,100	141,800

Source: International Tin Council, STATISTICAL BULLETIN.

TABLE 5

Estimated Free World Tin Position, 1962 to 1964

(long tons)

	1962	1963	1964
Ore Supply			
Production of tin in concentrates	141,600	141,500	146,900
Stocks at year's end	23,000	19,200	20,500
Primary Metal Supply			
Smelter production of tin metal	144,700	143,100	141,800
Net trade with Communist bloc countries	518	1,230	847−
Government stockpile sales	3,907	12,081	32,200
Buffer stock, sales +, purchases−	3,270−	3,270+	–
Commercial stocks at year's end	51,300	46,800	49,500
Primary Metal Consumption	157,900	160,700	166,700

Source: International Tin Council, STATISTICAL BULLETIN.

– Nil.

Exploration leading to the development of new deposits requires time, money and the prospect of continuous and profitable production. The dilemma is that most of the known reserves immediately available are of low grade and require high price levels to permit profitable exploitation. Demand, now at a 10-year high, is partly related to the business cycle. Current price levels have encouraged research into alternate coating materials for steel blackplate and consumers are finding that thinner coatings of tin on tinplate are usable for specific applications. Containers made from aluminum sheet are competitive in some container markets and in 1966 containers for dry-pack applications will be marketed using a vapour-deposited coating of aluminum on steel strip produced by a continuous high-speed mill at Fairless, Virginia.

In Britain, a portable radioisotope X-ray fluorescence analyser was developed for field and mine use in the detection and assay of tin ores.

There are a number of smelters producing tin from high- and low-grade concentrate. Their total capacity exceeds the amount of concentrate available for smelting. Numerous brands of varying purity are produced. New smelting capacity includes the doubling of capacity to 5,000 tons a year by Corporaçion National de Fundiçion at Oruro, Bolivia; a smelter of 25,000-ton capacity on Muntok Island, Indonesia, to be completed in 1965; a 15,000-ton smelter on Pukhet Island in Thailand to be completed in 1965; and a 9,000-ton smelter at Kulan, Malaysia.

USES

Information on the most effective way to use tin in manufacturing processes is available through the Tin Research Institute. This organization, financially supported by the miners of tin, is devoted to both research into new uses and practical application of technology.

In Canada, most tin is used for tinplate and tinning, as shown in Table 1. Straits brand, or equivalent grade, is favoured. Nearly all tinplate is made by electrolytically coating steel with tin; it is used mainly in the manufacture of food containers. Finished metal products requiring a thick hygienic protective coating are dipped in molten tin but this use is not significant in tonnage.

Tin-lead solders are of three main types: dip solder, which contains 20 per cent tin, used in the manufacture of radiator cores and similar equipment; plumber's solder, which contains 30 to 35 per cent tin; and general-purpose solder. The last mentioned, when used to fill seams and join wires, contains 40 to 60 per cent tin; when it serves the electrical and electronics industries the tin content is 59 to 65 per cent.

Bronze is a copper alloy containing 3 to 15 per cent tin. There are two main groups: the phosphor bronzes for machine parts, gears and bearings, and the tin bronzes containing 1 to 6 per cent zinc for valves and fittings. Lead-tin bronzes possess improved machinability and bearing qualities.

The alloying elements for white metals are tin, antimony, lead, copper and bismuth. Modern pewterware contains 95 per cent tin, 3 to 7 per cent antimony and 1 to 2 per cent copper. Britannia metal, which can be cast into intricate designs, contains 90 to 94 per cent tin. Type metal for linotype contains 3 to 5 per cent and for foundry type, 13 per cent. Fusible alloys which melt at low temperatures are used for safety devices such as fire sprinkler systems and pattern making.

Babbitt alloys are used for bearings. The high-tin babbitts are 83 to 91 per cent tin, 4 to 8 per cent copper and 4 to 8 per cent antimony. Lead-base babbitts, containing up to 12 per cent tin, are not so widely used. Tin-aluminum is another product used in bearings.

Tin-alloyed grey iron is becoming more widely used. Another use is the spray coating of tin and its alloys for bearings and other antifriction applications. Minor alloying uses include dental amalgams, and titanium and zirconium alloys.

Collapsible tubes of tin or tin-lead rather than aluminum are still employed where chemical inertness is required. Tinfoil is used in electrical condensers and as wrapping for some food products.

Organotin compounds are used mainly as stabilizers in vinyl plastics, as additives in toothpaste and as components of wood preservatives.

PRICES

The average price in cents (U.S.) per pound of tin traded on the three major exchanges in 1964 was: Straits-exworks, Penang, Malaysia, 151.76; Cash, London, England, 154.93; Prompt, New York, U.S.A., 157.74. Allowing for differences such as hedging, each of these markets affects the others and the differences relate to transporation costs, insurance and interest on money. In Canada, the larger consumers pay the equivalent of the New York price. Smaller consumers, purchasing from merchants who finance and hold stocks in inventory, would pay more. The price of Straits tin in Canada f.o.b. Montreal was 148.31 cents a pound at the beginning of 1964. It reached a high of 239.16 cents on October 29 and a low of 147.05 cents on April 7. The closing price at year's end was 170.40 cents and the average for the year was 175.28 cents.

TARIFFS

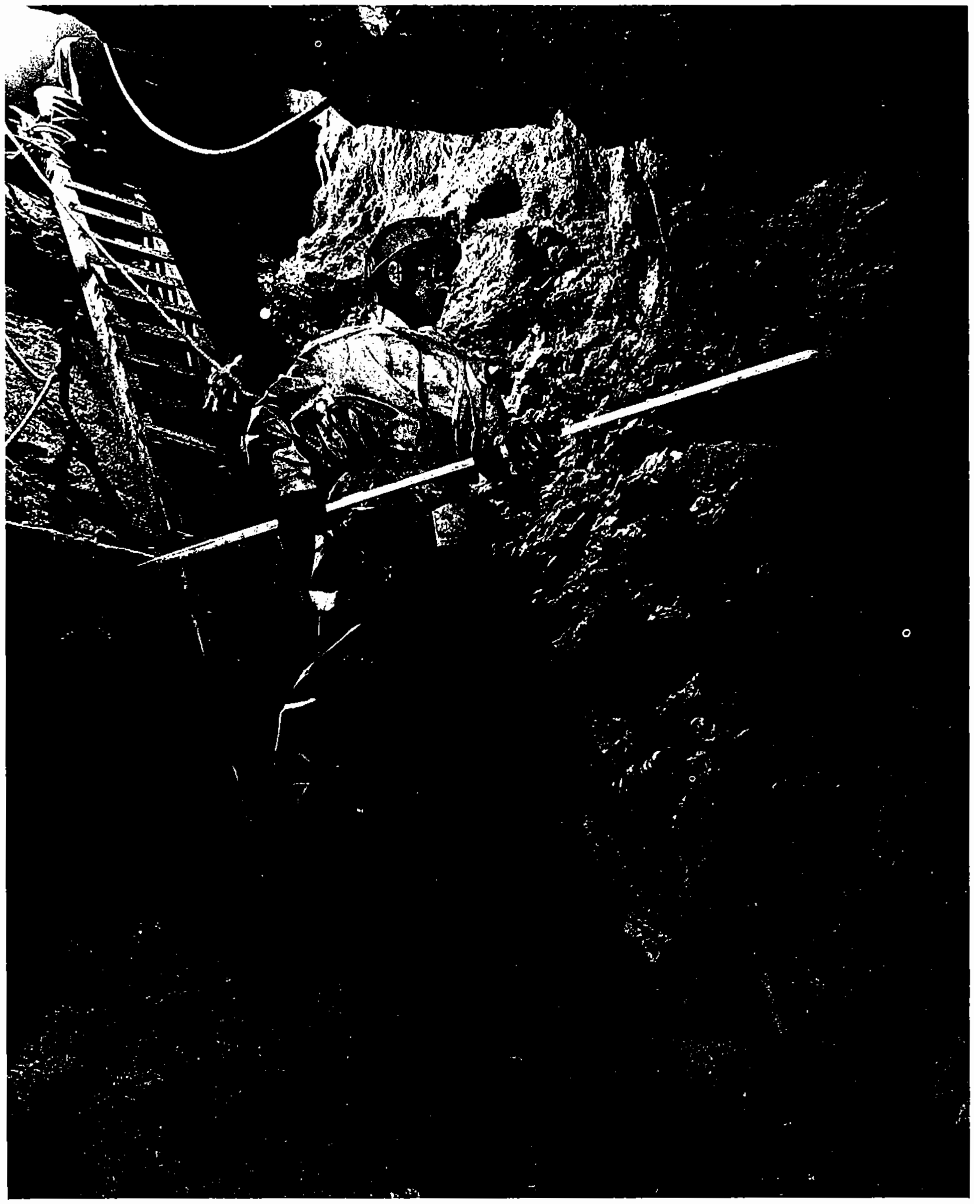
	British Preferential (%)	Most Favoured Nation (%)	General (%)
CANADA			
Tin in blocks, pigs, bars or granular form for use in Canadian manufactures....	free	free	free
Tin-strip waste and tinfoil................	free	free	free
Phosphor tin and phosphor bronze in blocks, bars, plates, sheets and wire	5	7½	10
Oxide of tin	free	15	15

TARIFFS (cont.)

	British Preferential (%)	Most Favoured Nation (%)	General (%)
Bichloride of tin and tin crystals	free	10	10
Sheet or strip of iron or steel, corrugated or not, rolled with surface pattern, or not coated with tin	10	15	25
Sheet or strip of iron or steel coated with lead or with alloys of lead and tin	free	free	15
Manufactures of tinplate, painted, japanned, decorated or not, and manufactures of tin not otherwise provided for	15	20	30

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
Tinplate, sheets and strips, wrought of tin, cut or not, pressed, or stamped to nonrectangular shapes	
Not clad	12% ad val
Clad	24
Tin wire	
Not coated or plated with metal	12.5
Coated or plated with metal	0.1¢ per lb plus 12.5% ad val
Tin bars, rods, angles, shapes and sections	12% ad val
Tin powder and flakes	12
Tin pipes and tubes, and blanks therefor, pipe and tube fittings	12
Tinfoil	35
Tin compounds and salts	12.5



Willroy Mines Ltd., Manitouwadge area. Scaling operations in a stope at mine.

Titanium

V.B. SCHNEIDER*

The value of titanium-bearing material shipped during 1964 as ore, heavy aggregate and titanium-bearing slag was at an all-time high of $21 million. Nearly all of this was accounted for by titanium-dioxide (TiO_2) and represents an increase of $6 million over that of 1963. Reports from the two Canadian TiO_2 pigment-producing companies indicate that both operated at near capacity throughout 1964 and in addition to supplying almost all domestic requirements they reported increased exports for the year.

An interesting advance in the titanium industry in recent years has been the development of the chloride process for the manufacture of TiO_2-based pigments that previously were produced only by the sulphate process. Significant improvements were achieved in the quality of pigments by the introduction of the chloride process. However, as a result of this new competition, producers using the sulphate process have improved the quality of pigment so produced and one large manufacturer of pigment that uses both methods has indicated that it is satisfied that pigments produced by either method are equally good for most applications. About 15 per cent of world pigment production is now made by the chloride process and the amount will increase but, in all probability, no faster than the over-all rate of growth in the pigment industry.

World mine production of titanium ores for 1964 has been estimated by the U.S. Bureau of Mines in its COMMODITY DATA SUMMARIES, January 1965, at 2.4 million tons of ilmenite and 272,000 tons of rutile. Compared with 1963, these estimates show an increase of 6 per cent for ilmenite production and 24 per cent for rutile.

Ilmenite ($FeTiO_3$), rutile (TiO_2) and sphene ($CaTiSiO_5$), which is also called titanite, are the most abundant of the titanium minerals. Sphene, which contains 41 per cent TiO_2, has been mined in the Kola Peninsula, U.S.S.R.

*Mineral Resources Division

Generally, only ilmenite and rutile are considered commercially important outside Russia. The maximum titanium-dioxide content of ilmenite is theoretically 53 per cent; that of rutile is theoretically 100 per cent.

TABLE 1

Titanium – Canadian Production, Imports and Exports, 1963-1964

	1963		1964p	
	Short Tons	$	Short Tons	$
Production[1] (shipments)				
Titanium dioxide	..	13,806,608	..	20,981,935
Imports				
Titanium dioxide, pure				
Britain	1,895	811,924	1,120	470,562
United States	1,472	794,221	693	360,725
W. Germany	–	–	26	11,843
Total	3,367	1,606,145	1,839	843,130
Titanium dioxide, extended				
United States	9,319	1,785,904	10,443	2,000,248
Titanium metal[2]				
United States	..	..	725	3,609,039
Britain	..	..	1	1,122
Total	..	..	726	3,610,161
Exports				
Titanium, unwrought, waste and scrap, wrought and alloyed[3]				
United States	28	37,167	31	17,112
Titanium dioxide[3]				
United States	280	10,970	3,298	1,344,287

Source: Dominion Bureau of Statistics.
[1]Producers' shipments of titanium dioxide slag. Tonnages not available for publication.
[2]New class effective 1964, not available for prior years. [3]As reported by the UNITED STATES IMPORTS FOR CONSUMPTION, REPORTS FT 110 and 125. No identifiable classes are available from official Canadian export statistics.
Symbols: p Preliminary; – Nil; .. Not available.

PRODUCTION

CANADA

The Canadian titanium industry is based mainly on the mining of ilmenite for the production of titanium-dioxide slag; to a minor degree ilmenite is also used as heavy aggregate. It is mined in the Allard Lake and St. Urbain areas of Quebec. Most of the Allard Lake ilmenite is smelted at Sorel, Quebec, to produce slag containing 70 per cent titanium dioxide (TiO_2) and a high quality of pig iron. Much of the slag is exported, mainly to the United States, for use as a raw material in the manufacture of titanium-base pigments. Some is shipped to

Canadian Titanium Pigments Limited at Varennes, Quebec, and to Tioxide of Canada Limited at Ville-de-Tracy, Quebec.

With a combined annual capacity in excess of 100 million pounds of titanium-base pigments, the two Canadian pigment producers met most of the domestic requirements and exported 3,298 tons valued at $3.6 million, to the United States. Both companies manufacture many grades of anatase and rutile types of titanium-dioxide pigment; many improved grades have been introduced to the trade as they were developed.

Prior to 1963, Canadian imports of titanium-base pigments were in the order of 25,000 to 30,000 tons a year with the United States and Britain being the major suppliers. Since then, domestic producers have been responsible for nearly eliminating imports despite rapid growth in domestic consumption. The Canadian market for titanium-dioxide pigments continues to expand and keep pace with requirements of Canada's secondary industries; consumption for 1964 is estimated by the Mineral Resources Division at 85 million pounds of TiO_2.

Quebec Iron and Titanium Corporation (QIT). This company was formed in 1948 with Kennecott Copper Corporation holding two-thirds interest and The New Jersey Zinc Company, the remainder. It operates eight electric-arc smelting furnaces with a combined annual feed capacity of 1.4 million short tons of ilmenite. Its smelter is at Sorel, Quebec.

Prior to treatment in the electric furnaces, the ilmenite from Allard Lake is fed to the beneficiation plant at Sorel where it is crushed and separated into two sizes – minus 5/16 inch to plus 20 mesh, and minus 20 mesh. Upgrading of the two fractions is accomplished in Dutch State Mine cyclones and Humphrey spirals. The combined concentrates, containing about 37 per cent TiO_2 and 42 per cent iron (Fe), are calcined in rotary kilns to lower the sulphur content. Electric smelting of the calcine in arc furnaces with powdered anthracite coal yields a slag containing about 70.5 per cent TiO_2 and 14 per cent FeO, and a low-phosphorus iron containing about 0.12 per cent sulphur and 2.25 per cent carbon.

QIT's slag was developed primarily for the manufacture of pigment by the sulphate process. Its use as a raw material for the chloride process is possible but not economically practicable without further treatment. Anticipating the increased popularity of the chloride process, QIT began a research program designed to develop a slag suitable for use with it. Laboratory quantities of synthetic rutile were made from titanium slag and distributed to potential users. The company reports that preliminary results have been encouraging and it is planned to supply pilot-plant quantities of it in 1965 for evaluation by prospective customers. QIT also expects that the development of synthetic rutile will provide a raw material for use in the titanium metal industry, thus opening up an entirely new market.

QIT's production of titanium slag at 486,358 long tons in 1964 was an all-time high; the company expects production in 1965 to be about the same.

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TABLE 2

Titanium – QIT Production, 1963-64

(long tons)

	1963	1964
Ore treated	817,286	1,239,520
Titanium slag produced	338,679	486,358
Iron produced	224,949	335,762

Source: Kennecott Copper Corporation's ANNUAL REPORT for 1964.

QIT owns one of the world's largest known reserves of ilmenite – 150 million tons of measured and indicated ore averaging 35 per cent TiO_2 and 40 per cent iron, and many millions of tons of inferred ore. This ilmenite is intergrown with hematite in orebodies consisting of dykes, irregular lenses or sill-like bodies, lying within an anorthosite mass covering 134 acres. The largest orebody, at Lac Tio, contains estimated reserves of 125 million tons of ilmenite. This reserve is in the Allard Lake area of Quebec about 22 miles north of Havre St. Pierre and about 500 miles downriver from Sorel.

Continental Titanium Corp. Continental Titanium Corp., formerly Continental Iron & Titanium Mining Limited, owns mining rights in the St. Urbain area about 8 miles north of Baie St. Paul, which is on the north shore of the St. Lawrence River, 60 miles downriver from Quebec City. The company reports measured and indicated reserves of 12.5 million tons averaging 35 per cent iron and 37 per cent TiO_2, and inferred reserves of 8 million tons. This company, formed in 1955, has been engaged in the mining of ilmenite for use as heavy aggregate and in the development of a continuous process designed to produce technical-grade titanium-dioxide. The process used is one of the high-temperature, pressure-leaching types with dilute sulphuric acid. Sales of ilmenite in 1964 for heavy aggregate and other uses amounted to 25,112 tons valued at $237,603.

In 1964, the company dropped its plans for construction of an industrial pilot plant that was to have had the capacity to produce 7,000 tons of titanium pigment a year and according to its annual report for 1964-1965, decided to concentrate its efforts towards the building of a smaller plant, which will have the capacity to produce 2,000 tons of 'ceramic grade' titanium dioxide a year.

Canadian Titanium Pigments Limited. This company, a wholly owned subsidiary of National Lead Company, New York, continued operations of its titanium-dioxide pigment plant at Varennes, Quebec throughout 1964. During the year some additional equipment was installed permitting an increase in output of approximately 20 per cent, to 30,000 tons a year. It manufactures anatase and rutile-type titanium-dioxide pigments. Titanium-bearing slag purchased from QIT and liquid sulphur for manufacture of sulphuric acid are the main raw materials. The company reported that production was primarily for the domestic market but that significant quantities were exported.

Tioxide of Canada Limited. This company, previously known as British Titan Products (Canada) Limited, is a wholly owned subsidiary of British Titan Products Company Limited, London, England. It manufactures a full range of titanium-dioxide pigments at its plant at Tracy, Quebec. The plant has a rated capacity of 22,000 tons a year; the company reported that the plant operated close to capacity in 1964.

TABLE 3

Titanium – Production, Trade and Consumption, 1955-64
(short tons)

	Production		Imports			Consumption	
	Ilmenite[1]	Titanium Dioxide Slag[2]	Titanium Dioxide Pure	Titanium Dioxide, Extended	Titanium Dioxide Pigments[3]	Titanium Dioxide Pigments	Ferro-titanium[4]
1955	445,635	117,042	. .	. .	35,799	30,436	156
1956	630,197	157,374	. .	. .	37,872	32,482	277
1957	824,432	186,422	. .	. .	34,234	32,622	252
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	37,224	94
1963	915,360	379,320	3,367	9,319	12,686	39,000e	78
1964p	1,388,262	544,721	1,839	10,443	12,282	42,000e	27

Source: Dominion Bureau of Statistics and company annual reports.
[1]Producers' shipments of ilmenite from Allard Lake and St. Urbain area. From 1955 to 1957 from DBS, and 1958 onwards from company annual reports. [2]TiO_2 content of slag for 1955 to 1958 from DBS; from 1959, gross wt. of 70-72% slag, from company reports. [3]Not available separately prior to 1962. 1955 to 1961 titanium and oxide pigments containing not less than 14% by weight of titanium dioxide. [4]1955 to 1958 gross weight; from 1959, Ti content.
Symbols: p Preliminary; . . Not available; e Estimated.

OTHER COUNTRIES

The United States is the largest consumer and producer of ilmenite. According to the United States Bureau of Mines*, production of ilmenite increased to about 930,000 tons in 1964 from 888,400 tons in 1963. The United States is also the world's largest consumer of rutile but as a producer it ranks well behind Australia. Production in 1964 was estimated at 12,000 tons, a slight increase from the previous year. Consumption of ilmenite concentrates in 1964 was 1.1 million short tons and consumption of rutile was 40,000 short tons.

Preliminary figures supplied by the Australian Bureau of Mineral Resources show that Australian production of rutile concentrate in 1964 amounted to 180,000 long tons, having a TiO_2 content of 173,400 tons; production of ilmenite

*U.S. Bureau of Mines, MINERAL INDUSTRIES SURVEYS, TITANIUM IN 1964, January 5, 1965.

concentrate was 308,100 long tons, containing 170,400 tons of TiO_2. For ilmenite concentrate there was an increase of 105,000 long tons from 1963 and for rutile there was a very slight decrease. Exports of rutile in 1964, at 194,000 long tons valued at £7 million, established a record high. Currently, three contracts with United States manufacturers of TiO_2 pigment, using the chloride process, call for total deliveries of 80,000 to 90,000 long tons a year. Australian industry expects demand to increase through the expansion of existing facilities and an increase in the number of pigment-producing plants using rutile and the chloride process.

Preparations began in 1964 for mining in Sierra Leone of perhaps the world's largest rutile reserves by Sherbro Minerals Ltd. Sherbro Minerals is owned by Pittsburgh Plate Glass Co. and British Titan Products Company Limited; reports indicate that it is being prepared to produce 100,000 tons of rutile a year.

A new titanium-producing pigment plant at Fredrikstad, Norway, started production during 1964. The plant is owned by Titan Co. A/S, a wholly owned subsidiary of National Lead Company. It was announced that an expansion program, to commence in 1965, will double plant capacity by mid-1966 to 15,000 metric tons of TiO_2 a year.

Japan is probably second only to the United States as a consumer of titanium dioxide and the Japanese market's growth has been from 18 to 20 per cent a year for the past few years. Consumption in 1964 was about 57,000 metric tons. Japan's TiO_2 production capacity is estimated by trade publications at about 90,000 tons a year. Exports, mostly to the United States, were about 28,000 tons in 1964.

TABLE 4

Production of Ilmenite Concentrates, 1963-64

('000 short tons)

	1963	1964p
United States	888	930
Canada*	379	545
Norway	276e	300
Australia	224	337
Malaysia	165	. .
Finland	120	. .
Spain	69	. .
Republic of South Africa	31	. .
India	29	. .
Other countries**	41	. .
Total	2,220	2,360

Sources: Company annual reports, U.S. Bureau of Mines MINERALS YEARBOOK, 1963, and U.S. Bureau of Mines, COMMODITY DATA SUMMARIES, January 1965.
*Slag containing 72% TiO_2. **Exclusive of Soviet bloc countries.
Symbols: e Estimate; p Preliminary; . . Not available.

TABLE 5

Production of Rutile Concentrates, 1963–64
(short tons)

	1963	1964p
Australia................	203,800	201,600
United States	11,915	12,000
Republic of South Africa ...	1,385	..
India	2,062	..
Other countries*	938	..
Total..................	220,100	272,000

Sources: U.S. Bureau of Mines MINERALS YEARBOOK, 1963, and U.S. Bureau of Mines, COMMODITY DATA SUMMARIES, January 1965.
*Exclusive of Soviet bloc countries.
Symbols: .. Not available; p Preliminary.

USES AND CONSUMPTION

Most ilmenite mined is used for the manufacture of titanium-dioxide pigments. Pigment-grade titanium dioxide is made principally by treating ilmenite with sulphuric acid, removing the iron of the ilmenite in solution, and grinding the titanium component to pigment size. Ilmenite mined by Quebec Iron and Titanium Corporation does not readily lend itself to this process because hematite is finely disseminated throughout the ilmenite and cannot be removed by standard ore-dressing methods. Thus, the amount of sulphuric acid consumed in iron removal would be economically excessive. At Sorel, a pyrometallurgical process is used to separate the iron as molten metal from the ilmenite and associated hematite. The high-titania slag so produced is then converted to TiO_2 pigments but with a much reduced acid consumption.

Titanium dioxide owes its value as a pigment to its high refractive index. To take full advantage of this property, the TiO_2 must be in powder form of extremely small, uniform-sized particles. It is the high refractive index of TiO_2 pigment that accounts for its opacity. The amount of pigment required per unit area to block out, or obscure, a checkerboard surface is a measure of the relative opacifying power of pigments. In comparison with other white pigments, titanium dioxide has 10 to 12 times the opacifying power of white lead, six times that of zinc oxide or antimony oxide and four times that of lithopone.

In addition to their superior opacity, titanium-dioxide pigments have a high degree of whiteness and brightness, enhance the durability of many media into which they are incorporated and are chemically inactive and nontoxic. Because of this combination of properties, titanium-dioxide pigments have largely replaced the materials formerly used as white pigments. Consumption of TiO_2 pigments in

Canada was about 42,000 tons in 1964; their use, by industry in percentage terms was approximately as follows:

Paint	66%
Floor covering	11
Paper	11
Rubber and plastics	5
Ink	2
Ceramics	2
Textiles	1
Others	2
Total	100%

TITANIUM METAL PRODUCTION AND FABRICATION

Using technical-grade titanium dioxide manufactured by Canadian Titanium Pigments Limited, Dominion Magnesium Limited, near Haley, Ontario, produces titanium in the form of sintered pellets weighing from 5 to 7 grams each. The principal application for these pellets is for special fuses which are sold almost entirely in Britain. Shipments in 1964 amounted to 15,087 pounds.

Atlas Titanium Limited, the 'special metals' subsidiary of Atlas Steels Company Division of Rio Algom Mines Limited, continued to carry out second-stage melting of imported ingots and process them to mill products for sale in domestic and export markets. As in previous years, a good portion of the company's production was material converted for its United States associate, Reactive Metals Inc. Atlas reported that in 1964 the sale of mill products in Canada and the processing of Reactive Metal Inc.'s material was double 1963's volume and that sales of its nickel anode plating baskets were made in over 20 countries. The success in exporting the plating baskets and other mill products led to the establishment of a permanent international sales office in Wembly, England, in June 1964. The company also reported that research and development is continuing on industrial applications for titanium, particularly in the form of exportable finished products.

Macro Division of Kennametal Inc., Port Coquitlam, B.C., is the only Canadian manufacturer of titanium carbide powder. It also uses titanium in the manufacture of tungsten-titanium carbide and several other multicarbides; the raw material is rutile.

There are two commercial manufacturers of titanium sponge in the United States. They are Titanium Metals Corporation at Henderson, Nevada, and Reactive Metals Inc. at Ashtabula, Ohio. Reactive Metals is jointly owned by National Distillers & Chemical Corp. and United States Steel Corporation.

The principal producers of titanium mill products in the United States are Reactive Metals Inc., Titanium Metals Corporation, Oregon Metallurgical Corp., Crucible Steel Company of America and Republic Steel Corporation. Metal producers in Japan are Osaka Titanium Manufacturing Co., Osaka, Toho Titanium Industry Co., Tokyo, and Nippon Soda Co., Ltd., Tokyo.

In the United States, all segments of the titanium metal industry increased production sharply in 1964. Consumption of titanium sponge metal was 11,000 tons and ingot output, including alloying constituents, was 13,964 tons; both were records.

Titanium is added to iron and steel in the form of low-carbon ferrotitanium; it acts as a deoxidizer, grain refiner and alloying ingredient, particularly for high-temperature and stainless steels. As a pure metal or alloyed with small amounts of aluminum, vanadium, molybdenum and chromium, titanium has about the same strength as high-grade steels but is 45 per cent lighter. The use of titanium is firmly established in the chemical and petrochemical fields, and in the electroplating and anodizing industries. The progress in developing desalinization plants is creating a tremendous potential for the use of titanium because of the metal's resistance to corrosion by sea water.

PRICES

United States prices quoted in E & MJ METAL AND MINERAL MARKETS of December 28, 1964, were as follows:

Titanium ore, f.o.b. cars, Atlantic ports	
Ilmenite, 59½% TiO_2, per lt	$23.00 to $26.00
54% TiO_2, per lt	21.00 to 21.50
Rutile, 96% per st	104.00
Titanium metal, per lb, delivered	
Max. 120 Brinell, 99.3%, 500 lb	1.32
Max. 90 Brinell, 99.9%, 25 lb	1.90
Max. 75 Brinell, 99.9%, 10 lb	4.00
Ferrotitanium, f.o.b. destination, northeastern United States	
Low carbon, per lb Ti content, lump (½-in) packed, 38-43% Ti, max. 0.10% C	1.35
Medium carbon, net ton, carload lots, lump, packed, 17-21% Ti, 3-5% C	375.00
High carbon, same basis as medium C, 15-19% Ti, 6-8% C	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	12½	15
Titanium sponge and sponge briquettes, ingots, blooms, slabs, billets of titanium, or titanium alloys for use in Canadian manufactures (expires June 30, 1966).............	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		
Ferrotitanium.................	10		
Titanium dioxide	15		
Titanium compounds	15		

*Duty temporarily suspended to June 30, 1965.

Tungsten

V.B. SCHNEIDER*

In 1964, Canada Tungsten Mining Corporation Limited became the first Canadian producer of commercial tungsten concentrates since July 1958 when Canadian Exploration, Limited, closed its tungsten operations at Salmo, British Columbia, at the termination of its contract with the United States General Services Administration (G.S.A.). Also in 1964, Canadian Exploration liquidated its stockpile of some 38,000 short-ton units (20 lb) of tungsten trioxide (WO_3), which it has held since it completed the sales contract with the G.S.A.

In 1963, Canada Tungsten shipped trial lots of concentrates for commercial testing from its property just east of the Yukon-Northwest Territories boundary and 135 miles north of Watson Lake. The company announced its discovery in 1958 and subsequent exploration and development work indicated ore reserves in the order of 1.5 million tons averaging 2.47 per cent WO_3. This makes the Canada Tungsten mine one of the highest-grade tungsten operations in the world. However, a depressed tungsten market from mid-1961 until mid-1964, which closed many tungsten mines and discouraged the development of potential producers, decided the company against bringing the mine into production earlier. It also provided additional time for the company to develop its milling process, which is designed to produce a high WO_3-content concentrate (70+%). Mining began in June and, after extensive alterations, milling operations started at the end of September.

During the depressed period, the quoted price in New York for imported tungsten concentrates dropped from $19.50 a short-ton unit of WO_3 on a 65-per-cent WO_3-content basis to $7.50 in August 1962; U.S. consumers pay an additional tariff of 50 cents a pound on the tungsten content, which amounts to $7.93 for each short ton unit of WO_3. This was the lowest price quoted for tungsten concentrates since early 1942. Low prices continued throughout most of 1963 but by March 1964 the price had gradually risen to $11.50 a short-ton

*Mineral Resources Division

TABLE 1

Tungsten – Production, Imports and Consumption

	1963		1964p	
	Pounds	$	Pounds	$
Production[1] (shipments WO_3)	..	..	..	..
Imports				
Tungsten in ores and concentrates[2]				
United States	1,155e	1,604	203,200	111,105
Argentina	79,300e	63,159	150,500	29,260
Bolivia	–	–	34,700	26,080
Korea	243,870e	129,814	1,400	1,020
Total	324,325e	194,577	389,800	167,465
Ferrotungsten[3]				
Austria	12,300	7,820	60,000	57,825
United Kingdom	516,200	160,731	50,000	20,708
Sweden	75,000	52,159	32,000	20,754
United States	17,500	22,218	30,000	35,115
Others	3,100	1,671	–	–
Total	624,100	244,599	172,000	134,402
Consumption (W content)				
Scheelite	565,369		..	
Tungsten metal and metal powder	147,576		..	
Tungsten wire	10,026		..	
Ferrotungsten	6,666		..	
Tungsten-carbide powder, sodium tungstate and tungstic oxide	175,287		..	
Total	904,924		740,410	

Source: Dominion Bureau of Statistics.
[1] Producers' shipments of tungsten concentrates (scheelite) – not available for publication. [2] W content in 1963 estimated as follows: United States 55%; Korea 55%; Argentina 39.65%. [3] Gross weight.
Symbols: p Preliminary; e Estimate; .. Not available.

unit and by the end of 1964 had risen to $21.50. Prices in Britain and Europe followed the same rising trend and the London Metal Bulletin price in December was 207 shillings a long-ton unit (22.4 lb). This was equivalent to a U.S. price of $25.60 a short-ton unit. In the opinion of most consumers and many producers these prices were unrealistically high and early in 1965 the prices eased to

$19 in the U.S.A. and 150 shillings in Europe. If these prices can be maintained, many traditional producers can operate and consumers may become encouraged to expand their uses for tungsten.

The tungsten industry's most recent troubles started when large quantities of tungsten concentrates, which originated in Communist China, were dumped on world markets at greatly reduced prices. This resulted in many established producers of tungsten in Korea, Bolivia, Portugal, Australia and South American countries being forced to cease operations. The large inventories held by the United States government under several stockpiling programs have also had a depressing effect on the market. These reserves as reported by the United States Office of Emergency Planning, amount to more than 208 million pounds of contained tungsten. Much of this is considered excess to requirements and could be released to United States consumers who use about 12 million pounds of tungsten annually. Therefore, United States stockpiled tungsten and the uncertainties of China's future releases of tungsten are formidable deterrents to prospective producers.

Imports of contained tungsten (W) in concentrates in 1964 were 389,800 pounds, valued at $167,465. A direct comparison with former years is not possible because formerly only the gross weight of imports was available. However, on the basis of estimates (Table 1) it appears that the W-content of the concentrates imported in 1964 was up about 23 per cent over that of 1963.

TABLE 2

Tungsten – Production, Trade and Consumption, 1955-64
(pounds)

	Production* (WO_3 content)	Imports		Exports Scheelite (W content)	Consumption (W content)
		Tungsten Ore**	Ferrotungsten		
1955	1,942,770	91,800	114,200	1,711,497	282,678
1956	2,271,437	123,800	205,500	1,763,793	284,318
1957	1,921,483	230,700	170,200	1,524,851	277,972
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	..	904,924
1964p	..	389,800	172,000	..	740,410

Source: Dominion Bureau of Statistics.
*Producers' shipments of scheelite (WO_3 content). **Prior to 1964 reported in gross weight. Commencing 1964 reported in W content.
Symbols: p Preliminary; .. Not available; – Nil.

The two principal minerals of tungsten are scheelite ($CaWO_4$) and wolframite [(Fe, Mn) WO_4]. Scheelite is found in association with gold-quartz veins at many active and long-dormant gold mines in Nova Scotia, Quebec, Ontario, Manitoba, British Columbia and Northwest Territories. At present, these occurrences are not of economic significance, though byproduct scheelite was recovered from gold-mining operations during World War II and the Korean conflict. Wolframite has been found in stream gravels and in quartz veins in the Atlin area of northern British Columbia and the Yukon Territory.

WORLD PRODUCTION AND TRADE

According to the United States Bureau of Mines*, world mine production of tungsten ores and concentrates in 1964 amounted to some 63.4 million pounds of contained W. This was 1.3 million pounds more than in 1963. Slight increases in production are reported for all the major producing countries except the Sino-Soviet bloc countries; however, since production in that area is not reported, it is possible only to speculate on its size.

There have been many reports in the trade press which indicate that production of tungsten in China may have been curtailed in 1964. Certainly, exports from China were down considerably from the disruptive levels reached in 1961-63 and there are reports of shipments of tungsten concentrates from noncommunist sources into countries that normally depend on Chinese tungsten. Preliminary reports indicate that imports and consumption of tungsten rose for most consuming countries in 1964 but the United States was a major exception. Though the industrial consumption increased by about 750,000 pounds in the United States, imports decreased by 1.2 million pounds from 1963. The AUSTRALIAN MINERAL INDUSTRY, QUARTERLY REVIEW, March 1965, reported that although Australian mine production of tungsten concentrates of 1,540 long tons, on a 65-per-cent-WO_3 basis, was only slightly above that of 1963, the value of tungsten exports increased from £249,953 in 1963 to £750,376 in 1964 and that domestic producers stocks were virtually liquidated in 1964.

Official United States tungsten production figures are not available because two mines account for all the production; both recover tungsten as a byproduct or co-product of molybdenum mining operations. The two mines are the Pine Creek mine of Union Carbide Nuclear Company, a Division of Union Carbide Corporation, near Bishop, California, and the Climax mine of Climax Molybdenum Company, a Division of American Metal Climax, Inc., at Climax, near Leadville, Colorado. Unofficial estimates suggest that United States production was 6.9 million pounds in 1964 and should be well over 7 million in 1965. Climax Molybdenum Company reported the production of 1.15 million pounds for 1964.

*U.S. Bureau of Mines, Division of Minerals, COMMODITY DATA SUMMARIES, January 1965.

Because of improved tungsten prices during the year the sense ot urgency that prevailed at the meetings of the United Nations *ad hoc* Tungsten Committee in 1963 was not present during 1964; the Committee concentrated its activities on establishing improved statistical data on all facets of the tungsten industry.

TABLE 3

World Production of Tungsten in Concentrates, 1963-64

(short tons, 60% WO_3 basis)

	1963	1964e
China	24,900e	..
U.S.S.R.	12,100	..
Republic of Korea	6,724	7,000
United States (shipments)	5,657	..
North Korea	4,400e	..
Bolivia (exports)	2,513	2,600
Australia	1,771	1,860
Portugal	1,635	1,750
Brazil	1,050	..
Japan	858	..
Other countries	3,092	..
Total	64,700	66,000

Sources: U.S. Bureau of Mines, MINERALS YEARBOOK, 1963; U.S. Bureau of Mines, Division of Minerals, COMMODITY DATA SUMMARIES, January 1965.
Symbols: e Estimated; . . Not available.

CONSUMPTION AND USES

The use of cemented tungsten carbide has increased greatly during the last 15 years through improvements in the technology of tungsten-carbide manufacture. Tungsten in tungsten-carbide tools does much more work in metal-cutting operations than is possible with steel tools containing the same amount of tungsten. This has changed the end-use pattern of tungsten. About 15 years ago, 90 per cent of the tungsten consumed went into the manufacture of ferrous alloys and 5 per cent into the manufacture of tungsten carbides. Now, in the United States, about 45 per cent is used in the manufacture of tungsten carbides, 20 per cent in ferrous alloys, 20 per cent as tungsten metal, 14 per cent in high-temperature and other nonferrous alloys and 1 per cent in chemicals. In Canada, the consumption pattern is somewhat different, as noted in Table 4.

Tungsten carbide is used for tipping such tools as milling cutters, reamers, punches and drills; as dies for wire- and tube-drawing; in such water-resistant parts as gauges, valve seats and valve guides, and as cores in armour-piercing steels.

TABLE 4

Consumption of Tungsten in Canada, by Use, in 1963
(lb of contained W)

Carbides	591,143
Electric and Electronics	11,284
Nonferrous Alloys	10,915
Iron and Steel	278,084
Pigments	13,498
Total	904,924

Source: Compiled in Mineral Resources Division from data supplied by the Dominion Bureau of Statistics.

In the nonferrous or superalloy field, tungsten is alloyed with cobalt, chromium, nickel, molybdenum, titanium and columbium in varying amounts to produce a series of hard-facing, heat- and corrosion-resistant alloys. The high-temperature alloys are used mainly in turbojet engines for such parts as nozzle guide vanes, turbine blades, combustion-chamber liners and tail cones. They are also used in heat exchangers, boiler superheaters and boiler superchargers. Stellite, a nonferrous alloy containing from 5 to 20 per cent tungsten with chromium and cobalt, is used in the production of welding rods for hard facing and in making high-speed tools.

The metal is used in ignition and other contact points in the automotive industry. It is also used for incandescent lamp filaments and in making certain types of bronze.

In Canada, the following are the leading consumers of tungsten:

ONTARIO

Atlas Steels Company, a division of Rio Algom Mines Limited	Welland
Canadian General Electric Company Limited	Toronto
A.C. Wickman Limited	Toronto
Johnson Matthey & Mallory Limited	Toronto
J.K. Smit & Sons of Canada Limited	Toronto
Canadian Westinghouse Company Limited	Hamilton
Dominion Colour Corporation Limited	New Toronto
Deloro Smelting & Refining Company, Limited	Belleville
Wheel Trueing Tool Company of Canada Limited	Windsor

QUEBEC

Crucible Steel of Canada Ltd.	Sorel
Ferro Technique Limited	Montreal
Gardner Steel Limited	Noranda

BRITISH COLUMBIA

Kennametal of Canada, Limited	Victoria
Boyles Bros. Drilling Company, Ltd.	Vancouver
Kennametal Inc., Macro Division	Port Coquitlam

Macro Division of Kennametal Inc. is the only manufacturer of tungsten-carbide powder in Canada. The company also manufactures tungsten trioxide powder, tungsten-metal powder, tungsten-titanium carbides, tungsten-tantalum-niobium carbides and vacuum-fused tungsten eutectic carbides. Other products containing tungsten manufactured at this plant include tungsten-carbides, ball-mill balls, matrix powers for diamond bits and diamond tools, and carbide powders of tungsten, titanium and tantalum that are used for plasma spraying. As raw material the company uses wolframite and scheelite concentrates. Other Canadian consumers start with partially processed and semi-fabricated tungsten products.

PRICES

According to E & MJ METAL AND MINERALS MARKETS of December 28, 1964, tungsten prices in the United States were:

	($)
Tungsten ore, per short-ton unit of WO_3 (20 lb), basis 65%, foreign, c.i.f. U.S. ports, import duty extra	
Wolfram..	21.00 to 21.50
Scheelite......................................	21.00 to 21.50
U.S. scheelite, f.o.b. mine or mill	17.00 to 19.00
Tungsten metal, per lb	
98.8% min., 1,000-lb lots	2.75
Hydrogen reduced 99.99%.........................	2.85 to 3.63
Ferrotungsten, per lb contained W, 70-80%, lots 5,000 lb or more, lump 1/4 in., packed	
Domestic......................................	1.75 (nominal)
Imported	1.50 (nominal)
Tungstic acid, 92.5%, per lb, 1,000-lb lots in drums (according to OIL, PAINT AND DRUG REPORTER, Dec. 28, 1964)	1.90

TARIFFS

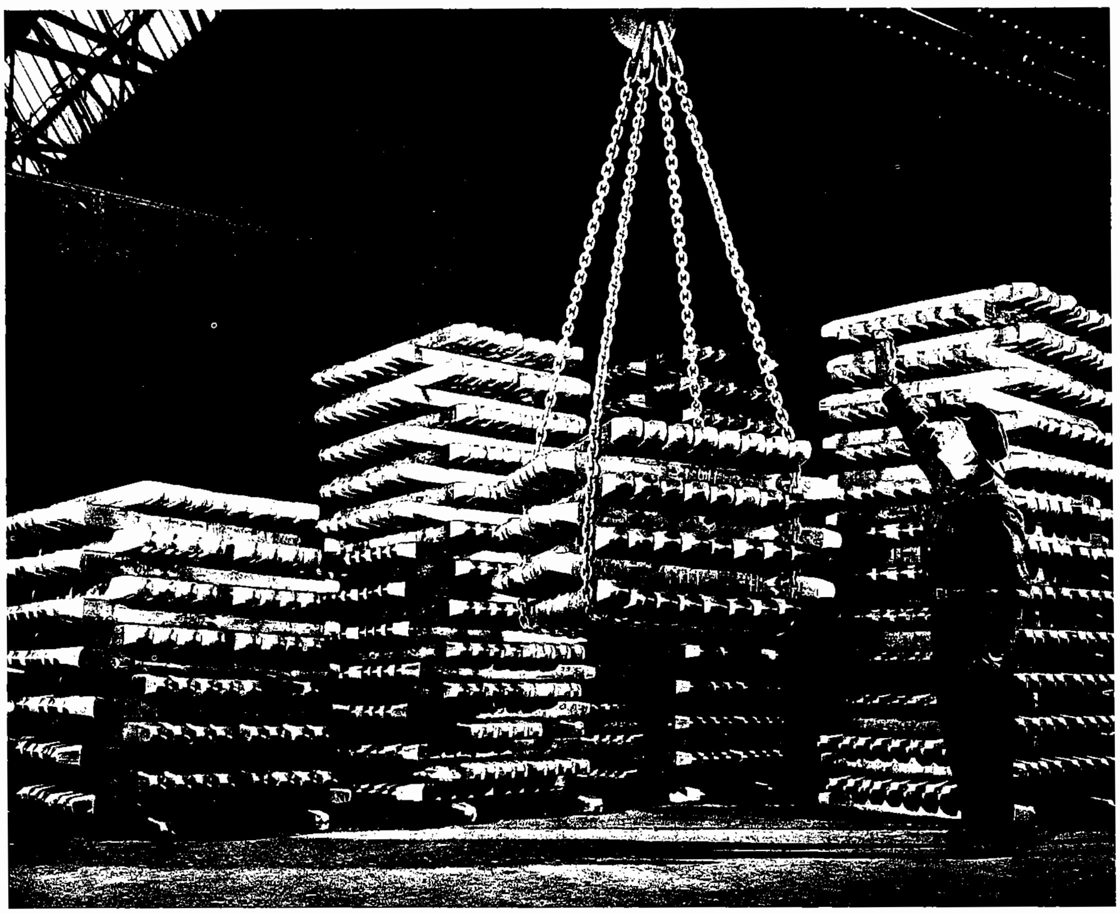
	British Preferential	Most Favoured Nation	General
CANADA			
Tungsten ores and concentrates......	free	free	free
Tungsten oxide in powder or lumps or in briquettes made with binding material used in steel manufacture .	free	free	5%
Tungsten carbide, in metal tubes for use in Canadian manufacturing.....	free	free	free
Ferrotungsten.....................	free	5%	5%
Tungsten rod and tungsten 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 for alloying purposes........	free	free	free

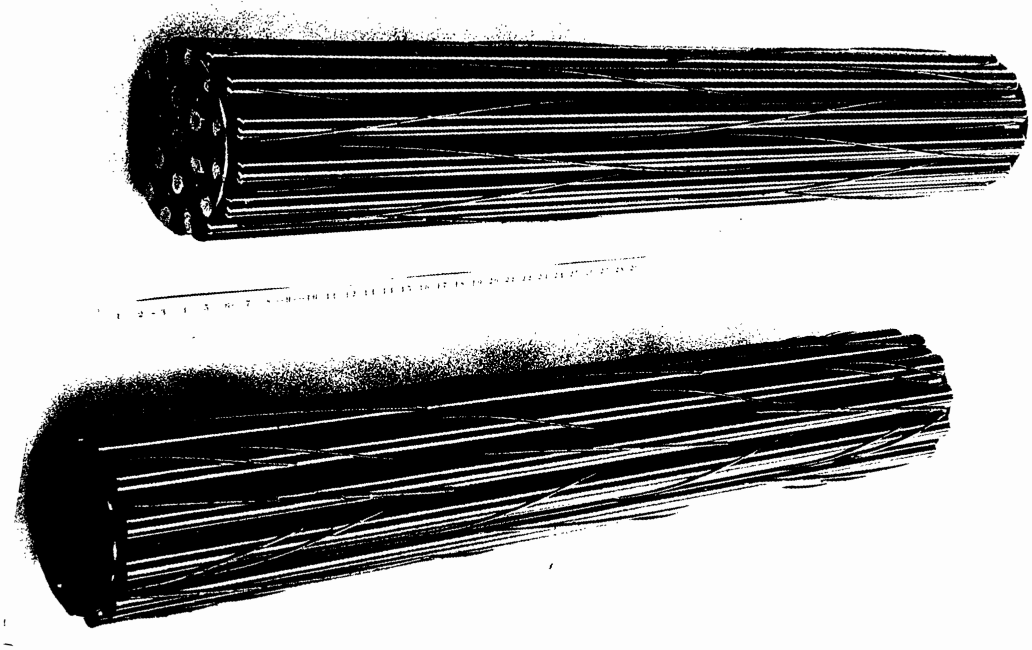
UNITED STATES	
Tungsten ore	50¢ per lb on tungsten content
Tungsten metal	
Unwrought	
Other than alloys	
Lump, grains and powders....	42¢ per lb on tungsten content +25%
Ingots and shots	21%
Other.....................	25.5%
Alloys	
Containing by weight not over 50% tungsten	42¢ per lb on tungsten content + 12.5%
Containing by weight over 50% of tungsten..............	25.5%
Waste and scrap	
Containing by weight not over 50% tungsten	42¢ per lb on tungsten content + 12.5%
Containing by weight over 50% tungsten	21%

TARIFFS (cont'd)

	British Preferential	Most Favoured Nation	General
Wrought........................	25.5%		
Ferrotungsten...	42¢ per lb on tungsten content + 12.5% ad val.		

Copper wire bars in the warehouse of International Nickel Company of Canada, Limited.





Nineteen-element uranium fuel bundles for NPD (top) and CANDU (bottom), 1965.

Uranium and Thorium

J.W. GRIFFITH*

Uranium

Production of uranium has declined steadily over the past five years. Volume of shipments in 1964, at 6,914 short tons of uranium oxide (U_3O_8), was 17 per cent below that of the previous year, as two more mines closed upon completion of contract deliveries. The value of shipments of U_3O_8 decreased by 38 per cent mainly as a result of the lower prices attached to deliveries under the 12,000-ton United Kingdom contract and the Canadian government stockpile program. Although output under present contracts is expected to continue declining for the next few years, recent world developments in nuclear power indicate a resurgence in uranium demand for peaceful purposes.

Despite some setbacks in the early development of nuclear energy for the generation of electricity, this new type of power is now considered to be competitive with conventional thermal power in certain high-cost fuel areas of the world and by 1970, it is expected to be competitive for base-load operations in many countries. Thus the outlook for the Canadian uranium industry, as a large supplier of uranium for reactor fuel, appears to be much brighter.

INDUSTRY DEVELOPMENTS

The federal government's short-term uranium stockpiling program, which was announced in June 1963, ended on June 30, 1964. Under this plan the government agreed to stockpile limited quantities of uranium that would enable three mines to remain in production until July 1, 1964. The three eligible mines were Denison Mines Limited, the Milliken mine of Rio Algom Mines Limited, both near Elliot Lake, Ontario, and Metal Mines Limited (Faraday mine) near Bancroft, Ontario. These mines otherwise would have had to close in 1963 or early 1964. The measure was adopted as a means of maintaining employment in the Elliot Lake and Bancroft areas for a slightly longer period so that alternative measures

*Mineral Resources Division

TABLE I
Uranium – Production and Exports

	1963		1964p	
	Short Tons	$	Short Tons	$
Production (U_3O_8), shipments				
Ontario	6,385	102,951,146	6,018	74,361,393
Saskatchewan	1,967	33,957,973	896	11,056,878
Total	8,352	136,909,119	6,914	85,418,271
Exports (U_3O_8)				
Britain		40,509,263		39,627,015
United States		96,879,093		34,862,680
West Germany		–		158,868
Japan		130,000		4,609
Brazil		13,025		–
Total		137,531,381		74,653,172

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

of assistance for these communities might be studied. As a result of the discontinuation of the stockpiling program, Faraday and Milliken closed on June 30, 1964. Stockpiled 'yellowcake' totals 2,683 tons of U_3O_8.

In addition to the contract for deliveries under the government's stockpile plan, Denison also received the undelivered portion of the contract held by Gunnar Mining Limited. Owing to depletion of ore, Gunnar was forced to close its mine in northern Saskatchewan in late 1963. Deliveries under its contract fell short by 1,200,000 pounds of U_3O_8 and Eldorado invited proposals from uranium producers in the Elliot Lake and Bancroft areas of Ontario to supply this quantity. The awarding of the contract was based on the greatest number of man-days of employment that a mine could guarantee in producing the 1,200,000 pounds and such additional quantity of U_3O_8 that it might wish to produce for its own stockpile. The price attached to the contract was $4.188 a pound of U_3O_8. Denison, the successful bidder, announced that it would also produce an equivalent amount on its own account, thereby enabling it to continue operating until July 1965.

The Denison mill treated a total of 1,275,384 tons of ore, averaging 3,573 tons a day and grading 3.14 pounds of U_3O_8 per ton. Production in 1964 was the lowest of any year during the company's 7½ years of operation. Mill recovery however, at 95.57 per cent, was the highest in its history. The company reported that much effort was expended on primary underground development to prepare the mine for future production. One major project during the year was the driving of a third ventilation opening to surface. An inclined heading was driven about 1,200 feet from the northernmost workings of the mine to a point under a small island in Quirke Lake.

During 1964, Denison's policy of selective mining was continued and the average grade of ore mined was the second highest in its history. Provisions were made, however, for the eventual recovery of areas of lower grade than those mined in 1964. In its annual report for 1964 the company reported reserves at 'approximately 300,000,000 pounds of U_3O_8'.

Denison carried out research on such projects as bacterial leaching in underground workings, the recovery of uranium from mine water and the production of a reactor-grade mine product. In addition, a solvent extraction plant was installed and tests confirmed that, with modifications, a precipitate, meeting nuclear-grade specifications, could be produced.

Rio Algom Mines Limited operated two mines and mills in the Elliot Lake district in 1964 – Nordic and Milliken. The latter ceased operations at the end of June after producing 1,170,478 pounds of U_3O_8 during the 6-month period. The average grade at Milliken was 2.24 pounds of U_3O_8 per ton and recovery was 94.5 per cent. The salvage of underground equipment at Milliken was begun at the end of June but a program of uranium recovery from mine waters was instituted when conventional mining was suspended. This program is now a function of Nordic mine and it employs about 20 men. By the end of 1964 approximately 49,000 pounds of U_3O_8 had been recovered by this method. Rio Algom reported that the leaching of uranium by mine water is aided by the action of bacteria and is accomplished by spraying the floors and walls of mined-out stopes. This was found to be an effective means of clean-up for mined-out workings but experience to the end of 1964 showed that economic recovery is not expected to continue indefinitely where no new ore surfaces are being created.

Operations at the Nordic mine and mill continued at a normal rate throughout the year with production totalling 2,953,387 pounds of U_3O_8. The mine treated 1,185,000 tons of ore with an average grade of 2.57 pounds of U_3O_8 per ton. Recovery was 95.2 per cent. A small amount of uranium was also recovered from mine water. The company reported that underground development was directed to opening up extensions to the eastern and western limbs of the orebody and by diamond drilling from surface to investigate the limits of the ore. The surface drilling resulted in the outlining of new reserves in the Pardee reef, located in the eastern part of the Nordic ore zone and approximately 25 feet above the Nordic reef, as well as additional reserves between the 14th and 19th levels in the latter reef. Additional reserves were outlined down to the 18th level. Compared with reserve figures published by the company for 1963, Nordic's reserves in 1964 showed a 46-per-cent increase in tonnage but a decrease of 7 per cent in grade. However, the grades were calculated after allowance for losses in mining and milling and are not comparable with grades published previously.

At year's end, Rio Algom's undelivered contracted uranium totalled 16,625,226 pounds. The Nordic mine is expected to deliver this quantity during the remaining contract period which runs to October 1971. Deliveries in 1965 are expected to amount to 2,761,000 pounds and in the following years they will be at a rate of 2.4 million pounds a year.

Total ore reserves of all Rio Algom mines in the Elliot Lake area were reported by the company to be nearly 61,000,000 tons, grading 2.41 pounds of U_3O_8 per ton. This tonnage includes proven ore, probable ore disclosed by underground development and probable ore disclosed by diamond drilling. This grade figure allows for losses in mining and milling. In addition, the company reported that widespread drilling adjacent to its mines has indicated substantial tonnages of slightly lower grade. About 50 per-cent of the company's properties in the Elliot Lake district are as yet unexplored.

Rio Algom Mines Limited co-operated with the federal Department of Mines and Technical Surveys, which set up a mining research group at Elliot Lake, by leasing buildings and making mine facilities available for the work of this group.

Rio Tinto Dow Limited, in which Rio Algom has a 50-per-cent interest, continued pilot plant development work on a process for the production of sinterable uranium dioxide of the type used in Canadian nuclear power reactors as well as in a number of planned and operating foreign reactors. Research in the production of other uranium compounds is also being carried out. This work was done in co-operation with Atomic Energy of Canada Limited and financial assistance from the National Research Council. A refinery, having a capacity of 150 tons of sinterable uranium dioxide a year, will be installed at the Nordic mine.

Stanrock Uranium Mines Limited discharged the remaining debts in its bankruptcy proceedings during 1964. Thus, for the first time since 1956, the company became free of long-term debt, other than the debt due in 1973 to Central Mortgage and Housing Corporation (a government-owned agency). Since the receivership and bankruptcy of the company in 1959, Stanrock has retired over $42,500,000 of debt and interest, together with charges incident to the receivership and bankruptcy.

During 1964 Stanrock delivered 1,597,943 pounds of U_3O_8 to Eldorado, leaving a balance of 209,607 pounds to be delivered in 1965. The contract price for 1964 production was about $5.45 a pound of U_3O_8. In October, the company ceased mining by conventional methods and began producing uranium concentrate by the collection and treatment of mine water alone. This includes the bacterial leaching process which involves 'washing down' the underground workings with water under pressure, collecting the runoff and pumping it to surface for mill treatment. The bacteria produce chemicals which in turn leach the uranium from exposed rock surfaces. As stated above, other mines in the Elliot Lake area are also employing this method but Stanrock is the only mine using it exclusively for the recovery of uranium. The company expects to recover approximately 15,000 pounds of U_3O_8 per month by the bacterial leaching method. Prior to conversion the mine was producing about 150,000 pounds per month. Over a two-year period, the same areas in the mine have been washed down seven times without a significant drop in recovery. The recovery of uranium by this method offers considerably reduced costs over the conventional method of mining but

TABLE 2

Canadian Uranium Producers' Statistics* for 1964

Company and Location	Mill Capacity (tons ore/ day)	Production (tons U_3O_8)	Ore Treated (millions of tons)	Millhead Grade (lb U_3O_8/ton)	Mill Recovery (%)	Remarks
Elliot Lake District, Ont.						
Denison Mines Limited................	6,000	1,975	1.28	3.14	95.57	
Rio Algom Mines Limited						
Milliken mine......................	3,000	585 (6 mo.)	0.53	2.24	94.5	Milliken mine closed in June 1964
Nordic mine	3,400	1,477	1.19	2.57	95.2	
Stanrock Uranium Mines Limited	3,000	775	..	..	..	Ceased mining Oct. 1964 but shipments to continue
Bancroft Area, Ontario.						
Metal Mines Limited (Faraday).........	1,500	195 (6 mo.)	0.18	2.30	94.9	Closed in June 1964
Beaverlodge Area, Sask.						
Eldorado Mining and Refining Limited ...	2,000	919	0.52	3.52**	..	

Source: Company annual reports.
*Most figures are approximate only. **Average recovery.
..Not available.

Stanrock's decision to convert was dictated primarily by a large increase in labour costs because of a shortage and a high turnover of miners in the late summer of 1964.

Operations at the Faraday mine in the Bancroft area of Ontario ceased on June 30, 1964, when its government contract was completed. Production during the 6-month period totalled 390,814 pounds of U_3O_8. The Faraday mine is owned by Metal Mines Limited, in which The Canadian Faraday Corporation Limited has an 85-per-cent interest. Diamond drilling is planned for some of the unexplored parts of the Bancroft property during 1965, in order to build up reserves for future markets. Remaining proven and probable reserves are 453,250 tons grading 0.144 per cent U_3O_8. Shutdown operations were carried out so as to permit minimum difficulty in any future reopening.

The bulk of the Bicroft plant and equipment of Macassa Gold Mines Limited, also in the Bancroft area of Ontario, was sold during 1964 and the company indicated that the remainder of the plant and equipment will be disposed of in 1965. Mining operations at Bicroft ceased in 1963.

The only uranium mine operating in the Beaverlodge area of northern Saskatchewan was that of Eldorado Mining and Refining Limited. Production under present contracts at this mine is expected to continue until early in 1967. Eldorado's mill treated a total of 522,148 tons of ore which yielded 1,837,029 pounds of U_3O_8. Operating costs increased slightly as a result of reduced production, increased development expenses and other additional cost increases. The company installed a 19-foot autogenous grinding mill to replace the original crushing and grinding facilities.

Mining operations at the property of Gunnar Mining Limited, on the north shore of Lake Athabasca, were terminated at the end of 1963.

RESOURCES AND FUTURE REQUIREMENTS OF URANIUM

Despite the present surplus in the world uranium supply, there is growing concern about long-term supplies for a market that is now expected to reach major proportions by 1980. The main reason for this concern is that in certain areas of the world the cost of power from nuclear-electric stations will soon be competitive with the cost of power from conventionally fuelled thermal-electric plants. In many countries nuclear power is expected to show economic advantages over conventional thermal power before 1975. Annual consumption of uranium for nuclear power in the Free World is estimated at 10,000 tons of U_3O_8 in 1970, increasing to about 75,000 tons in 1985.

Total established reserves of uranium in the Free World are 596,600 short tons of U_3O_8 (Table 3). These reserves constitute tonnages which can be exploited economically at a price of $10 a pound, or less, for U_3O_8.

Free World uranium reserves are more than sufficient to meet any forseeable demand for fuelling nuclear power plants. Therefore, the development of nuclear power programs should not be restrained because of concern about uranium supply.

Table 3
Free World Reserves* of Uranium
(as of Jan. 1, 1964)

Country	Short Tons U_3O_8
Canada	207,000
United States	160,000
South Africa	147,000
France	33,000
India	16,500
Australia	12,000
Spain	10,000
Argentina	1,100
Others	10,000
Total	596,600

*At $10 a pound of U_3O_8.
Source: Papers submitted to the Third International Conference on the Peaceful Uses of Atomic Energy, Geneva, Sept. 1964.

Present reserves of uranium in Canada are lower than they were in 1958, since prospecting ceased about this time. Canadian resources of U_3O_8, at prices ranging up to $20 a pound, are estimated at 1,100,000 tons and resources of ThO_2 are estimated at 700,000 tons (Table 4). These figures include present

TABLE 4
Canadian Resources* of Nuclear Fuels

Price Range ($/lb U_3O_8)	Tons U_3O_8	Tons ThO_2
5-10	500,000**	200,000
10-15	300,000	200,000
15-20	300,000	300,000
Total	1,100,000	700,000

*Includes proven reserves, potential reserves and an allowance for geologically probable future discoveries.
**The 207,000 tons of proven reserves (Table 3) are included.

reserves, geologically probable discoveries and an estimate of reserves potentially mineable at higher uranium prices. They are considered sufficient to supply prospective buyers for many years provided that growing demand brings higher prices for U_3O_8. Large but unmeasured additional resources of lower-grade material could be exploited if world consumption rates eventually outstrip rates of discovery of higher-grade ores. Canadian reserves of proven ore as of January 1, 1964, were estimated by the Department of Mines and Technical Surveys at

225,000,000 tons grading 0.12% U_3O_8 and 0.05% ThO_2. From this quantity approximately 207,000 tons of U_3O_8 and 82,000 tons of ThO_2 are recoverable at a price of less than $10 a pound for U_3O_8.

NUCLEAR POWER IN CANADA

In addition to several research reactors, Canada has a nuclear power demonstration plant (NPD) at Rolphton, Ontario, which went into operation in April 1962. This prototype nuclear power plant, of the heavy water type, has a net electrical output of 20 megawatts and requires very small amounts of uranium for annual refuelling purposes. A large commercial type nuclear power station being built at Douglas Point, Ontario, is expected to begin operating early in 1966. Known as CANDU, this station will have a net electrical output of 200 megawatts and will require not more than 25 tons of UO_2 (equivalent to 28 tons of U_3O_8) for annual refuelling. This reactor is also of the natural uranium heavy water type.

Ontario Hydro is planning to build the world's largest nuclear-electric generating station 20 miles east of Toronto, Ontario. Present plans call for two 500-megawatt (electrical) units to be operating at full power by November 1970. Early in 1965, tenders were being taken for components of up to six units with a time lapse of one year between completion of each unit but plans allow for a possible eventual plant of eight units having a total net capacity of 4,000 megawatts (electrical). The six-unit station, which is expected to be operating by 1975, will require an initial fuel charge equivalent to 750 tons of U_3O_8 and about 360 tons annually for refuelling.

Based on the assumption that Canada will have at least 6,000 megawatts of nuclear-electric generating capacity by 1980, forecasts of cumulative uranium requirements are estimated at 5,000 tons U_3O_8 between now and 1980 and 15,000 tons to 1985 with annual requirements of nearly 2,000 tons of U_3O_8 by 1985. Thus, domestic requirements of uranium for nuclear power purposes will not appreciably affect Canada's future ability to export uranium.

MARKETING

Procurement and marketing of most of the uranium produced in Canada has been the responsibility of Eldorado Mining and Refining Limited. Private producers are free to sell uranium abroad without reference to Eldorado but sales are subject to control measures administered through the Atomic Energy Control Board. Sales of uranium are permitted to countries that do not hold agreements with Canada for co-operation in the peaceful uses of atomic energy but the maximum amount any such country may receive from Canada is 2,500 pounds.

PRICES

The prices paid to the Canadian producers for the sale of mill concentrates (yellowcake) under government contract varied with each company, having been originally calculated to provide a profit after allowances for amortization of the major estimated capital costs and the estimated operating costs. Under most contracts, however, the maximum price paid was $10.50 a pound of U_3O_8 contained in the yellowcake. Before the announcement in November 1959 of the government's stretch-out plan, a few contracts were extended from 31 March 1962 to 31 March 1963; the price under these was either the original contract price or $8 a pound plus the amortization factor, whichever was the lower.

In recent years, some small individual transactions have taken place at prices as low as $3.65 a pound of U_3O_8 although such prices cannot be considered realistic in view of published cost figures. In any case, large sales by Canadian mines at such low prices are doubtful. The average price received by Canadian producers under a contract signed with the United Kingdom Atomic Energy Authority in 1962 was $5.03 (Can.) a pound.

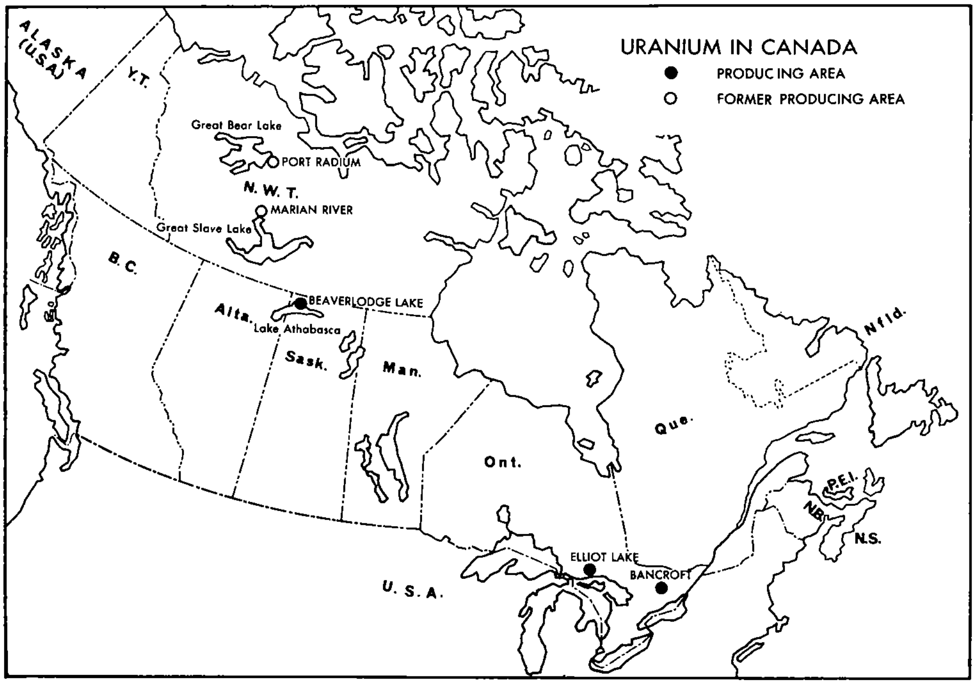
RESEARCH IN ORE TREATMENT

Ore treatment methods used at Canadian uranium mines have not changed significantly over the past few years although some future improvements, which are now known to metallurgists, will undoubtedly be made. The mines are not expected to make any major changes in flowsheets in the near future because the additional costs would hardly be justifiable over the short period of time remaining under present delivery contracts. The mine product, yellowcake, is a chemical precipitate of sodium or magnesium diuranate or a similar uranium compound, containing about 75 per cent U_3O_8. It is shipped to a refinery for further chemical treatment to produce a purified nuclear-grade product. Several companies have been doing research to determine the feasibility of making such a product at the mine site.

The Mines Branch of the Department of Mines and Technical Surveys has conducted laboratory investigations over a period of time on the flotation of uranium ores. A pilot plant program was carried out on one technique which appears to have possibilities of reducing overall process costs. Further flotation research is planned toward improving the selectivity of the process.

The new technique of leaching uranium from ore which, known as bacterial leaching, has been developed in mines at Elliot Lake, is dependent upon natural bacterial action on ore sulphides. It provides a most economical method of extracting uranium from the broken ore (mostly fines) left behind in underground workings and is used primarily as a scavenging process. Mine water is circulated from the upper mine openings down through the workings; the leach water is collected at each level for dispersion through pipes and sprays in the opening below. At one mine, the mine water at a pH of 2.2 contains 0.12 grams of U_3O_8 per litre; the average recovery is about 360 pounds of U_3O_8 a day. At another mine, uranium recovery represents about 8 per cent of total production. Research on flotation and bacterial leaching is continuing at the operating mines, at the Mines Branch in Ottawa and at the British Columbia Research Council.

Other new beneficiation techniques developed in Canada in recent years include the "K and H" electronic radioactive ore sorter, a device invented by



PRODUCERS IN 1964

1. Elliot Lake District, Ontario
   - Denison Mines Limited
   - Rio Algom Mines Limited (Milliken and Nordic mines)
   - Stanrock Uranium Mines Limited
2. Bancroft Area, Ontario
   - Metal Mines Limited (Faraday mine)
3. Beaverlodge Lake Area, Saskatchewan
   - Eldorado Mining and Refining Limited

FORMER PRODUCERS

1. Elliot Lake District, Ontario
   - Can-Met Explorations Limited
   - Preston Mines Limited (Stanleigh mine)
   - Rio Algom Mines Limited (Buckles*, Lacnor, Panel, Pronto, Quirke and Spanish-American mines)
2. Bancroft Area, Ontario
   - Bicroft Uranium Mines Limited
   - Canadian Dyno Mines Limited
   - Greyhawk Uranium Mines Limited*
3. Beaverlodge Lake Area, Saskatchewan
   - Black Bay Uranium Limited*
   - Cayzor Athabaska Mines Limited*
   - Consolidated Nicholson Mines Limited*
   - Gunnar Mining Limited
   - Lake Cinch Mines Limited*
   - Lorado Uranium Mines Limited
   - National Explorations, Limited*
   - Nesbitt Labine Uranium Mines Limited*
   - Rix-Athabasca Uranium Mines Limited*
4. Port Radium, Northwest Territories
   - Eldorado Mining and Refining Limited
5. Marian River Area, Northwest Territories
   - Rayrock Mines Limited

*Mines without mills

two Canadian engineers, L. Kelly and J. Hunter, formerly of Bicroft Uranium Mines Limited. It has given good results at several uranium mines in Canada and abroad. An earlier sorter for radioactive ore, invented by Dr. C. Lapointe of the Mines Branch, was used for several years at Eldorado's Port Radium operation to upgrade gravity concentrates.

PROSPECTING

Despite the present over-capacity of the uranium mining industry, it is becoming increasingly evident that renewed prospecting for new uranium deposits should not be long delayed. With its extensive areas of Precambrian sedimentary rocks similar to the conglomerates and related rocks of the Elliot Lake district of Ontario, Canada is considered to be a most favourable country for successful prospecting for uranium. In a paper presented at the Third International Conference on the Peaceful Uses of Atomic Energy at Geneva, J. Mabile and A. Gangloff of the French Atomic Energy Commission, stressed the importance of continuing to explore for uranium. Present resources of uranium in France and her territories are not sufficient to meet the future demand and so France must look abroad for additional resources.

Early in 1964 the French mining complex, Compagnie de Mokta, set up a Canadian subsidiary, Mokta (Canada) Ltée, to prospect for uranium in Canada. The company acquired a large number of claims in the Beaverlodge Lake area of northern Saskatchewan and a company official reported discoveries of uranium along the coast of Labrador. Although several large Canadian mining companies have recently shown an interest in renewed prospecting for uranium, Mokta is the only mining company in recent years that has announced any results. The Crown corporation, Eldorado Mining and Refining Limited, also staked a number of claims adjoining its main holdings in the Beaverlodge Lake area during 1964. Late in 1964, mining companies restaked claims in the Elliot Lake district that had been allowed to lapse some time ago.

Thorium

Thorium is widely distributed throughout the earth's crust. It has an atomic weight of 232.14, an atomic number of 90, a density of 11.5 and a melting point of 1,800°C. It is a soft, lustrous, greyish-white metal which oxidizes readily; this dark oxide coating on its surface thus protects it against further attack. Thorium is found in more than 60 minerals, some of the most important of which are monazite, thorianite, thorite, uranothorite and thorogummite. Although monazite is the principal ore mineral of thorium, the latter is not an essential constituent of monazite. The principal thorium minerals in Canada are monazite, thorite, uranothorite, allanite, and the niobate-tantalate family of minerals.

Canada began producing thorium raw materials in March 1959 when Rio Tinto Dow Limited* made trial shipments from Ontario's Elliot Lake district. Because the company's Elliot Lake plant is still Canada's sole producer of thorium salts, production statistics have not been released for publication. The plant has a designed capacity for 150 to 200 tons of thorium compounds a year. Owing to a sharp drop in demand for thorium products in 1962, only small quantities of thorium oxide were produced at the Elliot Lake plant. The company's extraction circuit was shut down early in 1963 but a new production campaign was begun in August 1964. The thorium market continues to be relatively small.

The thorium produced by Rio Tinto Dow is used in magnesium alloys and gas mantles and as a fuel in nuclear reactors. Both the reactor at Indian Point, New York, owned by Consolidated Edison Co. of New York, Inc., and the one at Elk River, Minnesota, a joint project of the United States Atomic Energy Commission and the Rural Cooperative Power Association, use thorium fuel from Canada.

Dominion Magnesium Limited, at Haley, Ontario, manufactures three thorium products – sintered pellets of pure thorium, thorium powder and a thorium-magnesium master alloy (40% Th). The company receives thorium concentrates from Rio Tinto Dow Limited and ships the finished products to the United States. Annual plant capacity is 200,000 pounds of thorium metal in the form of pellets of 98 per cent purity, or powder of 99.5 per cent purity. Shipments in 1964 totalled 6,455 pounds compared with 7,099 pounds shipped the previous year.

SOURCES OF THORIUM

The principal sources of thorium in Canada are the uranium ores of the Elliot Lake district, which are estimated to average 0.05 per cent thorium dioxide (ThO_2). The thorium is carried in the minerals monazite, uraninite and brannerite. The ores that were being mined near Bancroft for uranium are estimated to carry from 0.02 to 0.2 per cent ThO_2, but there has been less sampling for thorium than at Elliot Lake. Certain Bancroft deposits that have not been mined for uranium apparently carry considerably more thorium than do the uranium ores. The uranium ore reserves of the Elliot Lake and Bancroft areas are estimated to contain 82,000 tons of thorium. At the 1961 rate of uranium production in these camps it would be possible to recover approximately 4,000 tons of thorium oxide a year as a byproduct.

EXTRACTION PROCESS

The Rio Tinto Dow thorium recovery plant, near Elliot Lake, was constructed at a cost of $1 million. The first operating unit was put up near the Quirke mine of Rio Algom Mines Limited. Early in 1961 the closing of the Quirke mine led to the construction of a second unit at Rio Algom's Nordic mill, although a

* Rio Tinto Dow was formed by the Rio Tinto Mining Company of Canada Limited and Dow Chemical of Canada, Limited.

part of the original facilities at Quirke was still being used for the production of thorium oxide refined from sludge produced and shipped by the new Nordic plant. If the thorium market improves, additional thorium recovery units can readily be built to treat the waste solutions from other uranium mines of the Elliot Lake and Bancroft areas.

Thorium is obtained in dilute solution from the uranium treatment plant wastes. It is usually discarded in the mine-tailings dumps and is then not economically recoverable. The solution contains about a pound of thorium and about half a pound of rare earths to a thousand gallons. A relatively new process of solvent extraction* is used to extract and precipitate the thorium so as to separate it from iron, aluminum and the rare earths. The process, primarily chemical, consists of extracting the thorium from the waste liquor or the uranium circuits by solvent extraction, then stripping the thorium from the organic solvent with a strong sulphuric acid solution, followed by precipitating and thickening the thorium product. The thorium sludge is then filtered and dried, giving a crude product of about 25 per cent ThO_2.

Part of the cake is further refined to metallurgical-grade thorium oxide (99.8+% ThO_2) at the Quirke plant. One hundred pounds of thorium oxide contain about 88 pounds of thorium.

The rare earths – ytterbium, thulium, erbium, europium, holmium, dysprosium, terbium, gadolinium, neodymium, praseodymium, lanthanum and particularly yttrium – are also contained in the Elliot Lake ores and if market conditions warranted, could be recovered with thorium from the effluent of the uranium treatment plants in the proportion of 1 pound to every 3 or 4 pounds of thorium.

USES

Apart from its use as an alloying constituent, thorium has few major industrial applications. Because of its great tensile strength at high temperatures, it is alloyed with magnesium for use in the skin components of supersonic aircraft and space vehicles. These alloys also go into castings such as those in the compressor housings of jet engines. Thorium has been used for some time in incandescent gas mantles for gasoline lanterns, which are growing in popularity with campers. In atomic energy, thorium is one of the two naturally occurring source materials from which nuclear fuels may be generated. Over the past few years, experiments on the use of thorium as a fuel in 'breeder' reactors have been carried out in the United States and Britain.

A breeder reactor is one that converts a fertile material, such as thorium, into a fissile material which is capable of sustaining a chain reaction. In a breeder reactor it is theoretically possible to create more new fissionable material than is consumed. However, a number of technical obstacles must be overcome if such a reactor is to become more attractive than the uranium-fuelled type.

* Foreign plants use the sulphuric acid process or that of caustic attack on monazite. Thorium products are then separated from the accompanying rare earths.

Thorium has a number of special uses, for example, in arc-welding electrodes. It is used in the filaments of incandescent electric lamps along with tungsten and as a deoxidant in the production of such metals as molybdenum and molybdenum-rich alloys. It also is used in electron tubes and lamps for controlling starting voltages and maintaining stability, and as a catalyst in the chemical and petroleum industries. Because of its extremely high melting point, thorium oxide has been used as a refractory material and as an ingredient in special optical glass.

MARKETS AND PRICES

Although the Canadian producer has captured a large share of the world thorium market formerly held by monazite sand producers, the thorium market is still small, and no rapid expansion of outlets can be foreseen for the near future. Most of the thorium produced in Canada is shipped to the United States and Britain in the form of concentrates.

Metallurgical-grade thorium dioxide is priced at $5 a pound and the fluoride (metallurgical-grade ThF_4) is $4.25 a pound as quoted by Rio Tinto Dow Limited The prices of some thorium compounds were reported by Charles T. Baroch of the U.S. Bureau of Mines in ENGINEERING AND MINING JOURNAL, February 1965, as follows:

	Price Range* (U.S. $ per pound)
Thorium nitrate	3.50- 7.65
Thorium oxide	7.00-24.00
Thorium oxalate	6.23- 7.46
Thorium fluoride, anhydrous	76.00
Thorium metal, powder or pellets	15.00-50.00

* Price depends upon form, quality and the quantity purchased.

TARIFFS

The Canadian tariff rates listed below were obtained from the Department of National Revenue, Customs and Excise Division. Those for the United States are from tariff schedules of the United States, as of the end of 1964.

	British Preferential	Most Favoured Nation	General
CANADA			
Thorium ores	free	free	free
Thorium isotopes	free	free	25%
Thorium dioxide	15%	20%	25%

CANADA (cont.)

	British Preferential	Most Favoured Nation	General
Thorium bases or salts for the manufacture of incandescent gas mantles	free	free	free

UNITED STATES

	(%)
Thorium metal, unwrought	12½
Alloys of thorium, unwrought	15
Nitrates, oxides and other salts	35
Monazite sand and other thorium ores	free

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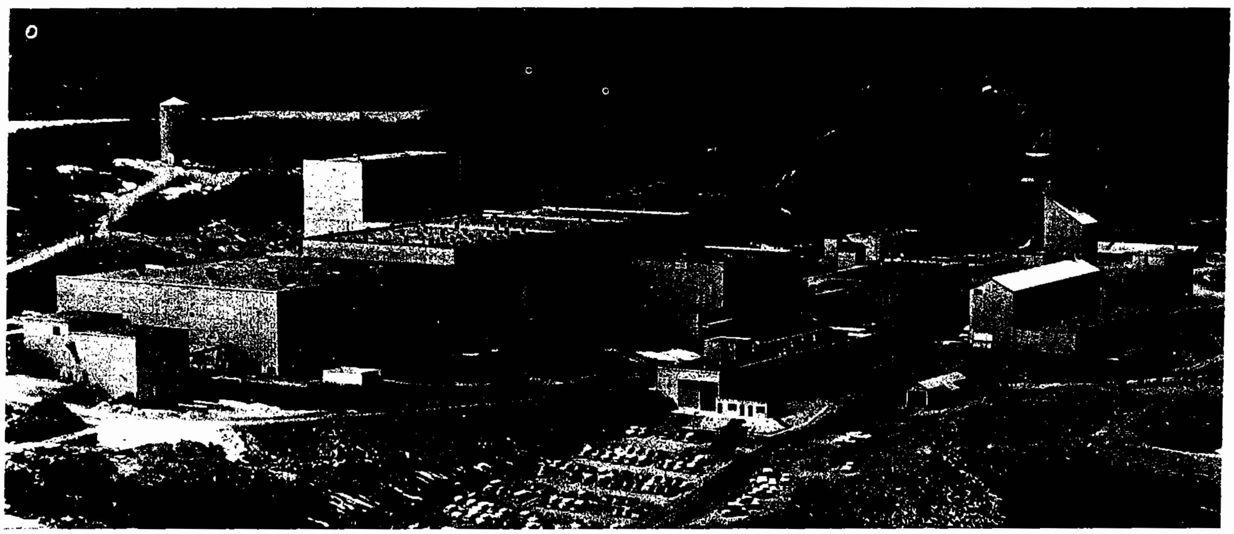

Rio Algom Mines Ltd., Nordic mine, Elliot Lake, Ontario.

Vanadium

V.B. SCHNEIDER*

In 1964 Canadian Petrofina Limited started the first vanadium pentoxide (V_2O_5) recovery operation in Canada at Pointe-aux-Trembles, Quebec. Initial recovery rate will be in the order of 800 pounds of vanadium pentoxide (V_2O_5) a day, increasing to about 1,500 pounds a day during 1966. The salable product will contain 98 per cent V_2O_5 maximum, 1 per cent Fe_2O_3 and traces of nickel, silicon, sodium and aluminum. Masterloy Products Limited of Ottawa, Ontario, reports that it is producing ferrovanadium for export and domestic consumption and expects that it will be using about 200,000 pounds of contained vanadium a year.

Although Petrofina's is the first commercial operation for the recovery of vanadium in Canada, a potential source exists in the slag produced at Sydney, Nova Scotia, from Wabana iron ore. The iron blast furnace slag contains from .075 to 1 per cent V_2O_5. The ash from the bitumen of the Athabasca tar sands contains about 4 per cent vanadium; this is equivalent to 240 parts per million in the bitumen.

The United States Bureau of Mines estimated in its COMMODITY DATA SUMMARIES of January, 1965, that non-Communist world production of vanadium in concentrates in 1964 was 14.8 million pounds. Although vanadium is a fairly common element, its occurrence in a concentrated form is rare and the vanadium content of concentrations rarely exceeds 2 per cent. Consequently, most of the vanadium produced has been derived as a byproduct in the recovery of other metals, particularly uranium in the United States, iron in the Republic of South Africa and lead in South-West Africa. Because of a curtailment in U.S. government stockpiling of uranium, production of it and of byproduct vanadium has been lower in recent years. The supply of vanadium remained well in excess of consumption with nearly all of United States production continuing to come from uranium mining and milling operations of the Western States.

*Mineral Resources Division

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In 1963 the uranium procurement program of the U.S. Atomic Energy Commission (AEC) no longer provided for purchases of vanadium concentrates or for payments of vanadium content of uranium ores or concentrates.

CANADA

Canadian Petrofina announced on February 3, 1965, it would construct a vanadium recovery plant in connection with an expansion program at its Pointe-aux-Trembles (Montreal) oil refinery. The vanadium pentoxide recovery plant was expected to cost about $1 million. The vanadium content of Venezuelan crude, processed by Canadian Petrofina at Montreal, is about 130 parts per million, which is considered to be relatively low for vanadium recovery. Petrofina processes about 32,000 barrels of Venezuelan crude oil a day, equivalent to about 1 million gallons. This crude contains about 1,200 pounds of vanadium, or 2,000 pounds of vanadium pentoxide, the form in which the metal is recovered. Construction of the plant was decided upon when a process for the extraction of V_2O_5 from crude oil was developed by Canadian Petrofina in conjunction with the Department of Mines and Technical Surveys, Ottawa.

The company reported that with an estimated processing cost of 30 cents a pound the project seemed sufficiently attractive to warrant commercial production, particularly as the crude capacity of the refinery will be doubled within the next year.

The largest use of vanadium is in the form of ferrovanadium, an addition agent in the manufacture of iron and steel. Canadian consumption by the iron and steel industry in 1964 was 204 tons gross weight having a metal content of 115 tons. The second largest use in Canada is as a catalyst in the manufacture of sulphuric acid in plants using the Contact Process. Besides ferrovanadium and vanadium pentoxide, other commercial forms of vanadium are: ammonium metavanadate, vanadium pentoxide, vanadium oxytrichloride and vanadium carbide, also used as a steel alloying agent.

WORLD PRODUCTION AND CONSUMPTION

The United States is by far the largest producer and consumer of vanadium. The U.S. Bureau of Mines reported that U.S. mine production in 1964 amounted to some 8.5 million pounds, primarily as a byproduct of uranium operations in the Colorado Plateau area. Kermac Nuclear Fuels Corporation, a wholly-owned subsidiary of Kerr-McGee Oil Industries, Inc., operates a plant for the recovery of V_2O_5 from ferrophosphorus at Soda Springs, Idaho. The ferrophosphorus is a waste product of Monsanto Company's nearby phosphorous recovery operations. The plant is capable of producing 75 tons of V_2O_5 a month from 12 to 15 tons of ferrophosphorous feed a day and its design is such that production could quite easily be doubled if feed were available.

TABLE 1

Vanadium Production in Ores and Concentrates, 1960–63
(short tons)

	1960	1961	1962	1963
United States	4,971	5,343	5,233	3,862
Republic of South Africa	656	1,422	1,393	1,391
South-West Africa	838	1,145	1,019	1,134
Finland	625	701	629	617
Others	146	116	12	–
Total	7,236	8,727	8,286	7,004

Source: U.S. Bureau of Mines, MINERALS YEARBOOK 1963, VOLUME 1.

The U.S. Bureau of Mines reported that vanadium is consumed by about 285 firms in the United States. The steel industry consumes 83 per cent of the total; nonferrous alloys, 10 per cent; and chemicals (largely catalysts), 5 per cent.

The strategic stockpile in the United States at the end of 1964 contained 15.7 million pounds of vanadium, which represents 552 per cent of the maximum objective.

Vanadium Corporation of America announced the signing of a long-term agreement for future purchases of South African vanadium concentrates from Anglo American Corporation of South Africa Limited. Anglo American estimates that the vanadium pentoxide content of its proposed iron ore operation in Africa amounts to more than 3 million tons of vanadium pentoxide; V_2O_5 production would be dependent upon scale of mining the vanadiferous magnetites of the Bushveld Complex.

After that of the United States, production from the Republic of South Africa and South-West Africa ranks second and third. In South-West Africa vanadium is recovered in lead-vanadium concentrates, the production of which in 1964 amounted to 11,020 tons. This material contains about 18 per cent vanadium pentoxide.

The United States is the largest consumer of vanadium and according to the U.S. Bureau of Mines MINERAL INDUSTRY SURVEYS, VANADIUM MONTHLY, March 2, 1965, vanadium consumption there amounted to 7,066,611 pounds in 1964. It is believed that West Germany and Britain rank second and third behind the United States as consumers of vanadium, particularly in the form ferrovanadium.

TABLE 2

Vanadium Consumed in the United States, by End-Use, 1964

	Pounds
Steel	
High-speed	598,436
Hot-work tool	247,596
Other tool	181,304
Stainless	66,969
Other alloy[1]	4,114,769
Carbon	736,024
Grey and malleable castings	45,934
Nonferrous alloys[2]	664,057
Chemicals	339,090
Other[3]	72,432
Total	7,066,611

Source: U.S. Bureau of Mines, MINERAL INDUSTRY SURVEYS, VANADIUM MONTHLY, MARCH 2, 1965.

[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, cutting and wear-resistant materials.

USES

Vanadium is consumed principally in the form of ferrovanadium, an alloy of iron and vanadium, as additions to steel for castings, forgings and rolled products, particularly tool steels. It is used mainly for its grain refining and alloying effects. It is also used in permanent magnetic alloys to which it provides good workability, both hot and cold. Compounds of vanadium are used in industry, the main one being vanadium pentoxide which is widely used in industrial catalysts, notably in sulphuric acid manufacture. Other uses appear certain for the near future, for example in the automotive field as a catalyst to reduce the emission of noxious or smog-forming fumes from automobile exhausts. Sodium and ammonium metabanadate have important uses in catalyst production, as an ingredient in coloured glazes for porcelain enamels and ceramic ware, and as driers or colour fixatives in paints, inks and dyes.

PRICES

E & MJ METAL AND MINERAL MARKETS of December 28, 1964, quoted vanadium prices in the United States as follows:

Vanadium ore per lb V_2O_5, f.o.b. mine or mill, domestic, nominal, 31 cents.

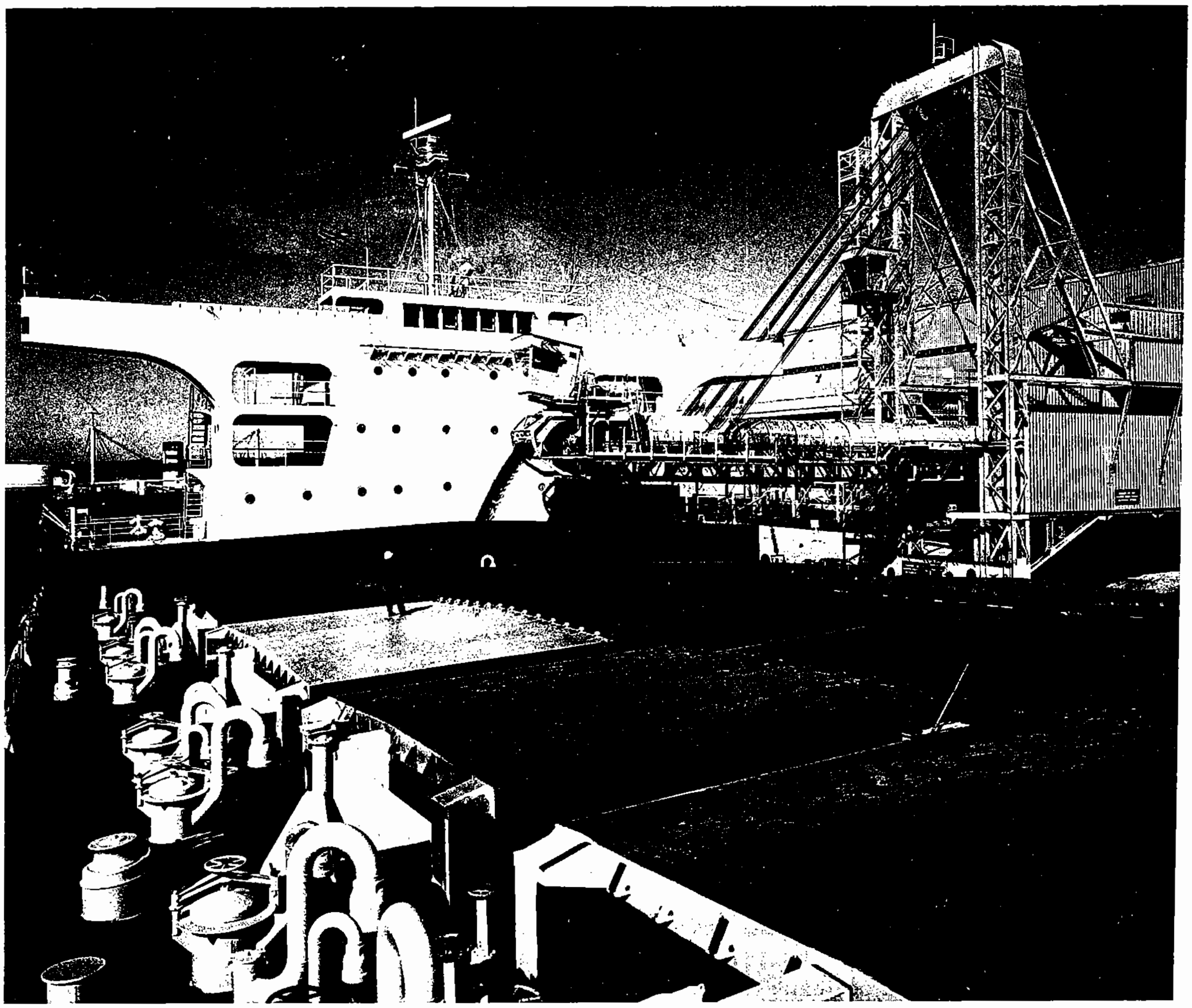
Vanadium metal per lb, 90% purity, 100-lb-lots, \$3.45.
Ferrovanadium per lb V content, carload lots, delivered, various sizes, 50–55% V, \$2.50.

TARIFFS

CANADA		British Preferential	Most Favoured Nation	General
329	Vanadium ores and concentrates	free	free	free
208g	Vanadium oxide in powder, lumps, formed into briquettes, for use in mfr. of steel	free	free	5%
208t	Vanadium metal, in lump, powder, ingot, block, (class or kind ruled to be not produced in Canada)	free	15%	25%
711	Vanadium metal, bars, rods, processed forms	15%	25%	25%
375	Ferrovanadium	free	5%	5%

UNITED STATES

601.60	Vanadium ore, concentrates	free
632.58	Vanadium metal, unwrought	10% ad val
633.00	Vanadium metal, wrought	18%
607.70	Ferrovanadium	12.5%
632.58	Vanadium metal waste and scrap	free
422.58	Vanadium carbide	12.5%
422.60	Vanadium pentoxide	32%
422.62	Vanadium compounds, other	32%
427.22	Vanadium salts	32%



Concentrated iron ore being loaded aboard carrier "Ore Chief", one of the world's largest bulk freighters.

Zinc

D.B. FRASER*

Canadian zinc production in 1964, according to preliminary figures, was 44 per cent greater than in 1963 and reached a record of 682,000 short tons. Value of production rose by 60 per cent to $193,285,000 as a result of higher production and prices during the year.

In terms of zinc contained in concentrates, output was 735,100 tons in 1964 compared with 497,200 tons the previous year.

The increase in mine production was due mainly to new mines in the provinces of Quebec and New Brunswick. In the Matagami district of northwestern Quebec, two new zinc-copper mines completed their first full year of operation and produced 190,000 tons of contained zinc compared with 18,000 tons in 1963. In the Noranda district, Lake Dufault Mines, Limited, opened a copper-zinc mine in the latter part of the year. In New Brunswick, a zinc-lead-copper mine was brought into production in March, increasing the province's output from 11,000 tons of recoverable zinc in 1963 to 54,000 tons in 1964.

Also contributing to the increase in mine production in 1964 were smaller amounts from several new mines, which included the Stall Lake copper-zinc mine at Snow Lake, Manitoba, the Consolidated Rambler zinc-copper mine in Newfoundland, and the first-recorded output of zinc from the Northwest Territories with the start of test shipments of ore from Pine Point in November. Production from Pine Point will increase Canadian output substantially in 1965.

* Mineral Resources Division

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TABLE 1

Zinc – Production, Trade and Consumption

	1963		1964p	
	Short Tons	$	Short Tons	$
Production				
All forms[1]				
Quebec	75,084	19,191,567	228,580	64,779,482
British Columbia	201,432	51,485,905	207,656	58,849,820
Ontario	66,470	16,989,728	68,420	19,390,110
New Brunswick	10,614	2,712,939	53,785	15,242,714
Manitoba	46,392	11,857,855	42,671	12,093,072
Newfoundland	34,485	8,814,473	41,498	11,760,108
Saskatchewan	33,320	8,516,479	28,429	8,056,816
Yukon	5,925	1,514,520	7,146	2,025,168
Northwest Territories	–	–	3,195	905,463
Nova Scotia	–	–	644	182,651
Total	473,722	121,083,466	682,024	193,285,404
Mine output[2]	497,180		735,130	
Refined[3]	284,021		337,728	
Exports				
Zinc blocks, pigs and slabs				
Britain	82,857	15,779,816	97,991	25,598,291
United States	74,251	17,852,987	78,563	20,442,703
Netherlands	8,122	1,752,531	15,534	4,721,877
India	21,535	3,835,231	15,126	3,910,987
Japan	1,874	356,196	7,538	1,926,003
West Germany	4,564	848,616	6,211	1,456,991
Belgium and Luxembourg	616	144,428	5,702	1,208,230
Italy	504	81,488	4,096	819,170
Thailand	34	7,212	1,656	331,775
Philippines	386	56,753	1,618	332,698
France	168	26,486	914	182,754
Other countries	5,091	922,768	3,127	794,159
Total	200,002	41,664,512	238,076	61,725,638
Zinc contained in ores and concentrates				
United States	156,964	13,093,348	188,750	19,541,874
Belgium and Luxembourg	14,379	1,296,013	93,377	15,015,361
West Germany	7,466	801,627	32,298	5,308,016
Poland	1,785	128,000	28,356	4,404,345
Japan	6,836	514,700	24,384	3,481,500
France	1,963	189,963	16,219	2,538,626
Britain	10,616	959,968	7,490	1,315,325
Norway	13,035	1,210,460	5,403	1,091,905

Table 1 (cont.)

	1963		1964p	
	Short Tons	$	Short Tons	$
Netherlands	–	–	4,869	855,984
Sweden	–	–	1,956,	134,630
Total	213,044	18,194,079	403,102	53,687,566
Zinc-fabricated materials, not elsewhere specified				
United States	556	202,203	1,022	305,838
Britain	504	321,030	691	247,482
Guatemala	–	–	124	51,733
Trinidad	91	38,188	13	6,495
Other countries	167	50,270	18	7,491
Total	1,318	611,691	1,868	619,039
Zinc and zinc-alloy scrap, dross and ashes				
United States	3,012	461,601	3,972	717,290
Belgium and Luxembourg	2,135	112,364	2,238	149,304
West Germany	–	–	608	69,066
Britain	257	15,623	465	68,183
Netherlands	318	21,034	239	27,757
Japan	–	–	134	28,366
Italy	–	–	133	28,122
Total	5,722	610,622	7,789	1,088,088
Imports[4]				
Zinc in ores and concentrates	..	..	13,697	2,287,000
Zinc dust and granules	1,171	353,148	1,851	610,000
Zinc slabs, blocks, pigs, anodes	639	167,347	22	8,000
Zinc bars, rods, plates, strip and sheet	788	465,688	833	531,000
Zinc slugs, discs, shells	..	138,547	482	193,000
Zinc oxide	2,232	158,191	1,167	274,000
Zinc sulphate	1,682	178,216	1,499	178,000
Lithopone	391	59,181	539	81,000
Zinc fabricated materials not elsewhere specified[5]	..	..	1,313	1,150,000

98115—43½

Table 1 (concl.)

	1963			1964		
	Primary	Secondary	Total (short tons)	Primary	Secondary	Total
Consumption						
Zinc used for or in the manufacture of						
Copper alloys (brass, bronze, etc.).............	7,296	95	7,391	10,166	101	10,267
Galvanizing:						
Electro..................	770	43	813	830	73	903
Hot-dip..................	37,070	326	37,396	43,283	325	43,608
Zinc die-cast alloy.........	14,919r	—	14,919r	17,966	—	17,966
Other products (including rolled and ribbon zinc, zinc oxide)..................	13,598	1,474	15,072	16,249	2,059	18,308
Total..................	73,653r	1,938r	75,591r	88,494	2,558	91,052
Stocks on hand at end of year......................	7,806	830	8,636	11,569	626	12,195

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. [4]Changes in statistical classification of imports, effective 1964, result in some 1964 classes not being comparable with those of previous years. [5]This class for 1964 is not comparable to the class 'zinc manufactures n.o.p.' of previous years. The latter included many categories of zinc end products which are not now included in the 1964 class 'zinc fabricated materials, n.e.s.'
Symbols: p Preliminary; — Nil; .. Not available; r Revised.

Production of refined zinc also set a record in 1964, rising to 337,700 tons from 284,000 tons the previous year. The three primary refineries operated at near-capacity throughout the year; the newest, at Valleyfield, Quebec, completed its first full year of operation and produced 67,710 tons compared with intitial production of 10,300 tons in the last quarter of 1963. Primary refining capacity at the end of 1964 was:

	Annual Capacity (short tons)
The Consolidated Mining and Smelting Company of Canada Limited, Trail, B.C.......	208,000

	Annual Capacity (short tons)
Hudson Bay Mining and Smelting Co., Limited, Flin Flon, Manitoba	79,000
Canadian Electrolytic Zinc Limited, Valleyfield, Quebec	84,000
Total	371,000

Zinc concentrates produced in Manitoba and Saskatchewan were refined at Flin Flon. Most of those produced in British Columbia and the Territories were refined at Trail; the rest was exported to refineries in the states of Idaho and Montana. Production from eastern mines, except that going to the Valleyfield zinc refinery, was exported to the United States, Europe and Japan.

Some of the zinc concentrates destined for the United States first went to Canadian roasting plants at Port Maitland, Ontario, and to Arvida, Quebec, for recovery of sulphur in the form of sulphuric acid.

Refined zinc was exported in 1964 to 33 countries. Britain and the United States together accounted for 74 per cent of the total, continental Europe for 14 per cent and Asian countries for 11 per cent. Exports of zinc concentrates were 89 per cent higher than in 1963. There were substantial increases in exports to

TABLE 2

Zinc – Production, Exports and Consumption, 1955–64
(short tons)

	Production		Exports			Consumption[3]
	All Forms[1]	Refined[2]	In Ore and Concentrates	Refined	Total	
1955	433,357	256,542	190,585	213,837	404,422	58,062
1956	422,633	255,564	199,313	183,728	383,041	61,173
1957	413,741	247,316	187,141	202,007	389,148	52,713
1958	425,099	252,093	217,823	195,708	413,531	56,097
1959	396,008	255,306	181,084	179,552	360,636	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	73,653r
1964p	682,024	337,728	403,102	238,076	641,178	88,494

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.

Symbols: p Preliminary; r Revised.

Belgium, West Germany, France, Netherlands, Poland and Japan. Those to the United States, which continued to be the largest single export market for zinc concentrates, increased by 20 per cent.

Reported domestic consumption of refined zinc was 21 per cent higher than in 1963, increasing by 17 per cent in galvanizing, 20 per cent in zinc die-casting alloy, 20 per cent in zinc oxide and rolled zinc production, and 40 per cent in the production of copper alloys.

TABLE 3

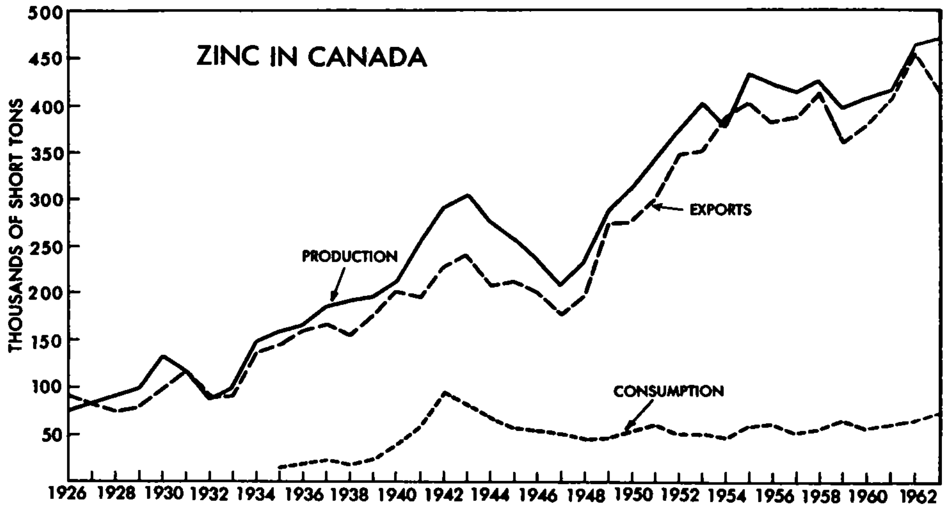
Free-World Production of Zinc, 1964

(short tons)

	Mine Production	Refined Production
Canada	735,000	338,000
United States	627,000	1,031,000
Australia	354,000	208,000
Peru	..	67,000e
Mexico	..	66,000e
Japan	238,000	349,000
West Germany	130,000	185,000
Italy	122,000	88,000
Spain	90,000	71,000
France	19,000	210,000
Belgium	—	244,000
Britain	—	123,000
Other countries		279,000
Total	..	3,259,000

Source: International Lead and Zinc Study Group.
Symbols: — Nil; .. Not available; e Estimate.

Free World consumption of zinc continued to rise in 1964, reaching a record total of about 3½ million short tons. The main increases were in the United States (83,000 tons), Japan (60,000 tons), West Germany (45,000 tons), Britain (29,000 tons) and France (25,000 tons). In total, the increase was nearly 300,000 tons. Production rose also but by a lesser amount. The United States government released 75,000 tons of zinc from its surplus stocks in the last half of the year, and producers' stocks were heavily drawn down in order to meet the rising demand. The U.S. zinc price rose from 13 to 14.5 cents a pound during the year. On the London Metal Exchange a low of £94 per long ton was recorded in January and a high of £148 in July, the year-end price being £112.75 or 15.1 cents a pound (Canadian).



UNITED STATES QUOTAS

The import quotas on unmanufactured lead and zinc imposed by the United States in October 1958 continued in effect during 1964, limiting commercial imports to 80 per cent of their annual average for the five-year period 1953 to 1957. The quota on Canadian zinc ores was 33,240 tons of contained zinc per quarter; on zinc metal it was 18,920 tons per quarter.

The quota on Canadian zinc ores was filled on the opening day of each quarter. The metal quota was filled in each quarter on the following dates: March 24, June 30, September 28, December 22.

The U.S. Tariff Commission in March 1964 instituted an investigation of the probable economic effect on the domestic industry of a reduction or termination of import quotas. Its report was not issued by the year's end. The annual report on quotas, usually released on October 1, was deferred since the special investigation was still underway.

INTERNATIONAL LEAD AND ZINC STUDY GROUP

The International Lead and Zinc Study Group, which has met regularly since 1959, held its Eighth Session in Madrid from October 21-30, 1964. In its review of current developments the Group noted the sharp rise that is taking place in zinc mine production, the slower rise in refined metal production and the low level of concentrate stocks in many countries. World consumption had risen by 8 per cent in 1963 from the previous year and a rise of 9 per cent was forecast for 1964. A lower rate of increase was forecast for 1965. Despite the release of zinc from United States government surplus stocks and a rise in imports from Soviet-bloc countries, supplies of zinc fell short of demand. The outlook for 1965 was for continuing shortages. The longer-term forecast of the Group to 1967 showed substantial increases in supply of zinc.

PRINCIPAL DEVELOPMENTS AT PRODUCING MINES AND REFINERIES

BRITISH COLUMBIA

Ore production in 1964 at the Sullivan mine of The Consolidated Mining and Smelting Company of Canada Limited totalled 2,711,000 tons, 116,000 tons more than the previous year. Production from the Bluebell mine was 258,000 tons and from the H.B. mine was 474,000 tons. Ore reserves at the company's mines that are tributary to the Trail smelter (Sullivan, Bluebell and H.B.) at September 30, 1964, were 75,000,000 tons containing 8,300,000 tons of lead and zinc. Zinc production in 1964 totalled 199,011 tons, 5,852 tons more than in 1963. Lead and zinc production was derived approximately 68 per cent from Sullivan concentrates, 14 per cent from concentrates of the company's other mines, 17 per cent from purchased ores and concentrates, and 1 per cent from old slag stockpiles. Work continued on the extension to the Trail zinc plant which, scheduled for completion by October 1965, will raise annual capacity to 235,000 tons.

MANITOBA AND SASKATCHEWAN

Hudson Bay Mining and Smelting Co., Limited, produced 71,012 tons of slab zinc, compared with 79,596 tons in 1963, from the treatment of copper-zinc ores mined in the Flin Flon and Snow Lake districts. Total ore treated was 33,000 tons less than in the previous year. Fifty per cent of the ore treated came from the Flin Flon mine, 12 per cent from the Coronation mine and 5 per cent from the Schist Lake mine, all at or near Flin Flon. The two mines at Snow Lake – Chisel Lake mine and the Stall Lake mine – accounted for 17 and 16 per cent. Ore reserves at year's end totalled 16,627,400 tons, 1,512,000 tons more than at the end of 1963.

TABLE 4

Principal Zinc Mines in Canada, 1964

Company and Location	Mill Capacity (tons ore/day)	Grade of Ore (Principal Metals) Zinc (%)	Lead (%)	Copper (%)	Silver (oz/ton)	Ore Produced 1964 (1963) (short tons)	Contained Zinc Produced 1964 (1963) (short tons)	Remarks
British Columbia								
The Anaconda Company (Canada) Ltd., Britannia Beach	4,000	0.57	—	1.24	0.15	444,757 (493,700)	1,985 (4,233)	Closed August to year's end due to a strike.
Canadian Exploration, Limited, Salmo	1,900	3.54	1.53	—	..	407,062 (368,673)	13,326 (14,091)	
The Consolidated Mining and Smelting Company of Canada Limited:								
(Sullivan, Kimberley)	10,000	..	..	—	..	2,711,000 (2,595,000)	133,424 (130,966)	Small tonnage of open-pit ore mined
(Bluebell, Riondell)	700	..	..	—	..	258,000 (256,000)	14,413 (14,463)	Exploration continued.
(H.B., Salmo)	1,200	..	..	—	..	478,000 (474,000)	20,941 (20,655)	Development of lower-grade ore zone begun.
Johnsby Mines Limited, Silverton	250	4.59	3.23	—	16.03	2,988 (—)	122 (—)	Development in vicinity of Standard-Mammoth-Hecla group.
London Pride Silver Mines Ltd., Kaslo	100	5.42	2.33	—	..	6,742 (—)	336 (—)	Development of Cork Province Claims.

Table 4 (cont.)

Company and Location	Mill Capacity (tons ore/day)	Grade of Ore (Principal Metals) Zinc (%)	Lead (%)	Copper (%)	Silver (oz/ton)	Ore Produced 1964 (1963) (short tons)	Contained Zinc Produced 1964 (1963) (short tons)	Remarks
Mastodon-Highland Bell Mines Limited, Beaverdell	90	1.8	1.3	–	34	25,090 (21,689)	382 (532)	Routine development
Reeves MacDonald Mines Limited, Remac	1,200	3.56	1.20	–	..	379,269 (145,966)	12,958 (4,822)	Strike ended December 1963, located ore extension of main orebody.
Sheep Creek Mines Limited, Toby Creek	500	4.13	1.49	–	0.59	182,958 (203,942)	6,971 (9,352)	
Yukon Territory								
United Keno Hill Mines Limited, Elsa (Hector-Calumet, Elsa, Keno, Silver King)	500	4.92	6.38	–	33.37	181,849 (186,721)	8,240 (7,380)	Routine operations.
Manitoba and Saskatchewan								
Hudson Bay Mining and Smelting Co., Limited, Flin Flon (Flin Flon,								

Chisel Lake, Stall Lake, Coronation, Schist Lake mines)	6,000	4.1	0.4	2.83	0.94	1,585,394 (1,618,617)	58,912 (77,774)	Stall Lake mine opened in February, underground development at Osborne Lake mine.
Ontario								
Kam-Kotia Porcupine Mines, Limited, Timmins	1,500	1.0	–	1.26	..	638,000 (400,091)	1,660 (23)	Changing from open-pit to underground mining
Noranda Mines Limited (Geco Division), ... Manitouwadge	3,300	5.52	..	2.09	2.48	1,299,300 (1,281,165)	56,640 (59,529)	Shaft sinking proceeding.
Willroy Mines Limited, Manitouwadge	1,500	3.34	0.35	1.10	1.38	530,151 (483,800)	15,353 (11,702)	Development of Willecho property, production planned early 1965.
Quebec								
The Coniagas Mines, Limited, Bachelor Lake	350	9.57	0.72	–	3.68	114,459 (111,418)	8,963 (13,882)	Ore reserves increased.
Lake Dufault Mines, Limited, Noranda[1]	1,300	7.56	–	5.00	2.37	112,117 (–)	6,094 (–)	
Manitou-Barvue Mines Limited, Val d'Or[2]	1,300	5.12	0.57	–	3.68	142,925 (174,365)	6,740 (8,826)	Closed for 2 months due to a lockout-strike.
Mattagami Lake Mines Limited, Matagami Lake	3,850	13.1	–	0.71	1.15	1,282,072 (166,725)	148,282 (16,550)	Mill capacity raised from 3,000 to 3,850 tons daily.

Table 4 (cont.)

Company and Location	Mill Capacity (tons ore/day)	Grade of Ore (Principal Metals) Zinc (%)	Lead (%)	Copper (%)	Silver (oz/ton)	Ore Produced 1964 (1963) (short tons)	Contained Zinc Produced 1964 (1963) (short tons)	Remarks
New Calumet Mines Limited, Calumet Island[3]	750	6.09	1.61	–	3.55	94,823 (93,360)	5,752 (6,134)	
Normetal Mining Corporation, Limited, Normetal	1,000	7.17	–	1.89	1.75	348,924 (345,384)	21,641 (14,744)	Preparing to sink an internal shaft.
Orchan Mines Limited, Matagami Lake[4]	1,900	12.79	–	1.06	1.59	369,272 (35,956)	41,570 (1,483)	Development for cut-and-fill mining in 1965, open stoping in 1964.
Quemont Mining Corporation, Limited, Noranda	2,300	2.38	–	1.16	0.70	752,691 (803,000)	13,574 (12,999)	
Solbec Copper Mines, Ltd., Stratford Centre	1,000	4.56	0.57	1.80	1.28	424,127 (188,493)	13,880 (7,212)	Started open-pit mining in May.
Sullico Mines Limited, Val d'Or	3,000	0.35	–	0.59	0.19	988,023 (1,007,046)	2,268 (1,042)	
New Brunswick								
Brunswick Mining and Smelting Corporation Limited, Bathurst	4,500	9.47	4.07	0.30	2.60	777,902 (–)	115,653[5] (–)	Data are for regular operations which began July 1, 1964, and do not

								include tune-up from March to June.
Heath Steele Mines Limited, Newcastle[7]	1,500	6.4	2.7	0.9	2.6	290,000 (265,939)	14,960 (11,113)	Routine development.
Nova Scotia								
Magnet Cove Barium Corporation, Walton	125	1.52	3.69	0.64	12.7	48,927 (49,058)	702 (639)	
Newfoundland								
American Smelting and Refining Company (Buchans Unit), Buchans ..	1,250	13.04	7.36	1.09	4.07	383,000 (376,000)	45,115 (47,900)	
Consolidated Rambler Mines Limited, Baie Verte[7]	500	2.23	–	1.26	1.09	57,381 (–)	685 (–)	Started production in September, new shaft collared.

[1]The mine and milling plant reached full production by October 1, 1964 following a two-month tune-up period. Data are for last quarter. [2]Also milled in a separate circuit 244,980 tons of copper ore averaging 0.82 per cent copper. [3]Data are for the fiscal year ending September 30, 1964. [4]Nine hundred tons of copper ore daily are custom-milled for New Hosco Mines Limited. [5]Zinc concentrate produced. [6]About half the mill capacity is used to treat copper ore from COMINCO's Wedge mine. [7]Production started September 1, 1965.

Symbols: – Nil; .. Not available.

QUEBEC

Production of zinc in Quebec rose from 75,000 tons in 1963 to 229,000 tons in 1964 due mainly to the output of two mines at Matagami Lake which opened in October 1963. Mattagami Lake Mines Limited, the larger of the two, increased its milling capacity from 3,000 to 3,850 tons of ore daily. Zinc production was 148,300 tons. The nearby Orchan Mines Limited operated a 1,900-ton mill, treating 1,000 tons of Orchan zinc-copper ore and 900 tons of copper ore daily from New Hosco Mines Limited.

Canadian Electrolytic Zinc Limited at Valleyfield, Quebec, produced 67,710 tons of slab zinc in 1964 from the treatment of zinc concentrates from the Matagami Lake, Manitouwadge and Noranda districts. Capacity was raised to 250 tons of slab zinc daily and plans were announced to make a further increase to 300 tons daily in 1965 and later to 400 tons daily. These plans included installation of roasting and acid-producing facilities at Valleyfield. Following three years of exploration and development, Lake Dufault Mines, Limited, a subsidiary of Falconbridge Nickel Mines, Limited, began production from a copper-zinc orebody 8 miles north of Noranda, reaching capacity output by October 1. From that date to the end of the year, 112,117 tons were milled and 6,094 tons of zinc in concentrates were produced.

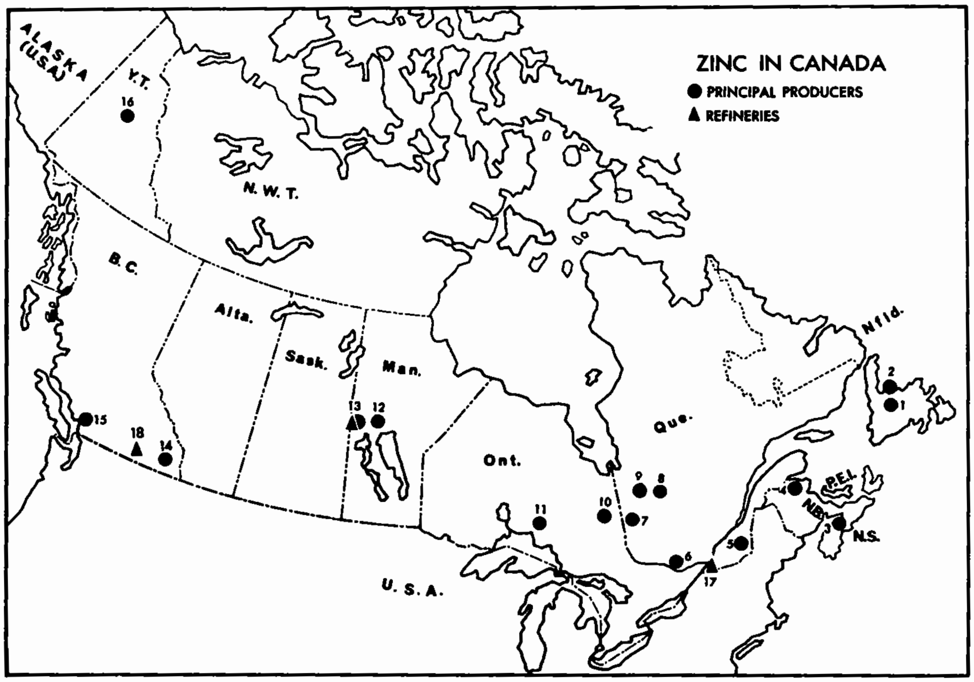
NEW BRUNSWICK

Production of zinc in New Brunswick rose from 10,600 tons in 1963 to 53,800 tons in 1964. The increase was due to the start of production at the Bathurst district No. 12 mine of Brunswick Mining and Smelting Corporation Limited and, to a lesser extent, to increased output by Heath Steele Mines Limited. At the No. 12 mine, zinc concentrates and lead-copper-silver concentrates were produced in a 4,500-ton mill. First shipments to Belgium were made from the port of Dalhousie in July. The company announced plans for the opening of two new zinc-lead mines in the Bathurst district and for the construction of additional milling capacity and steel, acid and fertilizer plants.

East Coast Smelting and Chemical Company Limited, a Brunswick subsidiary, continued construction of a zinc-lead blast furnace at Belledune Point, 21 miles north of Bathurst on Chaleur Bay. Construction began late in 1963 and is scheduled for completion in mid-1966 when production from the treatment of Brunswick concentrates will begin at an annual rate of about 30,000 tons each of lead and zinc.

NEWFOUNDLAND

In Newfoundland, Consolidated Rambler Mines Limited began production in September from its copper-zinc deposit at Baie Verte. Output was at an initial rate of 400 tons a day from the 500-ton mill.



PRINCIPAL PRODUCERS

1. American Smelting and Refining Company (Buchans Unit)
2. Consolidated Rambler Mines Limited
3. Magnet Cove Barium Corporation
4. Brunswick Mining and Smelting Corporation Limited; Heath Steele Mines Limited
5. Solbec Copper Mines, Ltd.
6. New Calumet Mines Limited
7. Manitou-Barvue Mines Limited; Normetal Mining Corporation, Limited; Quemont Mining Corporation, Limited; Sullico Mines Limited; Lake Dufault Mines, Limited
8. The Coniagas Mines, Limited
9. Mattagami Lake Mines Limited; Orchan Mines Limited
10. Kam-Kotia Porcupine Mines, Limited
11. Noranda Mines Limited (Geco Division); Willroy Mines Limited
12. Hudson Bay Mining and Smelting Co., Limited – 2 mines; Chisel, Stall Lake
13. Hudson Bay Mining and Smelting Co., Limited – 3 mines; Flin Flon, Coronation, Schist Lake
14. Canadian Exploration, Limited; COMINCO – 3 mines: Sullivan, H.B., Bluebell; Mastodon-Highland Bell Mines Limited; Reeves MacDonald Mines Limited; Sheep Creek Mines Limited; Johnsby Mines Limited; London Pride Silver Mines Ltd.
15. The Anaconda Company (Canada) Ltd.
16. United Keno Hill Mines Limited

REFINERIES

17. Canadian Electrolytic Zinc Limited, Valleyfield
13. Hudson Bay Mining and Smelting Co., Limited, Flin Flon
18. COMINCO, Trail

OTHER DEVELOPMENTS

NORTHWEST TERRITORIES

The Consolidated Mining and Smelting Company of Canada Limited continued development of its Pine Point zinc-lead deposit on the south shore of Great Slave Lake. Auxiliary service buildings were nearly completed, the main mill buildings were closed in and installation of milling equipment started. Work started on the stripping of a second orebody in preparation for open-pit mining. Exploration outlined several other orebodies.

The 430-mile railway from Roma, Alberta, to Hay River and Pine Point, although not entirely completed, came into limited operation early in November. Test shipments of ore were made to COMINCO plants in British Columbia at a rate of 2,500 tons a week. The 5,000-ton mill at Pine Point is scheduled to come into operation late in 1965.

BRITISH COLUMBIA

Western Mines Limited continued exploration of its Buttle Lake property on Vancouver Island. Reserves of zinc-copper-lead ore were reported to be 1,500,000 tons in the Lynx zone and 113,000 tons in the Paramount zone. Production at a rate of 750 tons daily is planned.

YUKON TERRITORY

United Keno Hill Mines Limited continued to carry out an extensive exploration program on its Mayo district properties.

Vangorda Mines Limited, a subsidiary of Kerr Addison Mines Limited, drilled two large-diameter holes in 1964 to obtain fresh ore samples for metallurgical testing. Located in the Pelly River district 126 miles northeast of Whitehorse, the deposit contains an indicated 9,400,000 tons of zinc-lead-copper ore.

MANITOBA

Hudson Bay Mining and Smelting Co., Limited, continued deveolpment of the Osborne Lake deposit, 13 miles northeast of Snow Lake, and of the Flexar deposit, 8 miles southwest of Flin Flon. Development of the Anderson Lake mine, between the Stall Lake and Chisel Lake mines, began late in the year.

Sherritt Gordon Mines, Limited, carried out a program of deep drilling on its Fox Lake copper-zinc deposit 28 miles southwest of Lynn Lake. The previous estimate of reserves in this deposit, which was discovered in 1961, was 4,600,000 tons. The revised estimate, based on drilling completed to the end of 1964, was 12,100,000 tons averaging 1.72 per cent copper and 2.28 per cent zinc to a depth of 2,000 feet. The deposit had not been bottomed and below 1,000 feet was open at both ends.

ONTARIO

Texas Gulf Sulphur Company early in 1964 discovered a zinc-copper-silver orebody in Kidd Township, 15 miles north of Timmins. In June a preliminary reserve estimate of 55 million tons of ore grading 7.08 per cent zinc, 1.33 per cent copper and 4.85 ounces silver a ton was announced. Subsequent drilling confirmed the ore value and added to the tonnage. Total drilling was more than 100,000 feet. Plans were made to begin production in 1966 from open-pit operations. Initial mill capacity will be 2 million tons of ore annually and provision was made in the design of the mill for expansion to 3 million tons, or about 9,000 tons a day. A later phase of the development, the company reported, will be the establishment of a smelter, a major capital investment to be considered when the Kidd Creek mine is in production. Work proceeded during 1964 on diamond drilling, metallurgical testing, construction of an access road and stripping of the clay overburden, which ranges from 5 to 50 feet thick. On December 3, the Ontario government approved plans for construction of a 16-mile spur line of the Ontario Northland Railway to the property.

QUEBEC

Plans were completed to bring into production the property of Mines de Poirier inc., a subsidiary of Rio Algom Mines Limited. Following diamond drilling and underground development work, reserves were estimated at 1,800,000 tons averaging 3 per cent copper and 1,400,000 tons averaging 8 per cent zinc. Production was scheduled for the beginning of 1966 at a rate of 1,500 tons of ore daily. The property is in Poirier Township, 50 miles north of Amos.

Joutel Copper Mines Limited, a subsidiary of Kerr Addison Mines Limited, carried out underground development and completed 18,485 feet of diamond drilling on its Joutel Township property 60 miles north of Amos. Reserves were 1,370,000 tons averaging 2.35 per cent copper and 434,000 tons averaging 8.98 per cent zinc and 0.2 per cent copper.

Cupra Mines Ltd., one of the Sullivan group of companies, continued development of a copper-zinc deposit in the Eastern Townships, 2.5 miles from the Solbec mine. The reserves to a depth of 1,400 feet were 1,014,000 tons averaging

3.25 per cent copper, 3.03 per cent zinc and 0.51 per cent lead. It is planned to begin production by September 1965 at a rate of 300,000 tons of ore a year. The ore will be trucked to the Solbec mill for treatment.

NEW BRUNSWICK

Brunswick Mining and Smelting Corporation Limited, which opened No. 12 Mine in March 1964, announced plans to open two new mines, the No. 6 about 6 miles south of the No. 12, and The New Larder 'U' property of an associated company, Key Anacon Mines Limited, 10 miles east of the No. 12. A lead-zinc concentrator will be built to treat the ore from these mines, which is expected to total 1,500 tons daily.

The Nigadoo deposit, 11 miles northwest of Bathurst, which was explored and partially developed from 1953 to 1958 by N.V. Billiton Mij of Holland, was acquired by the Sullivan group of companies in 1964. A subsidiary company, Nigadoo River Mines Limited, was formed to dewater and develop the deposit. Reserves calculated to a depth of 1,000 feet were 1,390,000 tons averaging 2.77 per cent zinc, 2.97 per cent lead, 0.34 per cent copper and 4.36 ounces of silver a ton, plus cadmium and bismuth. Further work was planned for 1965 with production expected to begin late in 1966.

NEWFOUNDLAND

Newfoundland Zinc Mines Limited, formed in 1963 to explore the claims of a syndicate consisting of Highland-Bell Limited, Leitch Gold Mines Limited and American Metal Climax, Inc., completed 17,000 feet of surface diamond drilling in 96 holes in 1964 on properties on the Great Northern Peninsula. Four zinc areas were located, one containing 100,000 tons averaging 10 per cent zinc, another containing 435,000 tons averaging 6 per cent zinc and a third of 50,000 tons averaging 5 per cent zinc. Further work is planned for 1965.

USES

About half the zinc consumed in Canada is used for galvanizing of steel. Use in zinc die castings in next is importance, accounting for 20 per cent of consumption. Copper alloys, zinc oxide and rolled zinc are other principal outlets. Consumption in all categories was higher in 1964 than in the previous year and amounted to a record 91,100 tons.

In galvanizing, zinc is applied as a corrosion-preventative coating to iron and steel products. Galvanized sheet, which accounts for the largest tonnage of galvanized products, is used in industrial and farm-building construction, in highway construction for guardrails, culverts and signs, and in automobile under-bodies as protection against the attack of road-salt solutions. One of the newer uses is in prepainted or polyvinylfluoride-coated galvanized sheet for residential house-siding. Other steel products commonly galvanized are wire and wire rope, tubes and pipe, and a wide range of machine and hardware parts and fittings.

Die castings of zinc-base alloys are used for many automotive, household appliances and machine parts. The alloys most commonly used for die casting are made of high-purity zinc to which is added about 4 per cent aluminum, 0.04 per cent magnesium and from zero to one per cent copper. Automobile components commonly made of zinc-base die castings include front-end grilles, instrument panels, head- and taillight assemblies, carburetors, fuel pumps and a variety of exterior and interior hardware. Zinc-base die castings are used in washing machines, sewing machines, lighting fixtures, oil burners, kitchen equipment and many other home appliances. Plumbing and hardware supplies also use zinc-base die castings extensively.

Brass, a copper-zinc alloy containing as much as 40 per cent zinc, is widely used in the form of sheets and strips, tubes, rods and wire, castings and extruded shapes. Zinc oxide is used in compounding rubber and in making paint, rayon yarn, ceramic materials, inks, matches and many other commodities. Rolled zinc is used in Canada mainly for making dry-cell batteries, terrazzo strip, weather stripping, roofing drains and gutters, and anticorrosion plates for boilers and ships' hulls. Zinc dust is used to make zinc salts and compounds, to purify fats, to manufacture dyes and to precipitate gold and silver from cyanide solutions. The more industrially important compounds of zinc are zinc chloride, zinc sulphate and lithopone, a mixture of barium sulphate and zinc sulphide used for making paint.

TABLE 5

United States Consumption, by End Use, 1963 and 1964

(short tons)

	1963	1964p
Galvanizing	420,287	433,614
Brass products	128,237	132,003
Zinc-base alloy	468,619	478,902
Rolled zinc	42,166	40,648
Zinc oxide	16,037	19,991
Other uses	29,767	26,722
Estimated undistributed consumption	–	56,700
Total	1,105,113	1,188,580

Source: U.S. Bureau of Mines Mineral Industry Surveys, UNITED STATES ZINC INDUSTRY, December 1964.
Symbols: 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, used chiefly for die casting; High Grade, used for making brass and miscellaneous products; and Prime Western for galvanizing.

In Canada, the electrolytic process produces Special High Grade and High Grade zinc. To meet consumer requirement for Prime Western, Canadian producers add small amounts of lead to the higher grades.

RESEARCH

Further progress was made in 1964 on the zinc research projects being carried out at the Mines Branch, Department of Mines and Technical Surveys, Ottawa, with the co-operation of the Canadian Zinc and Lead Research Committee and the International Lead Zinc Research Organization.

Investigation of the hot-dip galvanizing behaviour of low-alloy high-strength steels was extended to a group of materials different in composition and processing history from those previously tried. Earlier findings that alloying of the bath offered one effective means of suppressing the aggravated zinc attack to which such materials, notably high-silicon grades, are prone, were confirmed. As a first step in evaluating the industrial potential of the development, a limited scale test was made in a commercial galvanizing plant, yielding results in line with the laboratory experiments. Arrangements for a large-scale pilot program are well advanced. Further laboratory testing on this phase has been suspended but may be renewed depending on the outcome of the pilot investigation.

In an extension of the project dealing with the elevated temperature behaviour of galvanized coatings, tests were made with several grades of continuous strip produced in different plants. The results conformed to those of prior work which had indicated that the mode and rate of elevated temperature deterioration of different materials was a function of the continuous-strip processing conditions. The behaviour on heating of conventional hot-dip coatings of the type applied in general galvanizing practice is being investigated. Two separate studies have been undertaken, involving the performance of commercial coatings on thick-wall galvanized products and the mechanism of the flaking failure to which such coatings are prone.

Fundamental studies on the viscosity, density and surface tension of molten zinc and zinc alloys have been completed. Authoritative data obtained is in process of publication and covers several different grades of pure zinc, a range of Zn-Al, Zn-Pb, Zn-Sn and Zn-Cu binary alloys, as well as some more complex systems of importance in the galvanizing and die-casting fields. The results for viscosity and density have shown none of the anomalies near the melting point which have been observed by other workers, and these have been attributed to faulty techniques. In the case of the surface tension results, new data have been collected on the temperature coefficient of surface tension, which may contribute significantly to our knowledge of the liquid state.

Similar work is now being carried out on lead and lead alloys and will be extended to cover indium and cadmium.

The foundry characteristics of a new zinc-base sand-casting alloy have been investigated. It was shown that the alloy could be readily melted and cast, had mechanical properties as good as, or better than most sand-cast copper and aluminum alloys and hence may have an economic future as a general-purpose casting alloy.

PRICES AND TARIFFS

The Canadian price of Prime Western zinc f.o.b. Toronto and Montreal during 1964 was 13.0 cents a pound from the beginning of the year until April 13, when it was increased to 13.5 cents. This price remained in effect until October 21 when it moved to 14.5 cents. The price was 14.5 cents a pound for the remainder of the year.

The United States price f.o.b. East St. Louis was 13.0 cents a pound at the beginning of the year. It was increased to 13.5 cents on April 8 and to 14.5 cents on October 15 where it remained for the balance of the year.

At the beginning of the year the settlement and cash sellers' price on the London Metal Exchange was £96.5 per long ton (13 cents a pound Can.). The high for the year was £149 (20 cents Can.) reached on July 24. At year's end the price was £114.5 (15.5 cents Can.)

A new zinc price, producer basis, was first quoted in July 1964 at £125 per long ton (16.8 cents a pound Can.). The price remained at this level until September 4 when it was reduced to £110 (14.7 cents a pound Can.)

Canadian and United States tariffs during 1964 were as follows:

	British Preferential	Most Favoured Nation	General
CANADA			
Zinc 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	½¢	½¢	2¢

	British Preferential	Most Favoured Nation	General
Zinc, or zinc alloys containing not more than 10% by weight of other metal or metals, in form of foil, ribbon, strip, plate, discs, slugs; coated or not.....	5%	7½%	20%
Zinc dross and zinc scrap for remelting or processing into zinc dust	free	free	10%
Zinc manufactures not otherwise provided for........................	15½%	17½%	25%
Zinc flat rolled; zinc strip or sheet for lithographing.......................	free	free	10%

UNITED STATES

Zinc ores and concentrates*	0.67¢ per lb on zinc content
Zinc, unwrought*	
other than alloys of zinc	0.7¢ per lb
alloys of zinc	19% ad val
Zinc vaste and scrap*	0.75¢ per lb

Varying tariffs on other forms of zinc and zinc manufactures are applied

*Zinc-bearing ores and concentrates and unwrought zinc, excepting alloys of zinc and zinc dust but including zinc waste and scrap, are subject to quarterly import quotas.

Statistical Tables

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TABLE 1

Mineral Production of Canada, 1963 and 1964

	Unit of Measure	1963 Quantity	1963 $'000	1964p Quantity	1964p $'000
Metals					
Antimony..........	000 lb	1,601	625	1,719	866
Bismuth...........	"	359	704	387	840
Cadmium..........	"	2,475	5,941	2,518	8,033
Calcium...........	"	99	117	159	175
Cobalt	"	3,025	6,122	3,196	6,484
Columbium (Cb_2O_5).	"	1,393	1,300	2,250	2,305
Copper............	000 st	453	284,404	494	328,234
Gold..............	000 troy oz	4,003	151,118	3,811	143,855
Indium	000 oz	..	..	..	..
Iron ore...........	000 lt	26,914	313,183	34,522	402,892
Iron, remelt.......	000 st	...	9,247	...	15,955
Lead..............	"	201	44,256	200	53,864
Magnesium	000 lb	17,810	5,358	18,042	5,593
Mercury	"	-	-	6	22
Molybdenum (Mo content)..........	"	834	1,344	1,278	1,789
Nickel	000 st	217	360,393	233	381,997
Platinum group	000 troy oz	358	22,585	375	25,196
Selenium	000 lb	469	2,274	449	2,213
Silver.............	000 troy oz	29,932	41,426	31,112	43,557
Tellurium	000 lb	77	499	80	509
Thorium	"	..	..	..	..
Tin...............	"	927	649	356	623
Titanium ore	000 st	-	-	-	-
Tungsten (WO_3)	000 lb	..	..	..	..
Uranium (U_3O_8)....	"	16,703	136,909	13,828	85,418
Zinc	000 st	474	121,083	682	193,285
Total metals			1,509,537		1,703,705
Nonmetals					
Arsenious oxide....	000 lb	187	8	300	12
Asbestos..........	000 st	1,276	136,956	1,377	148,370
Barite	000 st	174	1,693	172	1,692
Diatomite	st	798	27	584	20
Feldspar..........	000 st	9	197	9	205
Fluorspar.........	"	...	1,976	...	2,292
Gem Stones........	000 lb	16	16	...	15

Table 1 (cont'd)

	Unit of Measure	1963 Quantity	1963 $'000	1964p Quantity	1964p $'000
Nonmetals (cont'd)					
Graphite..........	st	–	–	13	7
Grindstone.........	000	10	2	10	2
Gypsum	000 st	5,955	11,238	6,374	12,398
Helium	mcf	..	..	..	..
Iron oxide	000 st	1	74	1	79
Lithia	000 lb	644	682	1,050	1,152
Magnesitic dolomite and brucite	000 lb	...	3,440	...	3,467
Mica	"	1,183	44	1,203	96
Nepheline syenite...	000 st	254	2,699	288	3,027
Nitrogen...........	mcf	..	..	..	..
Peat moss	000 st	243	8,680	245	7,178
Potash (K_2O).......	"	627	22,500	862	30,660
Pozzolana	st	...	18	...	20
Pyrite, pyrrhotite ..	000 st	476	1,644	356	1,128
Quartz	"	1,837	3,688	2,131	4,603
Salt	"	3,722	22,317	3,893	23,076
Soapstone, talc, pyrophyllite	"	54	758	57	819
Sodium sulphate	"	257	4,121	330	5,328
Sulphur, in smelter gas	"	353	3,488	435	4,493
Sulphur, elemental .	"	1,250	13,380	1,611	15,410
Titanium dioxide, etc.	"	..	13,807	..	20,982
Total nonmetallics			253,453		286,531
Fuels					
Coal	000 st	10,576	71,756	11,319	72,735
Natural gas	000 mcf	1,117,425	150,469	1,317,718	176,665
Natural gas by-products	000 bbl	...	70,998	...	75,097
Petroleum, crude ..	"	257,662	615,205	274,595	675,425
Total fuels			908,428		999,922

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Table 1 (cont'd)

	Unit of Measure	1963 Quantity	1963 $'000	1964p Quantity	1964p $'000
Structural material					
Clay products......	$		38,154		40,535
Cement	000 st	7,014	118,615	7,745	133,087
Lime	"	1,451	18,504	1,491	19,122
Sand and gravel	"	189,571	123,854	189,375	124,050
Stone	"	62,655	79,884	63,631	83,647
Total structural materials.......			379,011		400,441
Total all minerals			3,050,429		3,390,599

Symbols: – Nil; .. Not available for publication; ... Not appropriate or not applicable; p Preliminary.

TABLE 2

Value of Mineral Production of Canada and its per Capita Value, Selected Years, 1926-1964

($ millions)

	Metallics	Industrial Minerals	Fuels	Total	Per Capita Value
					$
1926	115	56	69	240	25.44
1931	121	55	54	230	22.21
1936	260	43	60	363	33.11
1941	395	80	85	560	48.69
1946	290	110	103	503	40.91
1951	746	266	233	1,245	88.91
1956	1,146	420	519	2,085	129.65
1961	1,387	542	653	2,582	141.59
1962	1,496	574	781	2,851	153.53
1963	1,510	632r	908	3,050r	161.43
1964p	1,704	687	1,000	3,391	176.25

Symbols: p Preliminary; r Revised from previously published figure.

TABLE 3

Indexes of Physical Volume of Industrial Mineral Production in Canada, 1950-64

Unadjusted (1949 =100)

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
Total Industrial															
Production.......	106.9	116.6	120.9	129.1	128.5	142.3	154.9	155.4	154.4	166.1	167.4	172.9	186.0	195.9	213.3
Total Mining	109.5	123.4	131.0	142.1	158.7	185.2	212.3	227.8	227.0	251.1	253.3	266.9	287.4	294.4	326.5
Metals															
All metals......	103.5	107.9	110.3	115.7	129.0	142.7	151.0	170.0	180.3	201.3	197.9	191.7	197.7	193.8	210.7
Gold...........	107.9	103.9	106.9	97.9	104.5	107.7	107.9	106.7	109.7	108.4	111.2	107.1	100.1	95.5	91.0
Nickel	96.2	107.1	109.2	111.7	125.3	135.9	139.0	146.8	110.2	144.8	166.9	183.8	184.2	171.0	181.2
Lead...........	103.7	99.0	105.5	121.4	136.8	126.9	118.2	113.9	116.0	113.7	128.3	139.3	132.2	126.7	126.3
Zinc	108.6	118.4	128.9	139.5	130.5	150.3	145.5	142.0	147.2	137.4	142.1	145.0	160.3	158.5	233.7
Copper.........	100.4	102.5	98.0	96.1	114.8	123.7	135.2	137.1	131.8	151.6	168.7	169.5	176.7	174.0	186.4
Iron Ore	96.0	115.9	126.5	170.6	185.4	316.5	410.6	462.6	321.5	448.9	406.3	504.7	632.5	670.8	834.2
Fuels															
All fuels	112.1	143.5	163.9	192.7	215.6	273.2	344.7	358.2	329.5	363.1	380.2	430.7	480.8	513.6	554.7
Coal...........	98.5	95.6	90.5	81.5	75.2	74.1	74.6	65.4	56.7	51.9	53.3	49.9	48.8	52.0	55.1
Natural gas.....	107.3	120.5	128.9	147.8	169.6	204.5	235.0	295.1	401.6	503.9	589.2	712.0	1,005.7	1,179.8	1,382.3
Petroleum......	135.5	226.9	291.8	385.5	457.8	616.8	812.7	859.5	782.6	873.7	909.9	1,043.7	1,154.0	1,221.6	1,300.8
Nonmetals															
All nonmetals...	139.1	156.3	155.5	152.9	161.4	180.2	187.6	179.0	170.9	191.4	192.6	211.7	222.5	228.1	324.9*
Asbestos	151.8	170.7	171.5	162.3	167.8	191.9	188.4	184.3	178.3	193.5	201.4	223.4	234.1	239.1	259.9
Other nonmetals.	109.0	122.0	117.2	130.5	146.3	152.4	184.3	158.2	142.1	183.3	157.7	166.1	177.4	185.2	580.4*
Quarrying and															
sand pits......	119.3	142.9	153.5	154.3	189.6	204.3	237.7	264.2	308.2	317.7	301.2	337.1	380.5	370.9	431.8

*Includes potash production, which was not included in previous years.

TABLE 4

Percentage Contribution of Leading Minerals to Total Value of Mineral Production in Canada, 1955-64

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964p
Petroleum..........	17.0	19.5	20.7	19.0	17.5	17.0	18.9	19.4	20.2	20.0
Iron ore............	6.2	7.7	7.6	6.0	8.0	7.0	7.3	9.2	10.3r	11.9
Nickel	12.0	10.7	11.8	9.2	10.7	11.9	13.6	13.5	11.8	11.3
Copper.............	13.4	14.1	9.4	8.3	9.7	10.6	9.9	9.9	9.3	9.7
Zinc	6.6	6.0	4.6	4.4	4.0	4.4	4.1	3.9	4.0	5.7
Natural gas.........	0.8	0.8	1.0	1.5	1.6	2.1	2.6	3.8	4.9	5.2
Asbestos	5.4	4.8	4.8	4.4	4.5	4.9	5.0	4.6	4.5	4.4
Gold...............	8.7	7.2	6.8	7.4	6.2	6.3	6.1	5.5	5.0r	4.2
Cement	3.7	3.6	4.3	4.6	3.9	3.7	4.0	4.0	3.9	3.9
Sand and gravel	3.8	3.9	4.1	4.6	4.3	4.6	4.1	4.2	4.1	3.7
Uranium	1.4	2.2	6.2	13.3	13.7	10.8	7.6	5.5	4.5	2.5
Stone	2.4	2.3	2.7	2.6	2.5	2.4	2.6	2.4	2.6	2.5
Coal	5.2	4.6	4.1	3.8	3.1	3.0	2.7	2.4	2.4	2.1
Lead...............	3.2	2.8	2.3	2.0	1.6	1.8	1.8	1.5	1.5	1.6
Silver..............	1.4	1.2	1.1	1.3	1.2	1.2	1.1	1.2	1.4	1.3
Clay products.......	2.0	1.8	1.6	2.0	1.8	1.5	1.4	1.3	1.3	1.2
Potash	-	-	-	-	-	-	-	0.1	0.7	0.9
Platinum metals	1.3	1.1	1.2	0.7	0.7	1.2	0.9	1.0	0.7	0.7
Salt................	0.6	0.6	0.6	0.7	0.7	0.8	0.8	0.8	0.7	0.7
Titanium dioxide	0.3	0.4	0.4	0.3	0.4	0.5	0.6	0.4	0.5	0.6
Lime	0.9	0.8	0.8	0.9	0.9	0.8	0.7	0.6	0.6	0.6
Elemental sulphur...	..	..	..	0.1	0.1	0.2	0.3	0.3	0.4	0.5
Gypsum	0.4	0.3	0.4	0.2	0.3	0.4	0.3	0.3	0.4	0.4
Other minerals	3.3	3.6	3.5	2.7	2.6	2.9	3.6	4.2	4.3r	4.4
Total............	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Symbols: - Nil; .. Not available; p Preliminary; r Revised from previously published figure.

TABLE 5

Value of Mineral Production in Canada by Main Geological Regions, 1964

	Metals		Industrial Minerals		Fuels		Total, all Minerals	
	$ Millions	% of Total	$ Millions	% of Total	$ Millions	% of Total	$ Millions	% of Total
Canadian Shield	1,407.0	82.6	40.5	5.9	–	–	1,447.5	42.7
Appalachian Region	101.0	5.9	177.7	25.9	51.4	5.1	330.1	9.7
St. Lawrence Lowlands	2.3	0.1	299.7	43.6	8.6	0.9	310.6	9.2
Interior Plains	1.4	0.1	115.1	16.8	894.5	89.5	1,011.0	29.8
Cordilleran Region	192.0	11.3	54.0	7.8	45.4	4.5	291.4	8.6
Total, Canada	1,703.7	100.0	687.0	100.0	999.9	100.0	3,390.6	100.0

TABLE 6

Value of Mineral Production in Canada by Provinces and Mineral Classes, 1964p

	Metals		Industrial Minerals		Fuels		Total	
	$000	% of Total	$000	% of Total	$000	% of Total	$000	% of Total
Ontario..........	711,699	41.8	190,343	27.7	8,631	0.9	910,673	26.8
Alberta..........	2	–	52,341	7.6	688,504	68.8	740,847	21.8
Quebec	396,663	23.3	274,411	40.0	–	–	671,074	19.8
Saskatchewan	36,292	2.1	48,833	7.1	195,908	19.6	281,033	8.3
British Columbia .	176,872	10.4	48,740	7.1	44,192	4.4	269,804	8.0
Newfoundland	173,800	10.2	18,011	2.6	–	–	191,811	5.7
Manitoba	144,058	8.4	20,364	3.0	10,735	1.1	175,157	5.2
Nova Scotia	1,554	0.1	22,041	3.2	42,828	4.3	66,423	2.0
New Brunswick ...	30,411	1.8	11,045	1.6	8,573	0.9	50,029	1.5
Northwest Territories ...	17,235	1.0	–	–	453	–	17,688	0.5
Yukon Territory..	15,119	0.9	–	–	98	–	15,217	0.4
Prince Edward Island	–	–	843	0.1	–	–	843	0.02
Total, Canada ..	1,703,705	100.0	686,972	100.0	999,922	100.0	3,390,599	100.0

Symbols: - Nil; p Preliminary.

TABLE 7

Value of Mineral Production in Canada by Provinces, 1955-64
($ millions)

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964p
Ontario...........	584	651	749	790	971	983	944	913	874	911
Alberta...........	326	411	410	346	376	396	473	567	669	741
Quebec	357	423	406	366	441	446	455	519	541r	671
Saskatchewan	85	123	173	210	210	212	216	240	272	281
British Columbia ..	189	203	179	151	159	186	188	235	261	270
Newfoundland	68	84	83	65	72	87	92	102	138	192
Manitoba	62	68	64	57	55	59	101	159	170	175
Nova Scotia	67	66	68	63	63	66	62	62	66	67
New Brunswick....	16	18	23	16	18	17	19	22	28	50
Northwest Territories	26	22	21	25	26	27	18	18	16	18
Yukon Territory...	15	16	14	12	13	13	13	13	14	15
Prince Edward Island	-	-	-	-	5	1	1	0.7	0.8	0.8
Total, Canada ...	1,795	2,085	2,190	2,101	2,409	2,493	2,582	2,851	3,050r	3,391

Symbols: - Nil; p Preliminary; r Revised from previously published figure.

TABLE 8

Percentage Contribution of Provinces to Total Value of Mineral Production in Canada, 1955-1964

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964p
Ontario...........	32.5	31.2	34.2	37.5	40.3	39.4	36.6	32.0	28.7r	26.8
Alberta...........	18.2	19.7	18.7	16.5	15.6	15.9	18.3	19.9	21.9	21.8
Quebec	19.9	20.2	18.5	17.4	18.3	17.9	17.6	18.2	17.7r	19.8
Saskatchewan	4.7	5.9	7.9	10.0	8.7	8.5	8.4	8.4	8.9	8.3
British Columbia ..	10.5	9.7	8.2	7.2	6.6	7.5	7.3	8.2	8.6	8.0
Newfoundland	3.8	4.0	3.8	3.1	3.0	3.5	3.6	3.6	4.5	5.7
Manitoba	3.5	3.3	2.9	2.7	2.3	2.4	3.9	5.6	5.6	5.2
Nova Scotia	3.7	3.2	3.1	3.0	2.6	2.6	2.4	2.2	2.2	2.0
New Brunswick....	0.9	0.9	1.1	0.8	0.8	0.7	0.7	0.8	0.9	1.5
Northwest Territories ..	1.5	1.1	1.0	1.2	1.1	1.1	0.7	0.6	0.5	0.5
Yukon............	0.8	0.8	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.4
Prince Edward Island...	-	-	-	-	0.2	0.05	0.02	0.02	0.03	0.02
Total, Canada ..	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Symbols: - Nil; p Preliminary; r Revised from previously published figures.

TABLE 9 Production of Leading Minerals in

	Unit of Measure	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.
Petroleum, crude	bbl	–	–	–	4,688	–	1,243,784
	$	–	–	–	6,563	–	3,548,876
Iron ore	st	13,094,240	–	–	–	15,417,069	7,985,715
	$	142,524,360	–	–	–	155,581,064	84,423,975
Nickel	st	–	–	–	–	2,330	165,254
	$	–	–	–	–	3,914,025	268,506,035
Copper	st	14,505	–	284	10,523	160,288	201,031
	$	9,689,729	–	189,756	7,029,479	107,072,207	132,519,010
Zinc	st	41,498	–	644	53,785	228,580	68,420
	$	11,760,108	–	182,651	15,242,714	64,779,482	19,390,110
Natural gas	mcf	–	–	–	105,055	–	13,738,588
	$	–	–	–	111,998	–	5,082,144
Asbestos	st	50,281	–	–	–	1,245,442	15,500
	$	8,296,365	–	–	–	125,897,947	2,256,000
Gold	oz	18,679	–	63	1,440	944,941	2,135,269
	$	705,132	–	2,378	54,360	35,671,523	80,606,407
Cement	st	95,312	–	–	176,584	2,582,781	2,975,590
	$	1,897,662	–	–	2,947,363	41,755,259	47,768,953
Sand and gravel	st	3,930,010	187,600	6,439,028	4,798,699	43,111,121	75,333,285
	$	3,572,354	264,915	3,967,878	2,943,241	20,591,144	53,333,236
Uranium (U_3O_8)	lb	–	–	–	–	–	12,035,382
	$	–	–	–	–	–	74,361,393
Stone	st	278,714	578,200	428,940	2,952,297	32,510,262	22,460,048
	$	543,979	578,200	976,129	3,094,738	42,746,251	29,322,639
Coal	st	–	–	4,293,130	1,003,362	–	–
	$	–	–	42,827,600	8,454,868	–	–
Lead	st	24,368	–	1,576	22,377	3,279	1,988
	$	6,550,105	–	423,568	6,014,989	881,376	534,437
Silver	oz	1,338,901	–	539,801	1,478,231	4,757,251	10,719,539
	$	1,874,461	–	755,721	2,069,523	6,660,151	15,007,355
Clay products	$	95,000	–	1,539,739	768,631	6,416,153	23,316,149
Potash (K_2O)	st	–	–	–	–	–	–
	$	–	–	–	–	–	–
Platinum metals	oz	–	–	–	–	–	374,988
	$	–	–	–	–	–	25,196,159
Salt	st	–	–	430,633	–	–	3,265,909
	$	–	–	4,739,620	–	–	14,481,663
Titanium dioxide	st	–	–	–	–	..	–
	$	–	–	–	–	20,981,935	–
Lime	st	–	–	–	5,678	349,400	1,008,123
	$	–	–	–	140,488	4,616,693	12,236,864
Elemental sulphur	st	–	–	–	–	–	...
	$	–	–	–	–	–	13,426
Gypsum	st	349,774	–	5,117,205	103,986	–	490,000
	$	826,900	–	9,101,074	176,454	–	1,355,000
Total, leading minerals	$	188,336,155	843,115	64,706,114	49,055,409	637,565,210	893,259,831
Total, all minerals	$	191,811,558	843,115	66,422,811	50,028,913	671,074,811	910,673,057
Leading minerals as % of all minerals		98.2	100.0	97.4	98.1	95.0	98.1

Symbols: – Nil; .. Not available for publication. ... Not applicable.

Canada, by Provinces and Territories, 1964p

Man.	Sask.	Alta.	B.C.	N.W.T.	Y.T.	Total Canada
4,417,224	81,377,641	175,441,589	11,524,111	586,296	-	274,595,333
10,734,764	185,171,355	452,184,663	23,340,101	438,608	-	675,424,930
-	-	-	2,167,559	-	-	38,664,583
-	-	-	20,363,091	-	-	402,892,490
63,536	-	-	1,755	-	-	232,875
106,628,259	-	-	2,948,400	-	-	381,996,719
29,192	20,688	-	57,506	-	-	494,017
19,500,052	13,819,624	-	38,413,747	-	-	328,233,604
42,671	28,429	-	207,656	3,195	7,146	682,024
12,093,072	8,056,816	-	58,849,820	905,463	2,025,168	193,285,404
-	41,356,979	1,127,083,595	135,399,086	34,297	-	1,317,717,600
-	4,676,866	154,635,870	12,143,944	14,275	-	176,665,097
-	-	-	65,856	-	-	1,377,079
-	-	-	11,920,000	-	-	148,370,312
55,919	47,692	55	132,642	416,963	57,075	3,810,738
2,110,942	1,800,373	2,076	5,007,236	15,740,354	2,154,581	143,855,362
364,421	240,000	771,361	538,467	-	-	7,744,516
7,839,789	5,996,100	14,777,775	10,104,465	-	-	133,087,366
9,667,983	7,076,337	16,558,448	22,272,170	-	-	189,374,681
7,046,579	3,696,578	15,873,855	12,759,729	-	-	124,049,509
-	1,792,987	-	-	-	-	13,828,369
-	11,056,878	-	-	-	-	85,418,271
1,087,999	-	117,051	3,217,338	-	-	63,630,849
1,462,369	-	448,733	4,474,296	-	-	83,647,334
-	1,994,039	2,971,133	1,050,430		7,229	11,319,323
-	3,905,202	11,182,833	6,266,442		98,150	72,735,095
1,329	-	-	134,160	1,845	9,463	200,385
357,182	-	-	36,062,150	495,936	2,543,803	53,863,546
706,296	611,475	4	5,309,486	66,462	5,584,497	31,111,943
988,814	856,065	6	7,433,280	93,047	7,818,296	43,556,719
595,692	1,447,500	3,777,570	2,578,334	-	-	40,534,768
-	862,440	-	-	-	-	862,440
-	30,660,000	-	-	-	-	30,660,000
-	-	-	-	-	-	374,988
-	-	-	-	-	-	25,196,159
24,600	70,094	101,400	-	-	-	3,892,636
620,000	1,569,235	1,665,000	-	-	-	23,075,518
-	-	-	-	-	-	..
-	-	-	-	-	-	20,981,935
53,760	-	58,618	15,343	-	-	1,490,922
911,019	-	1,051,192	165,848	-	-	19,122,104
...	-	...	...	-	-	1,611,181
33,937	-	14,682,380	680,200	-	-	15,409,943
132,300	-	-	180,500	-	-	6,373,765
396,900	-	-	541,500	-	-	12,397,828
171,319,370	272,712,592	670,281,953	254,052,583	17,687,683	14,639,998	3,234,460,013
175,156,504	281,032,190	740,846,287	269,804,721	17,687,683	15,217,564	3,390,599,214
97.8	97.0	90.5	94.2	100.0	96.2	95.4

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TABLE 10 World Role of Canada as Producer

		World Production	1
			Canada
Nickel (mine production)	st	423,500	232,875
	% of world total		55
			Canada
Asbestos	st	3,500,000	1,377,079
	% of world total		39
			Canada
Zinc (mine production	st	4,184,124	729,939
	% of world total		17
			U.S.A.
Uranium (U_3O_8) concentrates (Free World)	st	26,000	11,847
	% of world total		46
			U.S.A.
Titanium concentrates (ilmenite)	st	2,360,000	930,000
	% of world total		39
			U.S.A.
Gypsum	'000 st	51,590	10,684
	% of world total		21
			U.S.S.R.
Platinum group metals (mine production)	troy oz	2,000,000	1,000,000
	% of world total		50
			Republic of the Congo
Cobalt (mine production) (Free World)	st	14,700	8,708
	% of world total		59
			U.S.A.
Cadmium (smelter production)	'000 lb	27,900	10,458
	% of world total		38
			U.S.A.
Aluminum (primary metal)	st	6,659,139	2,552,970
	% of world total		38
			Republic of S. Africa
Gold (mine production)	troy oz	53,000,000	28,840,000
	% of world total		54
			Mexico
Silver (mine production)	troy oz	255,700,000	44,000,000
	% of world total		17
			U.S.A.
Magnesium	st	166,700	79,488
	% of world total		48
			U.S.S.R.
Lead (mine production)	st	2,697,166	452,000
	% of world total		17
			U.S.A.
Barite	st	3,300,000	800,000
	% of world total		24
			U.S.A.
Copper (mine production)	st	5,233,451	1,251,216
	% of world total		24
			U.S.A.
Molybdenum (Mo content)	st	47,620	32,803
	% of world total		70
			U.S.S.R.
Iron ore	'000 lt	564,084	142,710
	% of world total		25
			U.S.A.
Potash (K_2O equivalent)	'000 st	13,000	2,897
	% of world total		22
			Peru
Bismuth (mine production)	st	3,650	818
	% of world total		22

Sources: For Canada, Dominion Bureau of Statistics. For other countries, nickel, zinc, aluminum, lead and copper from American Bureau of Metal Statistics; asbestos, platinum group metals, uranium,cobalt,cadmium, of Certain Important Minerals, 1964

Rank of the Six Leading Countries				
2	3	4	5	6
U.S.S.R.	New Caledonia	Cuba	U.S.A.	Finland
100,000	52,283	20,000	12,185	3,490
24	12	5	3	1
U.S.S.R.	Republic of S. Africa	S. Rhodesia	China	U.S.A.
1,300,000	215,592	153,451	130,000	101,092
37	6	4	4	3
U.S.A.	U.S.S.R.	Australia	Mexico	Peru
572,379	480,000	297,144	259,705	254,593
14	12	7	6	6
Canada	Republic of S. Africa	France	Australia	Spain
6,914	4,445	2,000	300	75
27	17	8	1	-
Canada*	Norway	Australia		
380,000	300,000	250,000		
16	13	11		
Canada	Britain	U.S.S.R.	France	Spain
6,374	5,052	4,740	4,639	4,258
12	10	9	9	8
Republic of S. Africa	Canada	Colombia		
600,000	374,988	30,000		
30	19	1		
Morocco	Canada	Zambia	Cuba	Australia
1,850	1,598	1,552	250	12
13	11	11	2	0.1
U.S.S.R.	Canada	Japan	Belgium	Republic of the Congo
3,968	2,518	2,231	1,857	896
14	9	8	7	3
U.S.S.R.	Canada	France	Japan	Norway
1,050,000	843,002	348,252	290,811	288,199
16	13	5	4	4
U.S.S.R.	Canada	U.S.A.	Australia	
12,500,000	3,810,738	1,450,000	960,000	
24	7	3	2	
Peru	U.S.A.	Canada	U.S.S.R.	
38,000,000	36,500,000	31,111,943	27,000,000	
15	14	12	11	
U.S.S.R.	Norway	Canada	Italy	Britain
35,000	25,353	9,021	6,063	5,512
21	15	5	4	3
Australia	U.S.A.	Canada	Mexico	Peru
393,603	283,274	206,359	192,708	164,506
15	11	8	7	6
W. Germany	Mexico	U.S.S.R.	Canada	Peru
500,000	300,000	220,000	172,415	140,000
15	9	7	5	4
Zambia	Chile	U.S.S.R.	Canada	Republic of the Congo
709,794	685,502	675,000	494,017	303,735
14	13	13	9	6
U.S.S.R.	Chile	China	Canada	Peru
6,614	4,660	1,653	639	502
14	10	4	1	1
U.S.A.	France	China	Canada	Sweden
81,328	60,501	49,210	34,522	26,116
14	11	9	6	5
W. Germany	E. Germany	France	U.S.S.R.	Canada
2,425	2,133	1,991	1,764	862
19	16	15	14	7
Mexico	Japan	Bolivia	Republic of Korea	Canada
529	412	287	221	194
14	11	8	6	5

titanium concentrates, gypsum, gold, silver, magnesium, barite, molybdenum, potash and bismuth from U.S. Bureau of Mines; iron ore from American Iron and Steel Institute. *U.S. Bureau of Mines.

TABLE 11

Net Value of Production in Canada of Commodity - Producing Industries 1959-1962

($ millions)

	1959	1960	1961	1962
Primary Industries				
Argiculture	1,850	2,043	1,715	2,443
Forestry	597	688	667	702
Fishing	106	100	110	128
Trapping	10	12	12	10
Mining	1,438	1,453	1,562	1,748
Electric Power	748	796	840	876
Total	4,749	5,092	4,906	5,907
Secondary Industries				
Manufacturing	10,153	10,380	10,690	11,741
Construction	3,710	3,635	3,701	3,788
Total	13,863	14,015	14,391	15,529
Grand total	18,612	19,107	19,297r	21,436

r Revised from previously published figure.

TABLE 12

Value of Exports of Crude Minerals and Fabricated Mineral Products, by Main Groups, 1963 and 1964

($ millions)

	1963	1964	Increase or Decrease $ millions	%
Ferrous				
Crude material	284.4	376.6	+ 92.2	+32.4
Fabricated material	195.5	246.4	+ 50.9	+26.0
Total	479.9	623.0	+143.1	+29.8
Non-ferrous				
Crude material	418.7	426.8	+ 8.1	+ 1.9
Fabricated material*	777.5	868.5	+ 91.0	+11.7
Total	1,196.2	1,295.3	+ 99.1	+ 8.3
Non-metals**				
Crude material	503.7	590.7	+ 87.0	+17.3
Fabricated material	64.4	75.2	+ 10.8	+16.8
Total	568.1	665.9	+ 97.8	+17.2
Total minerals** and products				
Crude material	1,206.8	1,394.1	+187.3	+15.5
Fabricated material*	1,037.4	1,190.1	+152.7	+14.7
Total	2,244.2	2,584.2	+340.0	+15.2

*Includes gold refined and unrefined. **Includes mineral fuels.
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 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, 1964

($ millions)

	1964
Ferrous	
Crude Material	94.7
Fabricated material	432.7
Total	527.4
Non-ferrous	
Crude material	99.7
Fabricated material*	169.5
Total	269.2
Non-metals**	
Crude material	460.4
Fabricated material	258.4
Total	718.8
Total minerals** and products	
Crude material	654.8
Fabricated material*	860.6
Total	1,515.4

*Includes gold, refined and unrefined. **Includes mineral fuels.
NOTE: The new import classification came into effect 1964. It is not possible to produce statistics comparable to those presented above for the years prior to 1964. See Note 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, 1963 and 1964

	1963		1964	
	$ millions	% of Total	$ millions	% of Total
Crude material	1,206.8	17.7	1,394.1	17.2
Fabricated material*	1,037.4	15.2	1,190.1	14.6
Total	2,244.2	32.9	2,584.2	31.8
Total exports*, all products	6,828.7	100.0	8,120.5	100.0

*Includes gold refined and unrefined which are considered non-trade items and not included in domestic exports.
See Note Table 12.

TABLE 15

Value* of Imports of Crude Minerals and Fabricated Mineral Products
in Relation to Total Import Trade, 1964

	1964	
	$ millions	% of Total
Crude material	654.8	8.7
Fabricated material**	860.6	11.5
Total	1,515.4	20.2
Total Imports**, all products	7,495.0	100.0

*Comparable statistics are not available for years prior to 1964 due to statistical classification changes which became effective in 1964. **Includes gold, refined and unrefined.
See Note Table 12.

TABLE 16

Value of Exports of Crude Minerals and Fabricated Mineral Products by Main Groups and Destination, 1964

($ millions)

	Britain	United States	Other Countries	Total
Ferrous materials and products........	65.0	449.4	108.6	623.0
Non-ferrous* materials and products ...	404.2	512.8	378.3	1,295.3
Non-metallic** mineral materials and products........................	18.9	525.1	121.9	665.9
Total............................	488.1	1,487.3	608.8	2,584.2
Percentage	18.9	57.6	23.5	100.0

*Includes gold refined and unrefined. **Includes mineral fuels.
See Note Table 12.

TABLE 17

Value of Imports of Crude Minerals and Fabricated Mineral Products By Main Groups and Sources, 1964

($ millions)

	Britain	United States	Other Countries	Total
Ferrous materials and products........	45.6	376.5	105.4	527.5
Non-ferrous* materials and products ...	29.1	121.6	118.4	269.1
Non-metallic** mineral materials and products........................	16.5	275.2	427.1	718.8
Total............................	91.2	773.3	650.9	1,515.4
Percentage........................	6.0	51.0	43.0	100.0

*Includes gold, refined and unrefined. **Includes mineral fuels.
See Note Table 12.

TABLE 18

Value of Exports of Crude Minerals and Fabricated Mineral Products from Canada, by Commodity and Destination, 1964

($ 000)

	U.S.A.	Britain	Other E.F.T.A.* Countries	E.E.C.** Countries	Japan	Other Countries	Total
Iron ore..................	293,900	35,713	-	8,057	18,270	67	356,007
Primary ferrous metals ...	67,550	17,362	2	7,621	5,786	3,269	101,590
Aluminum	121,946	98,458	5,909	31,243	13,558	55,502	326,616
Copper..................	77,889	77,002	23,168	19,160	39,415	19,303	255,937
Lead	13,233	10,757	-	9,222	2,412	2,213	37,837
Nickel	175,392	120,232	41,424	13,015	5,696	7,423	363,182
Zinc	41,008	27,228	1,350	32,382	5,437	9,716	117,121
Uranium	34,863	39,627	-	159	4	-	74,653
Asbestos	64,259	11,846	5,565	33,925	10,641	31,442	157,678
Fuels	383,440	596	2,332	819	9,326	820	397,333
All other minerals***	213,799	49,334	5,071	22,782	4,331	100,966	396,283
Total..................	1,487,279	488,155	84,821	178,385	114,876	230,721	2,584,237

*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 Table 12.

TABLE 19

Reported Consumption of Minerals in Canada and Relation to Production, 1964

Mineral	Unit of Measure	Consumption	Production*	Consumption as % of Production
Metals				
Aluminum	st	170,969	843,002	20.3
Antimony	lb	558,000	1,718,634	32.5
Bismuth	lb	53,676	387,213	13.9
Cadmium	lb	178,128	2,800,761	6.4
Chromium (chromite)	st	57,734	-	-
Cobalt	lb	365,851	3,196,322	11.4
Copper	st	185,044	494,017	37.5
Lead	"	82,736	200,385	40.6
Magnesium	"	3,762	9,021	41.7
Manganese ore	"	138,818	-	-
Mercury	lb	241,765	5,548	4,357.7
Molybdenum (Mo content) .	"	1,107,454	1,278,404	86.6
Nickel	st	6,899	232,875	2.9
Selenium	lb	13,968	448,750	3.1
Silver	oz	18,775,307	31,111,943	60.3
Tellurium	lb	1,473	79,789	1.8
Tin	lt	4,942	159	3,108.2
Tungsten (W content)	lb	740,410	..	..
Zinc	st	88,494	682,024	13.0
Nonmetals				
Feldspar	st	5,373	8,615	62.4
Fluorspar	"	155,826	..	..
Mica	lb	3,956,000	1,202,800	328.9
Barite	st	10,351	172,415	6.0
Talc, etc.	"	36,039	57,150	63.1
Nepheline syenite	"	42,666	288,493	14.8
Phosphate rock	"	1,462,044	-	-
Sodium sulphate	"	240,247	330,178	72.8
Sulphur, elemental	"	512,417	1,611,181	31.8
Potash (muriate of potash)	"	180,256	862,440	20.9
Fuels				
Coal	st	24,977,432	11,319,323	220.7
Natural gas	Mcf	504,503,388	1,317,717,600	38.3
Petroleum, crude	bbl	343,403,034	274,595,333	125.1

*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.
Symbols: - nil; .. Not available.

TABLE 20

Apparent Consumption of Minerals in Canada and Its Relation to Production, 1964

(short tons)

Minerals	Unit of Measure	Apparent Consumption*	Production**	Consumption as % of Production
Asbestos.........	st	43,603	1,377,079	3.2
Quartz (silica)....	"	2,761,707	2,130,837	129.6
Gypsum..........	"	1,397,452	6,373,765	21.9
Salt	"	3,231,000e	3,892,636	83.0
Cement	"	7,479,527	7,744,516	96.6
Lime	"	1,405,370	1,490,922	94.3
Iron ore	lt	9,281,682	34,521,949	26.9

*Production plus imports less exports. Consumption of these commodities as reported by consumers is not readily available. **Producers' shipments.
e Estimated.

TABLE 21

Domestic Consumption of Principal Refined Base Metals (a) in Relation to Production (b) in Canada, 1955-64

	Unit of Measure	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
Copper											
Domestic consumption (c)	st	138,559	145,286	118,225	122,893	129,973	117,636	141,807	151,525	169,750	202,101
Production	"	288,997	328,458	323,540	329,239	365,366	417,029	406,359	382,868	378,911	408,509
% Consumption of production		47.9	44.2	36.5	37.3	35.6	28.2	34.9	39.6	44.8	49.5
Zinc											
Domestic consumption (d)	st	58,062	61,173	52,713	56,097	64,788	55,803	60,878	65,320	73,653r	88,494
Production	"	256,542	255,564	247,316	252,093	255,306	260,968	268,007	280,158	284,021	337,728
% Consumption of production		22.6	23.9	21.3	22.3	25.4	21.4	22.7	23.3	25.0	26.2
Lead											
Domestic consumption	st	76,351	75,882	71,583	69,769	65,935	72,087	73,418	77,286	77,958	82,736
Production	"	148,811	147,865	142,935	132,987	135,296	158,510	171,833	152,217	155,000	151,372
% Consumption of production		51.3	51.3	50.1	52.5	48.7	45.5	42.7	50.8	50.3	54.7
Aluminum											
Domestic consumption (g)	st	91,522	91,869	77,984	101,886	114,344	120,831	135,575	151,893	166,909	170,969
Production	"	612,543	620,321	556,715	634,102	593,630	762,012	663,173	690,297	719,390	843,002
% Consumption of production		14.9	14.8	14.0	16.1	19.3	15.9	20.4	22.0	23.2	20.3

(a)Refined metal of primary and secondary origin. (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 to 1958; primary and secondary aluminum consumption for 1959 and thereafter.
r Revised.

TABLE 22

Annual Averages of Prices of Main Minerals* 1963 and 1964

	Unit of Measure	1963	1964	Increase or Decrease: Cents or Dollars	%
Aluminum ingot, 99.5%	cents/lb	22.623	23.741	+ 1.118	+ 4.9
Antimony, New York	cents/lb	34.25	42.06	+ 7.81	+22.8
Bismuth	$/lb	2.25	2.35	+ 0.10	+ 4.4
Cadmium	cents/lb	231.695	305.000	+ 73.305	+31.6
Calcium	$/lb	2.05	2.05	-	-
Chromium metal, 98.5%, .05% C	$/lb	1.15-1.19	1.15-1.19	-	-
Cobalt metal, 500 lb. lots	$/lb	1.50	1.50	-	-
Copper, U.S. domestic, f.o.b. refinery	cents/lb	30.600	31.960	+ 1.360	+ 4.4
Gold, Canadian dollars	$/troy oz	37.75	37.75	-	-
Iron ore, 51.5% Fe, lower lake ports					
Bessemer					
Mesabi	$/lt	10.80	10.70	- 0.10	- 0.9
Old Range	$/lt	11.05	10.95	- 0.10	- 0.9
Non-Bessemer					
Mesabi	$/lt	10.65	10.55	- 0.10	- 0.9
Old Range	$/lt	10.90	10.80	- 0.10	- 0.9
Lead, common, New York	cents/lb	11.137	13.596	+ 2.459	+22.1
Magnesium, ingot	cents/lb	35.250	35.250	-	-
Mercury	$/flask (76 lb)	189.451	314.787	+125.336	+66.2
Molybdenum metal	$/lb	3.35	3.35	-	-
Molybdenite, 95% MoS_2, contained Mo	$/lb	1.40	1.51	+ 0.11	+ 7.9
Nickel, f.o.b. Port Colborne (duty incl.)	cents/lb	79.000	79.00	-	-
Platinum	$/troy oz	79.755	87.985	+ 8.230	+10.3
Selenium	$/lb	4.60	4.50	- 0.10	- 2.2
Silver, New York	cents/troy oz	127.912	129.300	+ 1.388	+ 1.1
Sulphur, Mexican export price	$/metric ton	20.17	20.00	- 0.17	- 0.8
Tin, straits, New York	cents/lb	116.652	157.595	+ 40.943	+35.1
Titanium metal, A-1 99.3%, max. 0.15% Fe.	$/lb	1.32	1.32	-	-
Titanium ore (ilmenite) 59.5% TiO_2	$/lt	23 to 26	23 to 26	-	-
Tungsten metal	$/lb	2.75	2.75	-	-
Zinc, prime western, East St. Louis	cents/lb	11.997	13.568	+ 1.571	+13.1

*These prices, except those for gold, are in United States currency and are from E & M J Metal and Mineral Markets.

TABLE 23

Wholesale Price Indexes of Minerals and Mineral Products, Canada, 1954 and 1962-64

1935-39 = 100

	1954	1962	1963	1964
Iron and products	213.4	256.2	253.6	256.4
Pig iron	256.6	294.6	289.6	290.4
Rolling mill products	206.0	251.6	251.6	251.7
Pipe and tubing	232.0	271.5	273.2	271.0
Wire	236.7	292.5	274.0	274.9
Scrap iron and steel	211.7	279.0	243.0	269.4
Tinplate and galvanized sheet	219.7	238.3	238.3	238.2
Nonferrous metals and products				
Total (including gold)	167.5	192.1	197.5	205.9
Total (excluding gold)	224.1	260.8	270.0	284.9
Antimony	180.5	198.8	228.7	417.2
Copper and products	277.0	298.8	303.4	318.9
Lead and products	278.7	208.8	231.2	280.5
Silver	214.3	299.2	356.9	360.4
Tin	174.3	242.8	247.8	330.2
Zinc and products	260.6	262.9	278.3	307.5
Solder	196.0	221.8	226.9	299.4
Nonmetallic minerals and products	177.0	189.1	189.5	190.9
Clays and clay products	230.4	244.6	244.0	242.5
Pottery	150.2	222.1	227.2	225.5
Coal	172.9	197.9	200.2	201.6
Coal tar	213.7	235.7	219.6	211.6
Coke	227.3	257.8	260.6	263.9
Window glass	233.8	276.5	305.8	310.6
Plate glass	189.3	218.8	237.7	283.6
Petroleum products	167.5	162.3	160.6	159.8
Crude oil	n.a.	192.2	194.1	192.0
Gasoline	138.9	132.0	126.8	126.5
Coal oil	134.0	134.4	134.4	134.1
Asphalt	184.1	192.3	192.3	192.3
Asphalt shingles	150.4	109.8	111.5	106.1
Sulphur	198.6	223.5	225.6	226.2
Plaster	127.1	142.6	142.6	144.0
Lime	194.6	213.1	215.7	223.2
Cement	158.1	165.0	169.4	169.9
Sand and gravel	142.0	149.4	143.6	143.0
Crushed stone	163.9	171.1	171.6	159.0
Building stone	200.7	174.3	184.3	199.6
Asbestos and products	267.1	303.0	304.4	304.4
General wholesale price index (all products)	217.0	240.0	244.6	245.4

TABLE 24

General Wholesale Price Index and Wholesale Price Indexes of Mineral and Non-Mineral Industries 1940-1964

(1935-39 = 100)

	Mineral Products Industries			Non-Mineral Products Industries					General Wholesale Price Index
	Iron Products	Non-Ferrous Metal Products	Non-metallic Mineral Prod.	Vegetable Products	Animal Products	Textile Products	Wood Products	Chemical Products	
1940	108.7	106.9	106.7	98.1	106.1	118.1	119.0	108.5	108.0
1941	112.8	107.2	111.1	106.1	123.8	128.4	127.0	118.6	116.4
1942	116.0	107.2	114.5	114.9	137.1	131.2	132.3	127.9	123.0
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	295.5	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	315.8	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	223.4	250.9	248.3	331.0	191.2	245.4

TABLE 25

Principal Statistics of the Mineral Industry by Sectors, 1962

	Establishment	Employees	Salaries and Wages ($'000)	Cost of Fuel and Electricity ($'000)	Cost of Process Supplies*** ($'000)	Gross Value of Production ($'000)	Net Value of Production* ($'000)
Metallics							
Placer gold	39	231	1,341	102	14	2,161	1,990
Gold quartz	133	15,220	64,579	6,982	18,495	129,496	102,318
Copper-gold-silver	191	11,046	53,489	6,873	16,233	218,036	142,917
Silver-cobalt	21	611	2,517	305	292	6,108	5,011
Silver-lead-zinc	59	4,532	23,546	2,791	7,947	111,258	59,099
Nickel-copper	37	13,342	74,050	4,479	16,753	115,549	90,942
Iron	55	9,215	60,354	10,837	23,707	257,966	185,452
Other	29	5,120	30,355	4,989	22,119	164,135	135,817
Total	564	59,317	310,231	37,358	105,560	1,004,709	723,546
Industrial Minerals							
Asbestos	18	6,997	36,072	7,184	16,700	135,066	111,181
Feldspar, quartz and nepheline syenite	20	380	1,560	262	544	5,529	4,574
Gypsum	10	608	2,408	354	1,884	8,152	5,914
Salt	11	907	4,271	1,183	2,988	22,381	18,210
Sand and gravel	511	2,722	10,143	3,436	576	45,795	41,783
Stone	207	3,197	12,199	3,293	4,590	47,812	39,487
Clay products	93	3,699	14,805	5,406	5,645	37,822	26,772
Cement	20	3,679	20,636	17,719	16,222	117,562	83,622
Lime	22	949	4,016	2,505	2,153	14,451	9,792
Other	95	2,629	9,079	2,285	3,930	25,726	19,223
Total	1,007	25,767	115,189	43,627	55,232	460,296	360,558

Table 25 (Cont'd.)

	Establishment	Employees	Salaries and Wages ($'000)	Cost of Fuel and Electricity ($'000)	Cost of Process Supplies*** ($'000)	Gross Value of Production ($'000)	Net Value of Production* ($'000)
Fuels							
Coal	101	9,470	34,385	3,818	10,045	68,259	54,397
Petroleum and natural gas**	549	4,823	28,839	9,712	71,097	810,228	729,419
Total	650	14,293	63,224	13,530	81,142	878,487	783,816
Total, mining industry	2,221	99,377	488,644	94,515	241,934	2,343,492	1,867,920
Nonferrous smelting and refining ...	23	29,303	159,439	46,689	915,967	1,561,500	598,845

*Net value equals the gross value of production less the cost of process supplies, fuel and electricity, freight and smelter charges. **Includes natural gas processing. ***Includes cost of ores, concentrates, raw materials and containers.

TABLE 26

Principal Statistics[1] of the Mining Industry[2], 1957-62

	Establishments	Employees	Salaries and Wages ($'000)	Cost of Fuel and Electricity ($'000)	Cost of Process Supplies[4] ($'000)	Gross Value of Production ($'000)	Net Value of Production[3] ($'000)
1957	2,468	109,797	455,993	85,007	170,028	1,728,461	1,344,844
1958	2,502	106,434	460,446	86,872	183,838	1,751,242	1,364,924
1959	2,584	106,960	479,468	87,907	192,549	1,967,381	1,547,793
1960	2,473	103,556	480,011	89,219	217,147	1,997,463	1,560,682
1961	2,483	99,644	469,983	87,793	211,010[r]	2,095,666	1,671,549
1962	2,221	99,377	488,644	94,515	241,934	2,343,492	1,867,920

[1]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 new concept 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. Statistics on this new basis have been prepared back to 1957 and are presented in the table. [2]Does not include nonferrous smelting and refining industries. [3]Net value equals gross value of production less cost of process supplies, fuel and electricity and treatment charges. [4]Includes cost of raw materials and containers.

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TABLE 27

Consumption of Fuels and Electricity in the Canadian Mineral Industry, 1962

	Unit	Metal Mining	Nonferrous Smelting and Refining	Total	Production of Industrial Minerals	Production of Crude Mineral Fuels	Total, Mineral Industry
Coal and coke	st	123,523	1,000,279	1,123,802	890,889	42,380	2,057,071
	$	1,860,386	14,947,050	16,807,436	9,376,479	287,891	26,471,806
Gasoline and kerosene	gal	3,622,335	928,942	4,551,277	11,047,346	7,378,765	22,977,388
	$	1,297,228	261,215	1,558,443	3,453,491	2,774,210	7,786,144
Fuel oil	gal	62,538,468	58,911,405	121,449,873	99,258,016	2,940,746	223,648,635
	$	9,630,821	4,982,590	14,613,411	10,650,847	608,006	25,872,264
Liquefied petroleum gas	gal	840,819	475,892	1,316,711	627,718	771,988	2,716,417
	$	195,140	105,665	300,805	173,384	137,280	611,469
Natural gas	mcf	680,740	12,117,311	12,798,051	22,062,852	20,767,465	55,628,368
	$	343,160	4,443,010	4,786,170	6,803,333	2,041,707	13,631,210
Other fuels	$	409,377	79,699	489,076	228,211	121,761	839,048
Total fuels	$	13,736,112	24,819,229	38,555,341	30,658,745	5,970,855	75,211,941
Electricity purchased	millions kwh	3,373	6,154*	9,527	1,594	410	11,531
	$	23,621,502	21,869,368*	45,490,870	12,940,965	7,559,338	65,991,173
Total value, fuels and electricity purchased	$	37,357,614	46,688,597	84,046,211	43,626,710	13,530,193	141,203,114
Electricity generated by industry for own use	millions kwh	567	..	..	35	35	..

*Due to changes in statistical classification, some electricity formerly reported as purchased is from 1961, reported as generated for own use. .. Not available.

TABLE 28

Cost of Fuel and Electricity Used in the Canadian Mining Industry*, 1954-62

	1954	1955	1956	1957	1958	1959	1960	1961	1962
Fuel**									
$ millions...........	37.0	39.9	47.0	53.1	53.1	53.1	48.8	46.3	50.4
Electricity purchased									
millions kwh	3,243.3	3,540.2	4,213.5	4,585.9	6,292.9	5,163.7	5,193.9	5,083.6	5,375.9
$ millions...........	23.7	26.5	32.2	35.8	38.1	39.5	42.8	41.5	44.1
Total cost of fuel and electricity									
$ millions...........	60.7	66.4	79.2	88.9	91.2	92.6	91.6	87.8	94.5
Electricity generated for own use									
Millions kwh	426.2	486.9	557.7	590.0	526.7	550.9	575.4	581.4	637.5
Electricity generated for sale									
Millions kwh	18.8	47.1	12.0	14.2	15.8	17.0	32.9	29.0	31.5

*Excludes nonferrous smelting and refining. **Coal, coke, fuel oil, gasoline, gas, wood, etc.

TABLE 29

Cost of Fuel and Electricity Used in Nonferrous Smelting and Refining, 1954-62

	1954	1955	1956	1957	1958	1959	1960	1961	1962
Fuel*									
$ millions...........	24.8	24.3	29.9	27.3	23.4	26.3	26.9	27.2	24.8
Electricity purchased									
Millions kwh	12,690.2	13,803.7	13,981.4	13,668.2	15,081.2	14,574.6	18,224.7	5,389.1	6,154.0
$ millions...........	30.4	32.6	35.0	32.2	40.1	36.0	36.3	21.8	21.9
Total cost of fuel and electricity									
$ millions...........	55.2	56.9	64.9	59.5	63.5	62.3	63.2	49.0	46.7
Electricity generated for own use**									
Millions kwh	753.9	1,131.9	1,121.4	1,036.6	1,038.5	1,060.0	1,146.5	12,850.7	..
Electricity generated for sale									
Millions kwh	13.4	9.2	12.2	-	33.2	30.7	33.0	35.7	..

*Coal, coke, fuel oil, gasoline, gas, wood, etc. **Commencing in 1961 changes in statistical classifications account for decreases in electricity purchased and corresponding increases in electricity generated for own use.
.. Not available; - Nil.

TABLE 30

Employment, Salaries and Wages in the Canadian Mineral Industry, by Section, 1943-62

	1943		1948		1953		1958		1962**	
	Employees	$ Millions	Employees	$ Millions	Employees	$ Millions	Employees	$ Millions	Employees	$ Millions
Metal mining.............	37,575	80.0	41,890	115.2	51,711	191.4	61,999	289.6	59,317	310.2
Nonferrous smelting and refining	26,749	48.5	19,701	52.3	25,115	94.5	26,959	131.1	29,303	159.4
Industrial minerals	17,062	23.7	23,473	48.7	26,446	83.3	30,356	114.2	25,767	115.3
Fuels*..................	30,754	55.4	27,791	65.8	26,766	83.9	20,226	75.6	14,293	63.2
Total	112,140	207.6	112,855	282.0	130,038	453.1	139,540	610.5	128,680	648.1
Annual average of salaries and wages	$1,851		$2,499		$3,484		$4,375		$5,037	

*Coal, crude petroleum and natural gas, including natural gas processing after 1960. **Commencing in 1961 changes in statistical classifications account for decreases in electricity purchased and corresponding increases in electricity generated for own use.

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TABLE 31

Number of Wage Earners - Surface, Underground and Mill - Canadian Mining Industry*, by Sectors, 1954-62

	1954	1955	1956	1957	1958	1959	1960	1961	1962
Metallics**									
Surface	14,098	15,540	16,706	18,532	16,602	16,697	16,039	15,815	15,197
Underground	26,821	26,522	27,679	29,382	29,712	31,384	30,774	28,975	27,959
Mill	4,761	4,664	5,624	6,168	6,541	6,573	6,162	6,047	6,504
Total	45,680	46,726	50,009	54,082	52,855	54,654	52,975	50,837	49,660
Industrial Minerals									
Surface	11,826	12,204	12,804	14,347	14,029	13,988	10,321	9,485	9,656
Underground	1,659	1,632	1,798	1,749	1,458	1,327	1,164	995	951
Mill	10,825	11,445	12,163	11,573	11,216	11,639	10,741	10,511	10,770
Total	24,310	25,281	26,765	27,669	26,703	26,954	22,226	20,991	21,377
Fuels									
Surface	9,082	8,886	9,622	8,683	7,887	7,537	6,715	5,786	5,585
Underground	12,422	11,439	11,065	10,043	9,247	8,022	8,257	7,439	6,678
Mill	-	-	-	-	-	-	-	-	-
Total	21,504	20,325	20,687	18,726	17,134	15,559	14,972	13,225	12,263
Total									
Surface	35,006	36,630	39,132	41,562	38,518	38,222	33,075	31,086	30,438
Underground	40,902	39,593	40,542	41,174	40,417	40,733	40,195	37,409	35,588
Mill	15,586	16,109	17,787	17,741	17,757	18,212	16,903	16,558	17,274
Total	91,494	92,332	97,461	100,477	96,692	97,167	90,173	85,053	83,300

*Does not include nonferrous smelting and refining. **Includes placer operations. - Nil.

TABLE 32

Labour Costs in Relation to Tons Mined from Metal Mines*, 1943, 1953 and 1962

Types of Mines	Number of Wage Earners	Total of Wages ($ millions)	Average Annual Wage ($)	Tons Mined ('000 st)	Average Annual Tons Mined per Worker (st)	Wage Cost per Ton Mined ($)
1962						
Auriferous quartz......	13,370	54.2	4,054	13,660	1,022	3.97
Copper-gold-silver	9,290	43.7	4,704	17,745	1,910	2.46
Nickel-copper	11,906	63.5	5,333	17,970	1,509	3.53
Silver-cobalt**	520	2.1	4,038	235	452	8.94
Silver-lead-zinc	3,786	18.9	4,992	6,234	1,647	3.03
Iron ore	6,287	42.2	6,712	49,876	7,933	0.85
Miscellaneous metal mines	4,292	25.1	5,848	8,543	1,990	2.94
Total	49,451	249.7	5,049	114,263	2,311	2.19
1953						
Auriferous quartz......	16,815	52.1	3,100	15,247	907	3.42
Copper-gold-silver	6,346	22.4	3,529	7,438	1,172	2.71
Nickel-copper	10,598	42.4	3,997	15,004	1,416	3.28
Silver-cobalt**	649	1.9	2,955	269	414	7.13
Silver-lead-zinc	6,035	23.4	3,883	7,540	1,249	3.11
Miscellaneous metal mines***	5,117	20.0	3,905	8,935	1,746	4.35
Total	45,560	162.2	3,561	54,433	1,195	2.98
1943						
Auriferous quartz......	17,061	34.6	2,027	12,854	753	2.69
Copper-gold-silver	5,093	10.0	1,966	8,251	1,620	1.21
Nickel-copper	6,825	14.6	2,138	12,926	1,894	1.13
Silver-cobalt**	181	0.2	1,293	39	216	5.97
Silver-lead-zinc	2,690	5.5	2,039	3,253	1,209	1.69
Miscellaneous metal mines***	1,687	3.7	2,190	1,359	806	2.72
Total	33,537	68.6	2,045	38,682	1,153	1.77

*Excludes placer-mining operations. **In silver-cobalt mining operations considerable tonnages of old tailings were used. These tonnages are not included in this table.
***Includes iron-ore mines.

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TABLE 33

Man-Hours Worked and Tons of Ore Mined and Rock Quarried - Metal Mines and Industrial Mineral Operations 1954-62

	1954	1955	1956	1957	1958	1959	1960	1961	1962
Metal Mines*									
Ore Mined (millions st)	59.0	69.2	77.4	84.3	78.8	99.0	101.6	99.4	114.3
Man-hours Worked*** (millions)	111.8	116.6	126.4	135.7	133.6	133.3	130.5	124.9	124.4
Man-hours per Ton Mined (no.)	1.89	1.68	1.63	1.61	1.70	1.35	1.28	1.26	1.09
Industrial Mineral Operations**									
Ore Mined and Rock Quarried (millions st)	53.6	55.0	62.9	70.0	66.5	78.4	86.0	94.6	100.9
Man-hours Worked*** (millions)	30.0	31.7	32.7	32.2	29.3	29.3	27.4	26.9	27.2
Man-hours per Ton Mined (no.)	0.56	0.58	0.52	0.46	0.44	0.37	0.32	0.28	0.27

*Excludes placer mining. **Excludes salt, cement, clay products, stone for cement manufacture and stone produced for lime manufacture. ***Includes man-hours worked by all employees, surface, underground, mill and administration.

TABLE 34

Basic Wage Rates per Hour in Canadian Metal-Mining Industry on October 1, 1963

	Gold Mining ($)	Iron Mining ($)	Other Metal Mining ($)
Underground Workers			
Cage and shiptenders	1.58	..	2.27
Chute blaster	1.51	..	2.34
Deckman	1.48	..	2.05
Hoistman	1.69	..	2.44
Laborer	1.41	..	2.10
Miner	1.58	2.69	2.23
Miner's helper	1.44	2.35	1.86
Motorman	1.52	..	2.16
Mucking machine operator	1.49	..	2.24
Mucker and trammer	1.48	..	2.19
Timberman	1.58	..	2.31
Trackman	1.53	..	2.24
Open-pit Workers			
Blaster	...	2.51	..
Bulldozer operator	...	2.63	..
Driller, machine	...	2.62	..
Dump truck driver	...	2.73	..
Oiler	...	2.37	..
Shovel operator	...	2.99	..
Surface and Mill Workers			
Blacksmith	..	..	2.37
Carpenter, maintenance	1.71	2.82	2.31
Crusherman	1.52	2.40	2.19
Electrician	1.73	2.87	2.52
Filter operator	..	..	2.22
Flotation operator	..	..	2.16
Grinding-mill operator	..	2.49	2.20
Hoistman	..	2.44	..
Laborer	1.37	2.18	1.94
Machinist, maintenance	1.72	2.97	2.53
Mechanic, diesel	..	2.87	..
Mechanic, maintenance	1.66	2.77	2.41
Millman	1.57*	2.85	..
Pipefitter, maintenance	1.64	2.80	2.31
Solution man	..	..	2.41
Steel sharpener	1.60	..	2.26
Tradesman's helper	1.49	2.32	2.07
Truck driver, light and heavy	1.50	2.50	2.07
Welder, maintenance	1.70	2.80	2.48

*Includes filter operator, grinding-mill operator, (ball-mill operator, rod-mill operator, tubeman) and solution man.
Symbols: .. Not available; ... Not appropriate or not applicable.

TABLE 35

Average Weekly Wages and Hours of Hourly-Rated Employees in Canadian Mining, Manufacturing and Construction Industries, 1958-64

	1958	1959	1960	1961	1962	1963	1964
Mining							
Average hours per week	41.5	41.5	41.7	41.8	41.7	42.0	42.2
Average weekly wage	81.30	84.80	87.26	89.08	91.22	94.12	97.60
Metals							
Average hours per week	41.8	41.7	41.9	42.2	41.9	41.9	42.1
Average weekly wage	84.77	88.73	90.89	92.83	94.43	96.92	100.22
Fuels							
Average hours per week	40.0	39.9	40.6	40.3	40.7	42.2	42.1
Average weekly wage	75.12	77.11	80.13	80.98	85.63	89.58	92.68
Nonmetals							
Average hours per week	42.3	42.2	42.2	42.3	42.3	42.4	43.1
Average weekly wage	73.73	76.87	79.62	82.60	83.82	87.70	91.99
Manufacturing							
Average hours per week	40.2	40.7	40.4	40.6	40.7	40.8	41.0
Average weekly wage	66.77	70.16	71.96	74.27	76.55	79.40	82.88
Construction							
Average hours per week	40.7	40.2	40.4	40.3	40.3	40.8	40.7
Average weekly wage	72.36	74.20	78.36	79.93	83.16	87.51	91.80

TABLE 36

Average Weekly Wages of Hourly-Rated Employees in Canadian Mining Industry in Current and 1949 Dollars, 1958-64

	1958	1959	1960	1961	1962	1963	1964
Current Dollars							
All mining........	81.30	84.80	87.26	89.08	91.22	94.12	97.60
Metals	84.77	88.73	90.89	92.83	94.43	96.92	100.22
Gold............	68.09	68.95	70.81	73.34	75.76	77.38	80.28
Other...........	91.59	95.92	98.52	100.22	101.25	103.97	106.73
Fuels	75.12	77.11	80.13	80.98	85.63	89.58	92.68
Coal............	67.43	67.00	69.36	70.36	73.82	79.26	80.78
Oil and natural gas	89.20	92.74	96.57	95.66	102.35	105.83	110.18
Nonmetallics	73.73	76.87	79.62	82.60	83.82	87.70	91.99
1949 Dollars							
All mining........	64.99	67.04	68.17	68.95	69.79	70.77	72.08
Metals	67.76	70.14	71.01	71.85	72.25	72.87	74.02
Gold............	54.43	54.51	55.32	56.76	57.96	58.18	59.29
Other...........	73.21	75.83	76.97	77.57	77.47	78.17	78.83
Fuels	60.05	60.96	62.60	62.68	65.52	67.35	68.45
Coal............	53.90	52.96	54.20	54.46	56.48	59.59	59.66
Oil and natural gas	71.30	73.31	75.45	74.04	78.31	79.57	81.37
Nonmetallics	58.94	60.77	62.20	63.93	64.13	65.94	67.94

TABLE 37

Industrial Fatalities in Canada per Thousand Paid Workers in Main Industry Groups, 1952-1964

	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
Agriculture............	0.94	1.00	0.82	0.83	1.03	0.95	1.00	0.92	0.62	0.61	0.57	0.49	0.73
Logging (forestry)......	2.40	2.70	2.50	2.00	1.90	1.50	1.70	1.70	1.50	1.32	2.05	1.71	2.10
Fishing and trapping....	2.10	3.30	3.10	3.20	1.80	2.30	3.80	7.20	2.70	5.71	1.20	3.40	3.70
Mining*	2.30	2.00	2.00	1.60	2.10	1.50	2.20	2.00	1.92	1.75	1.91	2.15	1.85
Manufacturing	0.18	0.18	0.16	0.16	0.14	0.14	0.11	0.13	0.19	0.12	0.15	0.13	0.14
Construction...........	0.90	0.77	0.86	0.79	0.89	0.91	0.77	0.79	0.56	0.71	0.57	0.59	0.75
Public utilities.........	0.72	0.60	0.43	0.67	0.44	0.57	0.39	0.44	0.49	0.47	0.56	0.32	0.53e
Transportation, storage and communications...	0.62	0.46	0.53	0.56	0.56	0.50	0.40	0.44	0.37	0.38	0.39	0.40	0.38e
Trade.................	0.07	0.09	0.08	0.07	0.08	0.09	0.05	0.06	0.06	0.07	0.07	0.07	0.06
Finance	0.06	0.02	0.01	0.03	0.05	0.01	0.02	0.01	0.09	0.05	0.04	0.04	0.08
Service	0.12	0.09	0.08	0.07	0.06	0.07	0.07	0.06	0.07	0.06	0.08	0.08	0.07
Total...............	0.36	0.33	0.32	0.32	0.33	0.30	0.27	0.28	0.21	0.21	0.22	0.22	0.23

*Includes quarrying and oil-well drilling.

e Estimated in 1964 because of changes in standard industrial classification.

TABLE 38 Cost of Prospecting by Metal-Mining Industry,

	Placer Gold Operations	Gold Mines	Copper-Gold-Silver Mines
1962			
Newfoundland	-	13,000	499,436
Nova Scotia	-	4,379	77,152
New Brunswick	28,000	34,125	361,098
Quebec	32,100	2,158,699	5,055,025
Ontario	-	1,800,075	1,694,626
Manitoba	-	119,485	1,685,544
Saskatchewan	-	156,295	209,081
Alberta	1,400	467	-
British Columbia	3,445	377,016	2,957,805
Northwest Territories	-	159,979	330,956
Yukon Territory	35,890	171,745	482,685
Total, Canada	100,835	4,995,265	13,353,408
1961			
Newfoundland	-	7,794	588,297
Nova Scotia	-	12,997	184,268
New Brunswick	-	55,595	490,739
Quebec	52,134	1,300,112	7,450,734
Ontario	-	1,164,454	3,002,677
Manitoba	-	615,129	2,611,871
Saskatchewan	-	71,754	859,520
Alberta	3,209	-	892
British Columbia	11,771	263,003	2,666,130
Northwest Territories	-	162,483	248,158
Yukon Territory	32,370	10,099	263,862
Total, Canada	99,484	3,663,420	18,367,148

*Includes iron, uranium and molybdenum mining, etc.
- Nil.
Note: The amounts shown are the expenditures incurred by mining companies, as classified by their main type of metal-mining activity.

by Provinces and Types of Operations, 1961 and 1962 (dollars)

Silver-Cobalt Mines	Silver-Lead-Zinc Mines	Nickel-Copper Mines	Miscellaneous Metal Mines*	Total
-	535,779	606	136,230	1,185,051
-	86,543	297	124,655	293,026
-	162,842	-	58,567	644,632
-	6,725,228	1,542,879	1,100,316	16,614,247
47,553	353,178	3,840,373	1,672,100	9,407,905
-	58,563	3,309,538	201,567	5,374,697
-	68,622	267,005	52,211	753,214
-	161,000	-	39,000	201,867
-	985,502	835,968	1,029,958	6,189,694
-	163,144	603,729	230,395	1,488,203
-	206,887	20,000	720,398	1,637,605
47,553	9,507,288	10,420,395	5,365,397	43,790,141
-	476,305	-	484,443	1,556,839
-	48,404	-	28,119	273,788
1,307	125,817	-	261,738	935,196
12,016	5,101,504	1,771,332	3,135,387	18,823,219
77,743	107,419	2,544,031	800,749	7,697,073
4,886	20,000	3,812,959	44,254	7,109,099
-	8,920	329,047	44,150	1,313,391
-	10,655	-	10,000	24,756
6	696,468	4,650	352,319	3,994,347
-	294,337	365,527	213,601	1,284,106
-	161,926	-	5,000	473,257
95,958	7,051,755	8,827,546	5,379,760	43,485,071

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".

TABLE 39

Cost of Prospecting by Metal-Mining Industry in Canada, by Types of Operations, 1954-62
(dollars)

	Placer Gold Operations	Gold Mines	Copper-Gold-Silver Mines	Silver-Cobalt Mines	Silver-Lead-Zinc Mines	Nickel-Copper Mines	Miscellaneous Metal Mines*	Total
1954	35,240	3,399,755	3,188,890	24,733	6,843,897	6,785,804	6,536,916	26,815,235
1955	24,804	1,470,643	7,147,498	86,524	3,192,248	8,344,186	6,662,638	26,928,541
1956	31,620	4,264,955	18,315,885	111,102	3,571,201	13,310,337	8,795,159	48,400,259
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

*Includes iron, uranium, and molybdenum mining, etc.

Note: The amounts shown are the expenditures incurred by mining companies, as 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".

TABLE 40

Contract Diamond-Drilling Operations* in Canada, 1954-62

	Footage Drilled	Income from Drilling ($ millions)	Average Number of Employees	Total of Salaries and Wages ($ millions)
1954	5,639,574	15.9	2,352	7.8
1955	6,443,641	21.4	2,840	9.9
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

*Drilling operations conducted by contractors who employed diamond drills only, which were used chiefly in testing metalliferous deposits.

TABLE 41

Contract Drilling* in Canada for Oil and Gas 1954-62

	Footage Drilled				Gross Income from Drilling	Average Number of Employees	Total Salaries and Wages
	Rotary	Cable	Diamond	Total			
1954	9,609,140	457,480	-	10,066,620	58.8	4,559	18.1
1955	12,711,953	344,053	-	13,056,006	68.3	4,901	22.3
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

*Drilling done by contract-drilling companies only. Drilling by oil companies with their own equipment is not included.
- Nil.

TABLE 42

Ore Mined and Rock Quarried in the Canadian Mining Industry, 1961-62
(millions of short tons)

	1961	1962
Metallic ores		
Gold quartz	14.4	13.7
Copper-gold-silver	15.0	17.8
Silver-cobalt	0.2	0.2
Silver-lead-zinc	5.9	6.2
Nickel-copper	21.6	18.0
Iron	32.7	49.9
Miscellaneous	9.6	8.5
Total	99.4	114.3
Nonmetallics		
Asbestos	38.4	42.2
Feldspar and nepheline syenite	0.3	0.3
Quartz	0.9	1.1
Gypsum and anhydrite	5.1	5.4
Other*	2.3	3.2
Total	47.0	52.2
Structural materials		
Stone, all kinds**	48.9	50.5
Stone for manufacture of cement	8.2	9.3
Stone for manufacture of lime	2.6	2.7
Total	59.7	62.5
Total, ore mined and rock quarried	206.1	229.0

*Includes talc, salt, barite, fluorspar, mica mining, etc. **Exclusive of stone for the manufacture of cement and lime.

TABLE 43

Ore Mined and Rock Quarried in the Canadian Mining Industry,
at Five-Year Intervals, 1932-62
(millions of short tons)

	Metal Mines	Industrial-Mineral Operations	Total
1932	13.9	8.3	22.2
1937	28.0	17.8	45.8
1942	42.5	21.8	64.3
1947	33.3	30.5	63.8
1952	52.3	44.2	96.5
1957	84.4	82.1	166.5
1962	114.3	114.7	229.0

TABLE 44

Crude Minerals* Transported by Canadian Railways, 1963 and 1964

(millions of short tons)

	1963	1964p
Coal		
Anthracite	1.0	0.8
Bituminous	10.0	10.2
Petroleum, crude	0.4	0.5
Copper ore and concentrates	0.9	1.2
Iron ore and concentrates	27.7	35.8
Copper-nickel ore and concentrates	2.1	2.9
Aluminum ore and concentrates	1.9	2.3
All other ores and concentrates	3.8	4.8
Sand and gravel	6.5	7.1
Stone and rock	5.6	6.0
Asbestos	1.1	1.2
Gypsum, crude	4.8	4.9
Salt	1.2	1.3
All other crude minerals (chiefly industrial)	3.1	3.3
Total	70.1	82.3
All revenue freight moved by Canadian railways	171.7	198.3
Crude minerals as percentage of revenue freight total	40.8	41.5

Sources: Railway Transport, 1963 and Railway Freight Traffic, December, 1964.
*Both domestic and imported.
p Preliminary.

TABLE 45

Crude Minerals* Transported by Canadian Railways, 1955-64
(millions of short tons)

	Total of Revenue Freight	Total of Crude Minerals	Crude Minerals as % of Revenue Freight
1955	167.8	67.5	40.2
1956	189.6	75.7	39.9
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	171.7	70.1	40.8
1964p	198.3	82.3	41.5

*Both domestic and imported.
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TABLE 46

Primary Mineral Products* Transported by Canadian Railways, 1963 and 1964

(millions of short tons)

	1963	1964p
Aluminum bar, ingot, pig and slab	0.52	0.50
Copper, ingot and pig	0.51	0.34
Lead and zinc, bar, ingot and pig	0.46	0.52
Iron, pig	0.24	0.24
Iron and steel, billet, bloom and ingot	0.31	0.38
Coke	1.39	1.76
Asphalt	0.35	0.33
Total, primary mineral products	3.78	4.07
Total, all revenue freight	171.7	198.3
Primary mineral products as a percentage of all freight transported	2.2	2.1

Sources: Railway Transport, 1963 and Railway Freight Traffic, December, 1964.
*Both domestic and imported.
p Preliminary.

TABLE 47

Crude Minerals Transported Through Canadian Canals*, 1963 and 1964

(millions of cargo tons of 2,000 pounds)

	1963	1964p
Coal, bituminous	6.0	7.2
Petroleum, crude	0.2	0.1
Iron ore	20.8	28.9
Other metallic ores and concentrates	0.2	0.4
Clay and bentonite	0.3	0.3
Sand, gravel and crushed stone	1.2	1.3
Salt	0.6	0.7
Sulphur	0.2	0.2
Other crude materials, inedible	0.8	1.2
Total	30.3	40.3
Total freight traffic through Canadian Canals	74.6	93.3
Crude minerals as percentage of total freight traffic	40.6	43.2

Source: D.B.S. "Canal Statistics", 1964.
*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.
p Preliminary.

TABLE 51

Federal Income Tax Declared by Companies in Mining and Related Industries in Canada, Fiscal Year Ended March 31, 1962
($ millions)

Mining, Quarrying and Oil Wells	
Gold mining	3.4
Other metal mining	50.6
Coal mines	0.6
Oil and natural gas	11.6
Other nonmetal mines	12.1
Quarries	1.3
Prospecting and contract drilling	2.8
Total	82.4
Metallurgical and Metal-Fabricating Industries	
Iron and steel mills	32.0
Iron foundries	3.1
Metal smelting and refining	11.5
Boilers and fabricated structural material	1.6
Metal stamping, pressing and coating	8.2
Wire and wire products	3.8
Miscellaneous metal fabricating	5.6
Total	65.8
Nonmetallic Mineral Products	
Cement, clay and stone products	17.4
Glass and nonmetallic minerals	10.3
Fertilizers and industrial chemicals	13.9
Total	41.6
Petroleum and Products	
Petroleum refineries	39.7
Coal and petroleum products	7.1
Total	46.8
Total, mining and related industries	236.6
Total, all industries	1,363.3

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TABLE 52

Capital and Repair Expenditures of the Canadian Mining Industry

($000)

	1963			1964p			1965f		
	Capital	Repair	Total	Capital	Repair	Total	Capital	Repair	Total
Metals									
Gold mines................	7,524	9,382	16,906	5,841	8,776	14,617	3,966	7,855	11,821
Silver-lead-zinc	32,476	5,537	38,013	44,842	5,157	49,999	31,122	5,975	37,097
Uranium iron mines........	115,391	39,488	154,879	141,628	46,168	187,796	66,629	44,677	111,306
Other metal mines*	34,507	37,706	72,213	49,443	35,472	84,915	75,617	36,592	112,209
Total....................	189,898	92,113	282,011	241,754	95,573	337,327	177,334	95,099	272,433
Nonmetals									
Asbestos, gypsum, salt and other nonmetals	51,239	24,192	75,431	61,575	20,547	82,122	56,427	20,944	77,371
Quarries and sand pits	8,268	10,917	19,185	11,374	10,962	22,336	6,165	10,567	16,732
Total....................	59,507	35,109	94,616	72,949	31,509	104,458	62,592	31,511	94,103
Fuels									
Coal......................	2,423	4,231	6,654	5,006	4,307	9,313	4,117	5,308	9,425
Petroleum and natural gas ..	216,180	21,252	237,432	267,818	23,990	291,808	287,034	22,662	309,696
Natural gas processing	53,628	4,037	57,665	45,511	5,246	50,757	33,893	5,153	39,046
Total....................	272,231	29,520	301,751	318,335	33,543	351,878	325,044	33,123	358,167
Total mining industry	521,636	156,742	678,378	633,038	160,625	793,663	564,970	159,733	724,703

*Includes copper-gold-silver, nickel-copper and silver-cobalt mines.
Symbols: f Forecast; p Preliminary.

TABLE 53

Capital Investment in the Canadian Petroleum and Natural Gas Industries (a)

(millions of dollars)

									Capital Investment in Canada	
Year	Exploration	Development and Production	Oil Pipelines	Gas Transmission Pipelines	Gas Processing	Petroleum Refining	Marketing Oil (c)	Gas (d)	Petroleum and Natural Gas Industry	All Industries
1947	(b)	9.5	2.6	-	-	25.7	14.9	2.5	55.2	2,440
1948	(b)	37.3	4.3	-	-	32.6	9.7	3.8	87.7	3,087
1949	(b)	45.0	7.7	-	-	21.6	11.3	4.3	89.9	3,539
1950	(b)	53.9	55.0	-	-	24.1	16.7	6.6	156.3	3,936
1951	(b)	72.1	10.7	-	-	50.9	18.1	6.8	158.6	4,739
1952	59.8	101.6	91.9	2.7	1.3	60.5	25.0	6.4	349.1	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	9.3	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	94.9	63.6	79.4	760.3	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	568.0	8,262
1961	47.7	182.4	49.3	115.5	76.6	31.2	56.0	59.3	618.0	8,172
1962	53.9	182.7	20.8	51.4	21.8	64.8	47.7	69.3	512.4	8,715
1963	58.9	216.2	26.0	81.9	53.6	44.2	53.0	84.1	617.9	9,393
1964p	56.0	267.8	24.4	142.0	45.5	22.9	52.8	67.5	678.9	10,827
1965f	52.9	287.0	28.8	55.2	33.9	43.2	63.2	67.9	632.1	12,305

(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 52 to 56 inclusive 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 chiefly includes outlets reported by major companies. (d) Capital expenditures in gas marketing are on gas-distribution pipelines.

Symbols: f Forecast; - Nil; p Preliminary.

TABLE 54

Ownership and Control of Canadian Mineral Industry Year-End 1961 and 1962

	1961		1962	
	$ million	%	$ million	%
Mining				
Estimated total investment	2,428	100.0	2,590	100.0
Owned in: Canada	870	35.8	895	34.6
United States	1,400	57.7	1,532	59.2
Britain	86	3.5	95	3.7
Other countries	72	3.0	66	2.5
Petroleum and Natural Gas*				
Estimated total investment	6,428r	100.0	6,800r	100.0
Owned in: Canada	2,399r	37.3	2,526r	37.1
United States	3,444	53.6	3,547	52.2
Britain	296	4.6	355	5.2
Other countries	289	4.5	372r	5.5
Nonferrous Smelting and Refining				
Estimated total investment	968	100.0	1,042	100.0
Owned in: Canada	432	44.6	465	44.6
United States	421	43.5	436	41.8
Britain	62	6.4	89	8.6
Other countries	53	5.5	52	5.0

r Revised from previously published figure.
*Data apply only to companies whose main revenues are derived from oil and gas activities.

TABLE 55

Estimated Book Value, Ownership and Control of Capital Employed in Selected Canadian Industries Year-End 1960-62

	1960	1961 ($ billions)	1962
Total Capital Employed			
Manufacturing	12.2	12.7	13.1
Petroleum and natural gas*	6.1	6.4r	6.8r
Other mining and smelting	3.3	3.4	3.6
Railways	5.3	5.4	5.4
Other utilities	9.2	10.3	10.6
Merchandising and construction	9.4	9.4r	9.5
Total	45.6	47.6r	49.0
Resident Owned Capital			
Manufacturing	5.8	5.9	6.0
Petroleum and natural gas*	2.3	2.4r	2.5
Other mining and smelting	1.3	1.3	1.4
Railways	3.9	4.0	4.1
Other utilities	7.9	9.0	9.2
Merchandising and construction	8.5	8.5r	8.6
Total	29.9	31.1r	31.8
Non-resident Owned Capital			
Manufacturing	6.4	6.8	7.1
Petroleum and natural gas*	3.7	4.0	4.3
Other mining and smelting	2.0	2.1	2.3
Railways	1.4	1.4	1.3
Other utilities	1.3	1.3	1.4
Merchandising and construction	0.9	0.9	1.0
Total	15.7	16.5	17.2

*The investment data under "Petroleum and natural gas" apply only to companies whose main revenue is derived from oil and gas activities.
Note: Owing to rounding, figures do not add to totals in all cases.
r Revised from previously published figure.

TABLE 56
Foreign Capital Invested in the Canadian Mineral Industry,
Selected Years (End of Year) 1930-62
($ millions)

	Owned by All Non-residents		Owned by United States Residents	
	Mining and smelting	Petroleum and natural gas*	Mining and smelting	Petroleum and natural gas*
1930	311	150	234	147
1945	359	157	280	149
1955	1,121	1,854	975	1,716
1956	1,330	2,275	1,129	2,063
1957	1,570	2,849	1,307	2,570
1958	1,657	3,187	1,386	2,866
1959	1,783	3,455	1,513	3,108
1960	1,977	3,727	1,701	3,184
1961	2,094	4,029	1,821	3,444
1962	2,270	4,275	1,968	3,547

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

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